ARIANNE PHOSPHATE INC.

Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada

NI 43-101 Technical Report

N/D: 207090-19468-0000-GE-REP-0001
REVISION NO. 0

Effective Date: October 24, 2013
Issue Date: November 13, 2013

Prepared by

Cegertec WorleyParsons
WorleyParsons resources & energy
Hydro-Ressources Inc. Hydrogéologie et Environnement
LVM
GoldMinds Géoservices
SGS
Phosphate Consulting LLC Specialists in Phosphate Project Development
EY
Nardella
GENIVAR

SYNOPSIS

This document presents the NI 43-101 Technical Report for the *Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada*.

Disclaimer

This report has been prepared on behalf of and for the exclusive use of Arianne Phosphate Inc., and is subject to and issued in accordance with the agreement between Arianne Phosphate Inc. and Cegertec WorleyParsons. Cegertec WorleyParsons accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

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PROJECT 207090-19468-0000-GE-REP-0001 Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada

Rev.	Description	Orig	Review	Approval	Date	Customer Approval	Date
0	Final Version for QP Certification	Jean Bilodeau, eng.	EWingate Ewan Wingate [SIGNED] Henry J. Lamb, PCLLC	Yann Franck Pascal Vallee, eng.	2013-11-13	Jean-Sebastien David	2013-11-13

DATE AND SIGNATURE PAGE – CERTIFICATES OF QUALIFIED PERSONS

Effective Date: October 24, 2013

Issue Date: November 13, 2013

L.Nardella Associates Ltd
2292, boulevard Industriel, bureau 207
Laval, Qc, Canada, H7S 1P9
Telephone: 450-967-1000 ext.222, Fax: 450-967-4445
fcote@nardellagroup.com

Certificate of Qualified Person

To Accompany the Report entitled:

"Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada" dated November 13, 2013 with effective date of October 24, 2013.

I, Frédéric Côté, Engineer, do hereby certify that:

1) I am currently employed as Project Manager with L.Nardella Associated Ltd in an office located at 2292, boulevard Industriel, bureau 207, Laval (Québec), Canada, H7S 1P9;
2) I graduated from École Polytechnique de Montréal, Université de Montréal, Bachelor's in Mechanical Engineering in 1998;
3) I am a member in good standing of the Ordre des ingénieurs du Québec (OIQ), registration number 121372;
4) I have practiced my profession for 15 years since my graduation;
5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that as a result of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience that includes 12 years as consulting engineer and 3 years as project /construction manager for mining industry from which I cumulated over 10 years in capital cost estimation/preparation/review for capital investment projects, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;
6) I have participated in the preparation of the report entitled "Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada" November 13, 2013 and I am responsible for Sections 21.1, 25.8 and co-Author of Section 1.12;
7) I have not visited the site;
8) I have not had prior involvement with Arianne Phosphate Inc. and its Feasibility Study - Lac a Paul Project and property that is the subject of the Technical Report;
9) I am independent of the issuer as defined in Section 1.5 of NI 43-101;
10) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form; and
11) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

[SIGNED AND/OR SEALED]

Frédéric Côté. Eng.
Project Manager
L.Nardella Associated Ltd
FC/al

Claude Duplessis
Engineer

GoldMinds Geoservices Inc.
2999 Chemin Sainte-Foy, suite 200
Québec, Qc Canada G1X 1P7
Telephone: 418-653-9559 ext.202, Fax: 418-650-0880
goldminds.geoservices@gmail.com
c.duplessis@goldmindsgeoservices.com

Certificate of Qualified Person

To Accompany the Report entitled:

“Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” dated November 13, 2013 with effective date of October 24, 2013.

I, Claude Duplessis, Engineer, do hereby certify that:

1) I am currently employed as Sr. Engineer with GoldMinds Geoservices Inc. in an office located at 2999 Chemin Sainte-Foy, suite 200, Québec, Qc Canada G1X 1P7;

2) I graduated from UQAC, Chicoutimi, Qc, Canada, B.Sc. in Geological Engineering in 1988;

3) I am a member in good standing of the Ordre des ingénieurs du Québec (OIQ), registration number 45523; Association of Professional Engineers and Geoscientists of Alberta (APEGA), registration number 77963; Professional Engineers and Geoscientists of Newfoundland & Labrador (PEGNL), registration number 6981;

4) I have practiced my profession for 25 years since I graduated;

5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that as a result of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience that includes over 20 years of consulting in the field of Mineral Resource estimation, ore body modelling, mineral resource auditing and geotechnical engineering, I fulfil the requirements to be a “qualified person” for the purposes of NI 43-101;

6) I have participated in the preparation of the report entitled “Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” November 13, 2013 and I am responsible for Sections 1.2, 1.3, 1.5, 4, 5 ,6, 7, 8, 9, 10, 11, 12, 14, 23, 24.2, 25.1, 25.2, 26.1 and co-Author of Sections 1.10, 1.14, 1.16, 19, 25.7;

7) I have visited the site on August 22 and 23, 2008; on November 12 to 14, 2008; on February 1 to 4, 2009; on February 14 to 17, 2011; on February 7, 2012 and from 12 to 15 of Nov 2012 meeting in Chicoutimi with site visit;

8) I have had prior involvement with Arianne Phosphate Inc. and its Feasibility Study - Lac a Paul Project and property that is the subject of the Technical Report as I have been doing the independent QP for the mineral resources of the Lac a Paul project since 2008;

9) I am independent of the issuer as defined in Section 1.5 of NI 43-101;

10) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form; and

11) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

[SIGNED AND/OR SEALED]

Claude Duplessis
Sr. Engineer
GoldMinds Geoservices Inc.
CD/al

Gaston Gagnon
Mining Engineer

SGS Geostat
10 boul. de la Seigneurie Est, Suite 203
Blainville, Qc Canada, J7C 3V5
Telephone: 450-433-1050, Fax: 450- 433-1048
gaston.gagnon@sgs.com

Certificate of Qualified Person

To Accompany the Report entitled:

“Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” dated November 13, 2013 with effective date of October 24, 2013.

I, Gaston Gagnon, Mining Engineer, do hereby certify that:

1) I am currently employed as Sr. Mining Engineer with SGS Geostat in an office located at 10 boul. de la Seigneurie Est, Suite 203, Blainville, Qc Canada, J7C 3V5;
2) I graduated from Laval University, Québec, Canada, Bachelor’s in Mining Engineering in 1964;
3) I am a member in good standing of the Ordre des ingénieurs du Québec (OIQ), registration number 15918;
4) I have practiced my profession for 49 years since I graduated;
5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that as a result of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience that includes 21 years in base and precious metals mining in Canada, 6 years in mining overseas, 5 years of technical mining assistance in Canada and overseas, 17 years in mining for consulting engineering firms, I fulfil the requirements to be a “qualified person” for the purposes of NI 43-101;
6) I have participated in the preparation of the report entitled “Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” November 13, 2013 and I am responsible for Sections 1.13, 22 and 25.9;
7) I have not visited the site;
8) I have not had prior involvement with Arianne Phosphate Inc. and its Feasibility Study - Lac a Paul Project and property that is the subject of the Technical Report;
9) I am independent of the issuer as defined in Section 1.5 of NI 43-101;
10) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form; and
11) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

[SIGNED AND/OR SEALED]

Gaston Gagnon
Sr. Mining Engineer
SGS Geostat

Hubert Guimont
Engineer

LVM
1200, boulevard Saint-Martin Ouest, Bureau 300
Laval, Qc, Canada, H7S 2E4
Telephone: 514-281-5173, ext. 2392, Fax: 450-668-5519
hubert.guimont@lvm.ca

Certificate of Qualified Person

To Accompany the Report entitled:

“Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” dated November 13, 2013 with effective date of October 24, 2013.

I, Hubert Guimont, Engineer, do hereby certify that:

1) I am currently employed as Project Manager with LVM in an office located at 1200, boulevard Saint-Martin Ouest, Bureau 300, Laval, Qc, Canada, H7S 2E4;
2) I graduated from University Laval, Québec, Canada, Bachelor’s in Geological Engineering in 2003;
3) I am a member in good standing of the Ordre des ingénieurs du Québec (OIQ), registration number 142878;
4) I have practiced my profession for 9 years since I graduated;
5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that as a result of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience that includes 9 years in Geotechnical and Geoenvironmental Engineering, I fulfil the requirements to be a “qualified person” for the purposes of NI 43-101;
6) I have participated in the preparation of the report entitled “Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” November 13, 2013 and I am responsible for Sections 18.2.1, 18.2.2, 26.4 and co-Author of Sections 1.9, 1.16 and 25.6;
7) I have not visited the site;
8) I have not had prior involvement with Arianne Phosphate Inc. and its Feasibility Study - Lac a Paul Project and property that is the subject of the Technical Report;
9) I am independent of the issuer as defined in Section 1.5 of NI 43-101;
10) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form; and
11) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

<u>**[SIGNED AND/OR SEALED]**</u>

Hubert Guimont
Project Manager
LVM
HG/al

Michael E. Kelahan
Metallurgical Engineer

Phosphate Consulting LLC
6749 Crescent Woods Cir., Lakeland
Florida 33813, USA
Telephone: 863 529-3678, Fax: none
mkelahan@phosphateconsulting LLC

Certificate of Qualified Person

To Accompany the Report entitled:

“Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” dated November 13, 2013 with effective date of October 24, 2013.

I, Michael E. Kelahan , Metallurgical Engineer, do hereby certify that:

1) I am currently employed as Owner of Phosphate Consulting LLC in an office located at 6749 Crescent Woods Circle, Lakeland, Florida 33813;
2) I graduated from the University of Missouri at Rolla, BS Metallurgical Engineering, 1969 and also from the University of Utah, MS Metallurgical Engineering, 1971;
3) I am a member in good standing of the Mining and Metallurgical Society of America (MMSA), registration number 01446QP;
4) I have practiced my profession for 42 years in phosphate beneficiation worldwide since I graduated;
5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that as a result of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience that includes over 24 years of phosphoric acid pilot plant design and testing activities and for the last 28 years, managing or acting as the process lead on over 50 phosphate feasibility studies, I fulfil the requirements to be a “qualified person” for the purposes of NI 43-101;
6) I have participated in the preparation of the report entitled “Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” November 13, 2013 and I am responsible for Sections 1.4, 13, 25.5, 26.3 and co-Author of Section 1.16;
7) I have visited the site on September 20, 2012;
8) I have not had prior involvement with Arianne Phosphate Inc. and its Feasibility Study - Lac a Paul Project and property that is the subject of the Technical Report;
9) I am independent of the issuer as defined in Section 1.5 of NI 43-101;
10) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form; and
11) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

[SIGNED AND/OR SEALED]

Michael E. Kelahan

President
Phosphate Consulting LLC
MEK/al

Simon Latulippe
Engineer

GENIVAR inc.
5355, des Gradins blvd
Québec, Qc, Canada, G2J 1C8
Telephone: 418-623-2254 ext. 4147, Fax: 418-623-2434
simon.latulippe@genivar.com

Certificate of Qualified Person

To Accompany the Report entitled:

"Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada" dated November 13, 2013 with effective date of October 24, 2013.

I, Simon Latulippe, Engineer, do hereby certify that:

1) I am currently employed as Project Manager with GENIVAR inc. in an office located at 5355, des Gradins blvd, Québec, Qc, Canada, G2J 1C8;
2) I graduated from Laval University, Québec, Canada, Bachelor's in Geological Engineering in 1998;
3) I am a member in good standing of the Ordre des ingénieurs du Québec (OIQ), registration number 121692;
4) I have practiced my profession for 15 years since I graduated;
5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that as a result of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience that includes 2 years as mining geological engineer, 5 years as soil and groundwater studies and site reclamation, 8 years as Tailings and water management specialist in mining industry, I fulfil the requirements to be a "qualified person" for the purposes of NI 43-101;
6) I have participated in the preparation of the report entitled "Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada" November 13, 2013 and I am responsible for Sections 1.11, 18.2.4, 20, 26.6 and co-Author of Sections 1.9, 1.16, 25.6;
7) I have not visited the site;
8) I have not had prior involvement with Arianne Phosphate Inc. and its Feasibility Study - Lac a Paul Project and property that is the subject of the Technical Report;
9) I am independent of the issuer as defined in Section 1.5 of NI 43-101;
10) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form; and
11) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

[SIGNED AND/OR SEALED]

Simon Latulippe
Project Manager
GENIVAR inc.
SL/al

Alex Topalovic
Mining Engineer

WorleyParsons Canada Services Ltd
Suite 600, 4321 Still Creek Drive
Burnaby, BC, Canada, V5C 6S7
Telephone: +1 778 945 5470, Fax: +1 604 298 1625
alex.topalovic@worleyparsons.com

Certificate of Qualified Person

To Accompany the Report entitled:

"Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada" dated November 13, 2013 with effective date of October 24, 2013.

I, Alex Topalovic, Mining Engineer, do hereby certify that:

1) I am currently employed as Manager Mining with WorleyParsons Canada Services Ltd. in an office located at Suite 600, 4321 Still Creek Drive, Burnaby, BC, Canada, V5C 6S7;
2) I graduated from University Of Belgrade, Serbia with a Bachelor of Science (Mining Engineering) in 2000;
3) I am a Chartered Professional member in good standing of the Australasian Institute of Mining and Metallurgy (AusIMM), registration number 212032;
4) I have practiced my profession continuously since graduation;
5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that as a result of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience related to open pit mine planning and design experience, I fulfil the requirements to be a "qualified person" for the purposes of NI 43-101;
6) I have participated in the preparation of the report entitled "Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada" November 13, 2013 and I am responsible for Sections 1.6, 1.7, 15, 16.1 to 16.5, 16.7, 25.3, 25.4, 26.2 and co-Author of Section 1.16. I relied on technical data and results provided by Amanda Fitch (P.Eng, Ing.) and John Cairns (P.Eng) whom I supervised during the preparation of this report;
7) I have visited the site on September 20, 2012;
8) I have not had prior involvement with Arianne Phosphate Inc. and its Feasibility Study - Lac a Paul Project and property that is the subject of the Technical Report;
9) I am independent of the issuer as defined in Section 1.5 of NI 43-101;
10) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form; and
11) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

[SIGNED AND/OR SEALED]

Alex Topalovic, CP (Mining)
Manager Mining
WorleyParsons Canada Services Ltd
AT/al

Benoît Turgeon
Engineer

Cegertec WorleyParsons
255 rue Racine Chicoutimi, Qc, Canada, G7H 5C2
Telephone: 418-549-6680, Fax: 418-549-7105
benoit.turgeon@cegertecworleyparsons.com

Certificate of Qualified Person

To Accompany the Report entitled:

"Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada" dated November 13, 2013 with effective date of October 24, 2013.

I, Benoît Turgeon, Engineer, do hereby certify that:

1) I am currently employed as Engineering Manager with Cegertec WorleyParsons in an office located at 255 rue Racine Chicoutimi, Qc, Canada, G7H 5C2;
2) I graduated from UQAC, Chicoutimi, Qc, Canada, Bachelor's in Génie Unifié in 1995;
3) I am a member in good standing of the Ordre des ingénieurs du Québec (OIQ), registration number 116019;
4) I have practiced my profession for 18 years since my graduation;
5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that as a result of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience that includes 13 years as a consulting engineer and 5 years resident engineer for Hydro-Québec, I fulfil the requirements to be a "qualified person" for the purposes of NI 43-101;
6) I have participated in the preparation of the report entitled "Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada" November 13, 2013 and I am responsible for Sections 18.1.1, 18.1.2, 18.2.5 to 18.2.9 and co-Author of Sections 1.9, 1.16, 25.6, 26.5;
7) I have not visited the site;
8) I have not had prior involvement with Arianne Phosphate Inc. and its Feasibility Study - Lac a Paul Project and property that is the subject of the Technical Report;
9) I am independent of the issuer as defined in Section 1.5 of NI 43-101;
10) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form; and
11) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

[SIGNED AND/OR SEALED]

Benoît Turgeon. Eng.
Engineering Manager
Cegertec WorleyParsons
BT/al

Pascal Vallée
Engineer

Cegertec WorleyParsons
255 rue Racine Chicoutimi, Qc, Canada, G7H 5C2
Telephone: 514-895-5116, Fax: 450-708-1677
pascal.vallee@cegertecworleyparsons.com

Certificate of Qualified Person

To Accompany the Report entitled:

"Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada" dated November 13, 2013 with effective date of October 24, 2013.

I, Pascal Vallée, Engineer, do hereby certify that:

1) I am currently employed as Project Manager with Cegertec WorleyParsons in an office located at 255 rue Racine Chicoutimi, Qc, Canada, G7H 5C2;
2) I graduated from UQAC, Chicoutimi, Qc, Canada, Bachelor's in Génie Unifié in 1993;
3) I am a member in good standing of the Ordre des ingénieurs du Québec (OIQ), registration number 112891;
4) I have practiced my profession for 19 years in the mining industry since I graduated;
5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that as a result of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience that includes 5 years in major iron-ore project management, 5 years in mobile equipment maintenance and 9 years in production equipment maintenance, I fulfil the requirements to be a "qualified person" for the purposes of NI 43-101;
6) I have participated in the preparation of the report entitled "Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada" November 13, 2013 and I am responsible for Sections 18.1.3, 21.2 and Co-Author of Sections 1.12, 1.16, 25.8, 26.5;
7) I have not visited the site;
8) I have not had prior involvement with Arianne Phosphate Inc. and its Feasibility Study - Lac a Paul Project and property that is the subject of the Technical Report;
9) I am independent of the issuer as defined in Section 1.5 of NI 43-101;
10) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form; and
11) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

[SIGNED AND/OR SEALED]

Pascal Vallée
Project Manager
Cegertec WorleyParsons
PV/al

Michael Verreault
Hydrogeologist – Engineer
Hydro-Ressources Inc
1043, des Mésenges
St-Rédempteur, Qc, Canada G6K 1V5
Telephone: 418-590-2877, Fax: none
mv@hydroressources.com

Certificate of Qualified Person

To Accompany the Report entitled:

“Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” dated November 13, 2013 with effective date of October 24, 2013.

I, Michael Verreault, Hydrogeologist Engineer and Owner, do hereby certify that:

1) I am currently employed as President of Hydro-Ressources Inc in an office located at 1043, des Mésenges, St-Rédempteur, Qc, Canada G6K 1V5;
2) I graduated from UQAC, Chicoutimi, Qc, Canada, MS - Applied Science (Hydrogeology) in 2003;
3) I am a member in good standing of the Ordre des ingénieurs du Québec (OIQ), registration number 125243;
4) I have practiced my profession for 14 years since I graduated;
5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that as a result of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience that includes over 14 years in hydrogeology including 6 years in mining hydrogeology, I fulfil the requirements to be a “qualified person” for the purposes of NI 43-101;
6) I have participated in the preparation of the report entitled “Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” November 13, 2013 and I am responsible for Sections 16.6 and 18.2.3;
7) I have visited the site 7 times in 2012;
8) I have not had prior involvement with Arianne Phosphate Inc. and its Feasibility Study - Lac a Paul Project and property that is the subject of the Technical Report;
9) I am independent of the issuer as defined in Section 1.5 of NI 43-101;
10) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form; and
11) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

[SIGNED AND/OR SEALED]

Michael Verreault
President
Hydro-Ressources Inc
MV/al

Ewan Wingate
Process Engineer (Metallurgist)
WorleyParsons
Level 12, 333 Collins Street
Melbourne, Victoria, 3000, Australia
Telephone: + 613 8676 3044, Fax: +613 8676 5301
ewan.wingate@worleyparsons.com

Certificate of Qualified Person

To Accompany the Report entitled:

“Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” dated November 13, 2013 with effective date of October 24, 2013.

I, Ewan Wingate, Process Engineer, do hereby certify that:

1) I am currently employed as Principal Process Engineer (Metallurgist) with WorleyParsons in an office located at Level 12, 333 Collins Street , Melbourne, Victoria, 3000, Australia;
2) I graduated from Technikon Witwatersrand, Johannesburg, South Africa with a Higher National Diploma – Extractive Metallurgy in 1993;
3) I am a Chartered Professional member in good standing of the MAusimm(CP - Metallurgy) registration number 302064 and FSAIMM registration number 700672;
4) I have practiced my profession for 21 years since I graduated;
5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that as a result of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience that includes 12 years mining and mineral processing operations and 8 years in engineering mainly in minerals and base metal concentrator design, I fulfil the requirements to be a “qualified person” for the purposes of NI 43-101;
6) I have participated in the preparation of the report entitled “Feasibility Study to Produce 3Mtpy of High Purity Apatite Concentrate at the Lac a Paul Project, Québec, Canada” November 13, 2013 and I am responsible for Sections 1.1, 1.8, 1.15, 2, 3, 17, 24.1, 27 and Co-Author of Sections 1.10, 1.14, 1.16, 19, 25.7;
7) I have visited the site on September 20, 2012;
8) I have not had prior involvement with Arianne Phosphate Inc. and its Feasibility Study - Lac a Paul Project and property that is the subject of the Technical Report;
9) I am independent of the issuer as defined in Section 1.5 of NI 43-101;
10) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form; and
11) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

[SIGNED AND/OR SEALED]

Ewan Wingate
Principal Process Engineer
WorleyParsons
EW/al

List of Abbreviations

Description	Abbreviation
Abrasion Index	Ai
Acid Rock Drainage	ARD
Below Penalty Level	BPL
Billion	B
Bureau d'Audiences Publiques sur l'Environnement (Environment Public Hearing Board)	BAPE
Canadian dollar	CAD$
Canadian Environmental Assessment Act	CEAA
Canadian Environmental Protection Act	CEPA
Capital Expenditures	CAPEX
Certificate of Authorization	CofA
Chinese Yuan Currency	CNY
Coarse Ore Silo	COS
Cubic meter	m^3
Cubic meter per hour	m^3/h
Cut-Off Grade	COG
Di-Ammonium Phosphate	DAP
Di-Calcium Phosphate	DCP
Engineering Procurement and Construction Management	EPCM
Entente de Principe d'Ordre Général (Agreement in Principle of General Nature)	EPOG
Environmental Impact Assessment	EIA
Environmental Impact Statement	EIS
Environmental Quality Act	EQA
Feasibility Study	FS
Feet	ft
Fond Minier du Saguenay-Lac St-Jean (Mining Fund for the Saguenay-Lac St-Jean Area)	FMSLSJ
Free On Board	FOB
Grams	g
General and Administration	G & A
Gestion des Titres Miniers (Mining Claims Management)	GESTIM
Greenhouse Gas	GHG
Global Positioning System	GPS
Gross Combined Weight	GCW
Government of Québec	GQ
Gram per liter	g/L
Grams	g
Grams/tonne or parts per million	g/t or ppm

Description	Abbreviation
Hectare	ha
High Grade	HG
Horsepower	hp
Inches	in
Internal Return Rate	IRR
Job Efficiency Factor	JEF
Kilogram per liter	kg/L
Kilograms	kg
Kilometers	km
Kilovolt	kV
Kilowatt	kW
Kilowatt per hour per tonne	kWh/t
Life of Mine	LOM
Light Radar or Laser Radar (for terrestrial surveys)	LIDAR or LiDAR
Liter per hour	L/h
Low Intensity Magnetic Separation	LIMS
Measured and Indicated	M&I
Medium Grade	MG
Megawatt	MW
Megawatt per hour per day	MWh/d
Metal Leaching	ML
Metal Mining Effluent Regulation	MMER
Meters	m
Metric tonnes	tonnes, T or t
Microns	µm
Milligram per liter	mg/L
Million of cubic meter	Mm^3
Millions of metric tonnes	Mt
Millions of metric tonnes per year	Mtpy
Mineral Liberation Analyzer	MLA
Ministère Développement Durable, Environnement, Faune et Parcs (Ministry of Sustainable Development, Environment, Wildlife and Parks)	MDDEFP
Ministry of Natural Resources	MNR
Ministère des Ressources Naturelles (Ministry of Natural Resources)	MRN
Minor Element Ratio	MER
Mono-Ammonium Phosphate	MAP
National Instrument 43-101	NI 43-101
Net Present Value	NPV
Net Productive Operating Hours	NPOH

Description	Abbreviation
Net Smelter Return	NSR
Operating Expenses	OPEX
Particle Size Distribution	PSD
Parts per million, parts per billion	ppm, ppb
Preliminary Feasibility Study	PFS
Preliminary Economic Assessment	PEA
Preventative Maintenance	PM
Qualified Person	QP
Quality Assurance Quality Control	QA/QC
Regional County Municipality	RCM
Request For Quotation	RFQ
Revenue Factor.	RF
Revised Statutes of Quebec	RSQ
Rock Quality Designation	RQD
Run of Mine	ROM
Semi-Autogenous Grinding	SAG
Société Québécoise d’Exploration Minière (Quebec Society for Mining Exploration)	SOQUEM
Specific gravity	SG
Square meter	m^2
Stripping ratio	SR
Suite Anorthositique du Lac Saint-Jean (Lac St-Jean Anorthositic Complex)	SALSJ
Système National de Références Cartographiques (National Topographic System)	SNRC or NTS
Tailings Storage Facility	TSF
Tonnes Metric	tonnes, T or t
Tonnes per cubic meter	t/m^3
Tonnes per day	tpd
Tonnes per hour	tph
Tonnes per month	tpm
Tonnes per year	Tpy, tpa
Tri-Sodium Phosphate	TSP
Unité de Recherche et de Service en Technologie Minérale (Research and Service Unit in Mineral Technology)	URSTM
US dollar	$USD or $US
Volt	V
Work Breakdown Structure	WBS
X-Ray Fluorescence	XRF

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1. SUMMARY

1.1 Introduction

Arianne Phosphate Inc. (Arianne) is a Quebec based phosphate mineral resources development company. It is listed on the Toronto Stock Exchange (TSX VENTURE: DAN) and the Frankfurt Stock Exchange (FRANKFURT: JE9N) (OTCBB: DRRSF).

In 2012, Arianne commissioned Cegertec WorleyParsons to provide an independent Qualified Person's (QP) review and National Instrument (NI) 43-101 Technical Report for the Lac a Paul Phosphate Rock Project.

The study was prepared by Cegertec WorleyParsons with contributions from Dessau for tailings storage, impoundment and water management, Goldminds Geoservices Inc. for resource estimates and Ernst & Young for financial modelling and economic analysis. Additional technical elements of the study have been authored by Genivar, Phosphate Consulting LLC, Hydro-Ressources Inc., Journeaux Associates, URSTM, Jenike&Johanson, Outotec, FLSmidth, CRU International and Integer Research Ltd. A Mineral Resource has been certified by Goldminds Geoservices Inc. based on the National Instrument ("NI") 43-101 compliant Mineral Resource authored by Goldminds Geoservices Inc. and published by Arianne on March 7, 2013. Jacobs Engineering Group Inc. (Jacobs) and COREM have conducted the metallurgical test work including pilot test work for the process design. L. Nardella Associates Ltd also supported Cegertec WorleyParsons in cost estimating and project execution planning. In addition to the above mentioned contributors, SGS Canada certified the economic analysis.

The Project is based on the extraction and processing of a high-grade phosphate ore to produce a high purity apatite concentrate. The associated metallurgical waste will be stored in a purpose-built tailings storage facility located near the mine. The Project is anticipated to process a nominal 18.6 million tpa of ore and produce on average 3 million tpa of phosphate rock concentrate, which will be transported from the mine site to a future deep water port on the north shore of the Saguenay River at St-Fulgence for export.

The expected life of mine for the Project is 25.75 years (excluding pre-production) based on the Paul Zone deposit alone.

1.2 Location and Access

The Arianne's Lac a Paul Phosphate Rock Project is an advanced-exploration stage phosphate project located in northern Quebec, approximately 200 km north of the town of Saguenay in the Saguenay-Lac-St-Jean region, Quebec, Canada. The Lac a Paul Property consists of 498 contiguous CDC (map-staked claims) with a total area of approximately 27,617 hectares.

There is access to existing infrastructure including roads and a location for a future deep water port. The Lac a Paul Project will be powered by Hydro-Québec through Rio Tinto Alcan's existing hydropower infrastructures from the Chute-des-Passes generating station, which has sufficient capacity for the Project and is located at about 35 km from the Project.

1.3 Geology and Exploration

The Lac-Saint-Jean anorthosite is the largest anorthositic complex in the world, occupying an area of nearly 20,000 km^2. The Property lithology consists mainly of intrusive rocks subsequently associated with anorthositic rocks of Lac St-Jean. The rocks are displayed in the form of coalescing lobes consisting of leuconorites, anorthosite, norite, gabbronorite, gabbro with olivine, and gabbro. The lower pyroxenite contains dunites, peridotites, Fe-Ti oxides, apatite, jotunites and mangerites.

Mineralization at the Lac a Paul project originated from magmatic sedimentation and segregation within the anorthositic complex. The main geological unit of interest is a Nelsonite consisting of apatite and ilmenite-rich layers. Nine apatite mineralized zones are reported within Arianne's Lac a Paul project. Zones No 1 and No 2 are low-grade apatite-ilmenite bearing gabbros. Zone No 4 is constituted by titanoferous oxides. Only Zone No 2 was explored significantly with diamond drilling. The seven (7) other zones, Zone Manouane, Zone Paul, Zone Nicole, Zone Lucie, Zone Lise, Zone Intersection and Zone Castor are considered nelsonites and are most promising. The Paul and Manouane Zones are the main interest of this report.

At the beginning of the seventies, geological mapping and geochemistry studies were conducted in the Lac a Paul area by the Ministry of Natural Resources (MNR). Mineral exploration in the Lac a Paul area was initiated by the Mining Fund of Saguenay Lac-St-Jean (FMSLSJ) in 1994. In 1997, hole Pau-97-02 (Virginia Gold Mines) showed an intersection of 8.99% P_2O_5 and 9.42% TiO_2 on 41.09 meters along the core. Later on, SOQUEM (in a joint-venture partnership with Virginia Gold Mines) carried out exploration work on the anorthositic complex of Lac Saint-Jean.

In 1998, a Phosphorus and Titanium showing, which was found in the area of the Lac a Paul, was upgraded during a prospection campaign conducted by the Mining Fund of Saguenay–Lac-Saint-Jean.

In May 1999, a petrographic description of the mineralized zone was done by IOS Services Géoscientifiques Inc. and in December 1999, Arianne Resources Inc. took an option on the Property owned by the FMSLSJ.

From 1999 to 2001, Arianne performed exploration work for titanium and phosphorus in collaboration with the FMSLSJ; areas of interest were around Zones 1, 2, 3 and 4 (sampling, drilling, ore processing), before reactivating the Lac a Paul project in 2008.

Prior to 2009, a total of 57 diamond drill holes were completed by previous owners and Arianne Resources Inc. on the Property.

Arianne's exploration program of 2010/2011 included a sampling campaign performed on specific claims of the Property and a diamond drilling program. A total of seventeen (17) drill holes totaling 4,125 m were carried out on the Paul Zone by the company Nordic Drilling of Val d'Or and 1,418 samples were sent to ALS Chemex Laboratory in Val d'Or. Thirty-five (35) holes totaling 6,548 m were drilled on the Manouane Zone by Forage Nordic de Val d'Or (QC). 2,072 samples were sent to the ALS Chemex Laboratory.

Arianne's exploration program of 2011-2012 on the Lac a Paul Property focused primarily on converting the inferred resources of the Paul Zone to Indicated and Measured resources. The second goal was to explore the zones exhibiting similar geological and geophysical characteristics as Paul and Manouane since they had interesting values in the previous exploration campaign. The zones delineated by this campaign are named Nicole, Traverse, Lise and Lucie. One hundred five (105) diamond drill holes totaling 30,352 meters were drilled on the Paul Zone.

In 2013, Arianne now has 153 diamond drill holes totaling 39,371 meters on the Paul Zone and has developed other targets in the Lac a Paul Property.

1.4 Mineral Processing and Metallurgical Testing

Feasibility Study test programs were conducted by multiple contractors as summarized below (reports are included in the list of references, Section 27):

- Samples of bulk Paul deposit ore and concentrate were shipped to Jenike & Johanson (J&J) to evaluate the material flow characteristics.
- A sample of final concentrate was shipped to FLSmidth for drying tests.
- Jacobs conducted ore characterization testing, preliminary bench scale flotation tests, ore variability testing, and pilot plant testing on core and bulk samples from the Paul deposit. Jacobs also subcontracted tests to vendors to determine the Bond abrasion index, JK drop weight, Bond ball mill work index, and Qemscan analysis.
- COREM conducted preliminary bench and pilot plant testing of flotation columns. Concentrate and tailings samples generated from pilot plant testing were subsequently tested by Outotec and FLSmidth.

The findings from the test program conducted by Jacobs are summarized as follows:

- Provided design data for beneficiation of Lac a Paul ore and completed Paul ore characterization and size reduction test programs.
- Indicated that ore from the Paul deposit can achieve a 40% P_2O_5 grade with 87% P_2O_5 recovery with an acceptable MER and CaO/P_2O_5 ratio. This finding is based on bench-scale tests using mechanical flotation cells by Jacobs and pilot-scale column flotation testing by COREM.
- Indicated that magnetic separation and desliming are not needed prior to flotation.

- Indicated by ore variability tests that the nine ore types with head grades assaying from 3.9% to 12.8% P_2O_5 can consistently achieve a 40% P_2O_5 concentrate grade with P_2O_5 recovery ranging from 63% to 92%.

Jacobs subcontracted the pilot plant test program to COREM. A key component of the pilot plant test program was a 48-hour continuous test run. The flow sheet developed by Jacobs consisted of grinding and LIMS in closed circuit followed by flotation using mechanically agitated cells configured as a rougher/scavenger. The concentrate was sent to the apatite cleaner section where it was cleaned twice. The cleaner tailings were recycled. Overall, the best final concentrate grade from the continuous 48-hour test was 39.4% P_2O_5 at a P_2O_5 recovery of 45.4%. The best P_2O_5 recovery was 78.8% with a corresponding final concentrate grade of 36.4% P_2O_5. The 48-hour continuous test run results were inconclusive because: (1) the pilot plant was not at equilibrium; (2) the grind F_{80} utilized by COREM was possibly too coarse; and (3) the multiple recycle steams likely contributed to the equilibrium issues previously noted.

Independently from the Jacobs test program, COREM conducted bench scale laboratory tests and pilot plant testing of an identical sample of bulk Paul ore. The main objectives of the program were to:

- Demonstrate that column flotation technology can give P_2O_5 recovery of at least 90% with a concentrate grade of 39% P_2O_5 or higher during an extended test (>8 hour).
- Provide test data to support development of process engineering for the Feasibility Study conducted by Cegertec WorleyParsons.

The column cell pilot plant was configured as a rougher, two cleaners, and a cleaner-scavenger. The cleaner-scavenger tails were recycled. Feed F_{80} was nominally 185 µm and operation was continuous for 8 to 9 hours. Three formal sampling campaigns were carried out during the continuous pilot plant test and the P_2O_5 recovery and grade for each campaign are given in Table 1.4.1. After making minor adjustments in reagent usage, cell solids, and air flow rates, the pilot plant was allowed to stabilize prior to conducting sampling campaigns 2 and 3. The average P_2O_5 recovery and concentrate grade from sampling campaigns 2 and 3 are 91.6% and 38.6% P_2O_5, respectively; which better represents the performance attainable from the pilot plant using column flotation cells.

Test Campaigns	Weight %	%P_2O_5	%P_2O_5 Recovery
Campaign 1	12.2	39.6	74.2
Campaign 2	16.9	39.2	91.8
Campaign 3	18.0	38.1	91.5
Average (1-3)	**15.7**	**39.0**	**85.8**
Average (2-3)	**17.6**	**38.6**	**91.6**
Recommended for FS		**38.6**	**90.0**

Table 1.4.1 Pilot Plant Test Results Summary

For the FS, the averaged P_2O_5 recovery was downgraded to 90% to compensate for scale-up to a commercial facility. The concentrate grade selected for the FS was 38.6% P_2O_5 although there is potential to increase the product grade to 39% P_2O_5 or even higher while still maintaining the overall P_2O_5 recovery at or near 90%.

After reviewing the results from both cell types, Jacobs concluded that column cells appear to be a superior option for beneficiating Lac a Paul ore.

Chemical analysis of a representative sample of the flotation concentrate collected from the column cell confirmation test run is given in Table 1.4.2.

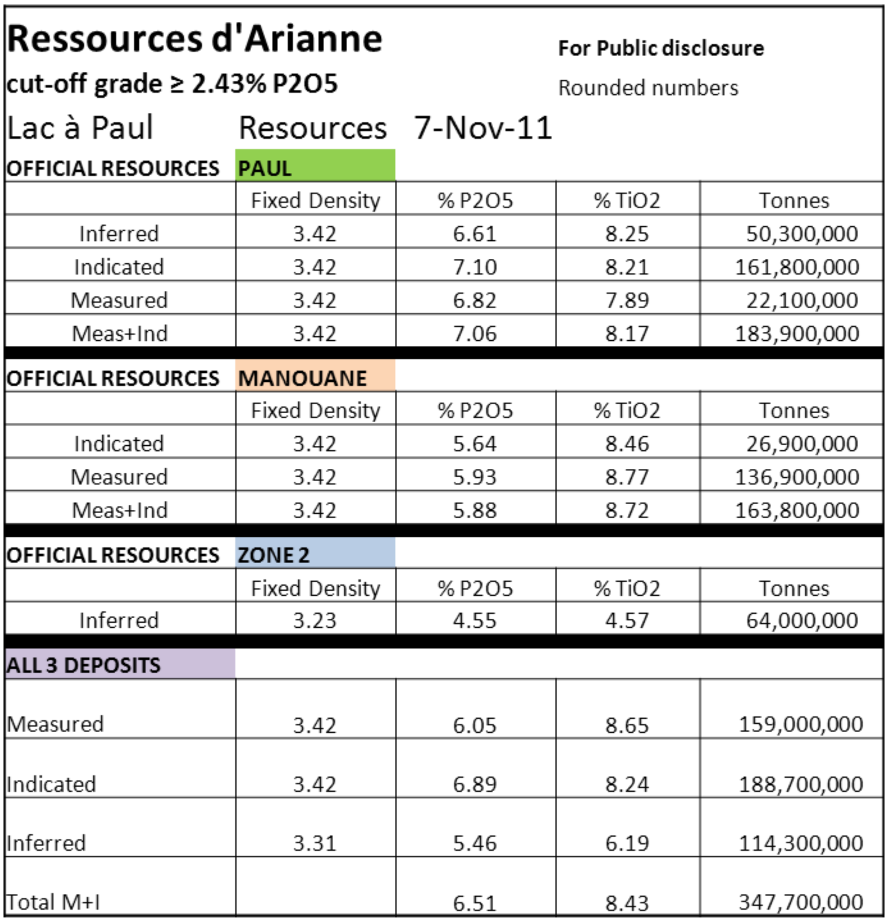
Constituent	Units	Analysis
P_2O_5	%	38.60
CaO	%	51.25
MgO	%	0.70
Fe_2O_3	%	2.00
Al_2O_3	%	0.45
SiO_2	%	1.55
TiO_2	%	0.65
Na_2O	%	0.37
K_2O	%	0.19
Cl	%	0.06
F	%	1.08
LOI	%	0.54
CaO/P_2O_5	Ratio	1.33
MER	Ratio	0.08

Table 1.4.2 Concentrate Chemical Analysis Results

1.5 Mineral Resource Estimate

In 2011, mineral resources for the Manouane Zone of the Lac a Paul Project were estimated using a 2.43% P_2O_5 cut-off grade. At this base case cut-off, the Manouane Zone hosts a Measured Mineral Resource of 136.9 million tonnes grading 5.93% P_2O_5 and an Indicated Mineral Resource of 26.9 million tonnes grading 5.64% P_2O_5. The mineral resource estimates are outlined in Table 1.5.1. Mineral resources for Zone No. 2 of the Lac a Paul Project were estimated using the same cut-off grade that was used in for Paul and Manouane, 2.43% P_2O_5. At this base case cut-off, the Zone No. 2 hosts an Inferred Mineral Resource of 64.0 million tonnes grading 4.55% P_2O_5.

The following mineral resources models are presented in Table 1.5.1 for each zone and the total for all three zones as per November 7, 2011. Manouane and Zone No. 2 are still current.



Ressources d'Arianne **For Public disclosure**
cut-off grade ≥ 2.43% P2O5 Rounded numbers
Lac à Paul Resources 7-Nov-11

OFFICIAL RESOURCES	**PAUL**			
	Fixed Density	% P2O5	% TiO2	Tonnes
Inferred	3.42	6.61	8.25	50,300,000
Indicated	3.42	7.10	8.21	161,800,000
Measured	3.42	6.82	7.89	22,100,000
Meas+Ind	3.42	7.06	8.17	183,900,000
OFFICIAL RESOURCES	**MANOUANE**			
	Fixed Density	% P2O5	% TiO2	Tonnes
Indicated	3.42	5.64	8.46	26,900,000
Measured	3.42	5.93	8.77	136,900,000
Meas+Ind	3.42	5.88	8.72	163,800,000
OFFICIAL RESOURCES	**ZONE 2**			
	Fixed Density	% P2O5	% TiO2	Tonnes
Inferred	3.23	4.55	4.57	64,000,000
ALL 3 DEPOSITS				
Measured	3.42	6.05	8.65	159,000,000
Indicated	3.42	6.89	8.24	188,700,000
Inferred	3.31	5.46	6.19	114,300,000
Total M+I		6.51	8.43	347,700,000

Table 1.5.1 – Mineral Resource Estimates – 3 Deposits November 2011

The Author cautions that mineral resources that are not mineral reserves have not demonstrated economic viability.

Paul Resource Update 2013

For the 2013 Paul model resource update, interpretation of the mineralized structures on cross sections was provided by Arianne's geologists, Hugues Guérin Tremblay and Daniel Boulianne. The nelsonite, transition, mixed and low grade zones with enriched apatite content were interpreted by Arianne's technical team. Cross-sections were simplified by senior QP Claude Duplessis, geological engineer, who created envelopes which were integrated into GENESIS with 3D envelope modelling.

Mineral resources for the Paul zone were estimated by using a 4.00% P_2O_5 cut-off grade. This cut-off was applied by the Author to show the robustness of the resource; the Feasibility Study determined the exact cut-off grade at 3.5% P_2O_5.

- Although the cut-off grade is higher than for the PFS, the Measured and Indicated resources of the Paul Zone increased by 221% compared to the last estimate released in 2011 (see Table 1.5.2).
- The Measured and Indicated mineral resources (M+I) of the Paul Zone amount to 590.24 Mt at 7.13% P_2O_5.
- The mineral resource estimate was calculated according to NI 43-101.

Comparison of the Paul Zone's Mineral Resources
(March 2013 versus November 2011 resources estimates)

Resources	March 2013 (cut-off grade: 4.0% P_2O_5)		November 2011 (cut-off grade: 2.43% P_2O_5)	
	Tonnage (Mt)	Grade P_2O_5 %	Tonnage (Mt)	Grade P_2O_5 %
Measured (M)	336.76	7.22	22.10	6.82
Indicated (I)	253.48	7.02	161.80	7.10
Total (M+I)	**590.24**	**7.13**	**183.90**	**7.07**
Inferred	9.81	5.89	50.30	6.61

Paul update of mineral resources effective: March 7, 2013
Mineral resources which are not mineral reserves have not demonstrated economic viability.
These resources are not additive to the current Mineral Reserves

Table 1.5.2 Paul Zone Updated Mineral Resources 2013

1.6 Mineral Reserve Estimate

The resource block model for the Lac a Paul FS was prepared and provided to CWP by Claude Duplessis of Goldminds Geoservices Inc. (GMG), on February 6, 2013. The model name is "Modelfinal1_06022013.csv" and covers the Paul mineralized zone.

The Model was delivered in Comma Separated Value (CSV) file format, and was accompanied by wireframe and point files:

- HG_zone_Mesh.dxf (Wireframe representing High-Grade Mineralization, closed volume).
- MG_zone_Mesh.dxf (Wireframe representing Mixed-Grade Mineralization, closed volume).
- topolidarexportxyz.xyz (Topography File).
- topoOVBexportxyz.xyz (Overburden File).
- WasteprismEnvelope.dxf (Wireframe representing Waste Rock, closed volume).

The wireframe and point files allowed for coding in specific waste zones, ore zones, topography and overburden. The model coordinate system used is UTM NAD 83 ZONE 19, with no applied model rotation. The block size of the model is 10m (x-coordinate) x 5m (y-coordinate) x 10m (z-coordinate).

The pit optimizations were produced in Dassault Systèmes' Geovia Whittle (4.5.1) software (Whittle). Various pit optimization parameters were used in order to produce the pit optimization shell. These parameters include: selling price, mining, processing and G & A costs, weight recovery (dependent on P_2O_5 grade item and on process information), pit slopes (as recommended by Journeaux) and surface constraints from water bodies. Whittle then produced the pit with the highest discounted cashflow.

From the optimized economic pit shell, an economic cut-off grade was calculated. The cut-off grade calculated for this project is 3.5% P_2O_5. A dilution of 2% and an ore loss of 3% were also estimated for the project.

A pit was then designed within the selected optimized economic pit shell. Operational parameters such as ramp, berms, benching configuration and recommended slopes were applied for the design. The geotechnical pit design parameters were recommended by Journeaux Assoc. (Journeaux) in their report entitled "Report on Pit Slope Design (Report No.L-12-1558)" for the FS (included in the reference list, Section 27).

The Mineral Reserves were derived from the pit design and are presented in Table 1.6.1. The Mineral Resources comprise these Mineral Reserves.

Final Engineered Pit Design Mineral Reserve Estimate		
COG $P_2O_5 \geq 3.5\%$		
Dilution=2%. Ore Loss=3%)		
	Tonnage	**P2O5**
	(Mt)	**(%)**
Proven	313.71	6.92
Probable	158.38	6.80
Total Reserve	**472.09**	**6.88**
Inferred	--	
Waste Rock	527.31	
Overburden	9.06	
Total Stripping	**536.36**	
SR	1.14	

Table 1.6.1 Lac a Paul FS Mineral Reserve (Effective October 15, 2013)

1.7 Mining Methods

The mine plan for the Lac a Paul Feasibility Study was based on mining operation over 360 days, seven days per week and 24-hour days. The plan assumes that there will be four crews divided among two separate rotations. On each rotation there will be a crew that either works day-shift or night-shift.

The mine life is 25.75 years (excluding the 18 months allocated for preproduction). The mine plan is based on the assumption that the mill requires a throughput of 55ktpd ROM, operating at a 93% availability (of 365 days). The yearly ore tonnes mined satisfy the yearly requirement of the mill. The mine plan has been developed by sequencing four designed phases.

The complete mine plan consists of a pre-production period in which no ore is milled (only stockpiled). Following the 18-month preproduction (or pre-strip) period, there is a processing ramp up that follows the schedule:

- First 3 months of production = 3 months/ 12 months x 35% x (18.645 million tonnes);
- Following 6 months = 6 months/ 12 months x 80% x (18.645 million tonnes).

After the first two shorter periods, each subsequent period (12 months) produces at 100% capacity. Stripping ratios were optimized for the earlier years of the LOM.

Conventional drill, blast, load and haul mining methods will be used for the pit. The equipment fleet was sized based on specific operating parameters of the mine and equipment, and from the haulage profiles. A fleet of secondary and auxiliary equipment has also been sized to satisfy the operations' requirements.

It is assumed that the fleet will be owned and operated by Arianne. The blasting will be contracted out to a third party who will supply all explosives, accessories, services and workforce. Manpower requirements have been based on the assumption to operate four production crews. For non-production personnel it is recognized that some positions can be staffed five days per week while others require coverage seven days per week by assigning additional duties. The maximum required staff occurs in Period 9 when there are 249 hourly personnel required (operations and maintenance), and 31 salaried personnel required.

Water inflows for the pit have been estimated by Hydro-Ressource Inc. in 5-year increments. With this information, CWP estimated costs associated to the dewatering of the pit.

1.8 Recovery Methods

The beneficiation plant is designed to process an average of 55,000 tonnes per day of Run of Mine (ROM) ore to produce on average 3 million tonnes per annum of phosphate rock concentrate grading at 38.6% P_2O_5 with concentrate P_2O_5 recovery of 90%.

The ROM ore is trucked from the open pit mine to the primary crusher. The crushed product is then conveyed overland to a Coarse Ore storage Silo (COS) providing approximately 50,000 tonnes of storage for the beneficiation plant. The ore is reclaimed from the COS and conveyed to the beneficiation plant to feed a two stage grinding circuit. The grinding circuit is made up of one primary 15,000 kW SAG Mill and two secondary 11,000 kW Ball Mills operating in a closed circuit with classification hydrocyclones. The classification hydrocyclone product is fed to a Low Intensity Magnetic Separation (LIMS) circuit where magnetite rich gangue is removed ahead of the flotation circuit. The non-magnetic material is then dewatered through two stages of dewatering hydrocyclones before being fed to two parallel trains of flotation preconditioning tanks for reagentising. The magnetic material is discharged to the combined plant tailings thickener.

The beneficiation plant has been designed such that there is a turn down ratio of 50%. This means one ball mill and the associated downstream LIMS circuit and flotation circuits can be switched off for maintenance without stopping the entire plant.

The phosphate flotation circuit is designed to produce a concentrate grading at about 39% P_2O_5. The flotation circuit is designed to make use of an all column flotation cell arrangement. The flotation tailings are pumped to the tailings thickener prior to disposal in the plant tailings storage facility. The flotation concentrate is also thickened, filtered in pressure filters and dried in a flash dryer to obtain a product moisture content of 1.0±0.5%.

The dried concentrate from the flash dryer is fed to two 100,000 tonne dome storage silos which form part of the product load-out section. The apatite concentrate is transported via trucks from site to the future export facility at St-Fulgence on the north shore of the Saguenay River.

1.9 Infrastructure

The Lac a Paul phosphate rock project has good access to local infrastructure such as water, electricity and roads. The infrastructure requirements have been broken up into on site and off site services.

The major additions for off-site services required for the mine are;

- ***161kV Power line*** - a step-down substation from 345 kV to 161 kV to be constructed at Chute-des-Passes. This new substation will supply power through a 45 km long, 161 kV transmission line to the mine site.
- ***Concentrate Transportation and Load out facilities*** - The Phosphate concentrate will be transported by trucks, hauling 120 tonnes of concentrate in custom built trailers from the Mine to a load-out site at Saint-Fulgence (237 km in distance). This site will be equipped with trucks/trailers washing and trailers unloading facilities.

  Concentrate storage facilities will be built in close proximity to the wharf, which will be used to feed the Arianne's stationary ship loader. The wharf will be constructed as part of the Lac a Paul Project. The ship loader is part of the Lac a Paul Project to be installed and used to load Handymax or Supramax ship types. A winch with pulley system, operated by remote control, will be used to move vessels along the wharf (with dolphin type moorings).

The on-site infrastructure will include the following;

- ***Tailing storage facility and water management*** - A tailings storage facility (TSF) to store and manage the tailings was selected for the life of mine of the Lac a Paul project, estimated at 25 years. The process water will be stored in a retention pond. The scheme of operation proposes transfer of free water from the tailings park to retention pond and recycled back into the process water system.
- ***Waste rock dump*** – The waste rock dump will be located north of the open pit. The total waste rock storage requirement is designed for the total capacity of 236.7 Mm^3. The waste rock dump is expected to have a final elevation of 520 m for an average height of 50 to 70 m and locally, a maximum height of 110 m.
- **Site Layout and Camp Site Accommodations –**
  - The ***Paul Pit Area*** is located north and northeast of Lac a Paul; it covers an area of approximately 20 km^2 (5 km x 4 km), and is composed of the following areas.
    - The **Paul Pit** is located on the north side of the current Chemin-des-Passes. It will extend ≈ 2.6 km from east to west and 0.8 km from north to south. A 400 m exclusion zone is planned around the perimeter of the Paul Pit.
    - The **North waste rock pile** is located north of the Paul Pit; it will cover an area of ≈ 567 ha by the end of its mining period.

    - The **Explosives area** is located 1.5 km northeast of the Paul Pit, on the southern boundary of the waste rock pile. This zone is composed of 2 distinct sites, each covering an area of 1 ha. Two 1 km exclusion zones are planned around the perimeter of each of these sites.
  - ***Plant and Work Camp Area*** is located on the east side of Lac a Paul, approximately 800 m from the shore. It is divided into four distinct areas, spread over an area of approximately 600 ha (2 km x 3 km) and comprises the following areas.
    - The **Crusher** area is located furthest north; it includes the main crusher, a 4.9-ha platform where approximately 500,000 tons of Run of Mine ore can be stored and a 1.8-ha platform for maintaining and refueling mining vehicles (garage and fuel).
    - The **Plant**, covering an area of 18.5 ha is located 1.25 km south of the main crusher. This zone primarily includes an ore stockpile, the processing plant, concentrate storage silos, conveyors for transporting the ore and concentrate, a concentrate loading station, a tailings thickening station, a main electrical substation, mechanical maintenance workshops, a laboratory, a warehouse, locker/shower rooms, administrative offices, a nursery, a gatehouse.
    - The **Work Camp**, covering an area of 4.8 ha, is located northeast of Lac du Grizzly, approximately 20 m from the shoreline and ≈300 m southwest of the Plant zone. The Work Camp area extends over 400 m from north to south and ≈200 m from east to west. It will feature buildings for employee accommodations and services, most notably a kitchen and dining room. During the mine's operating life, 17 dormitory-type buildings will be installed. This number will be temporarily increased to 30 during the construction period. The Work Camp zone will also feature drinking water supply and wastewater treatment facilities, which will serve both the Work camp and Plant areas. These facilities will be located to the northwest and northeast of the Work Camp platform, respectively.
    - The **Water intake** covers an area of 0.33 ha and is located on the eastern shore of Lac a Paul, 1.25 km from the Work Camp zone and 2.1 km from the Plant zone.
  - ***Tailings Storage Facility*** is located 3 km southeast of Lac a Paul and 2 km from the plant. This area extends 2.3 km from north to south and 3.4 km from east to west. It is primarily composed of tailings piles with dikes, roads and water management equipment such as pumping stations, pipelines and ditches. By the end of the mining period, the piles will cover ≈530 ha. An above-ground effluent pipe will transfer effluents from the Processing Plant to the Tailings Pond and a water line will return treated water from the Tailings Pond to the plant.
- ***Site roads*** - Mining roads will be used for activities relating to mining production. Local roads will intersect the existing Chemin-des-Passes. They will have a gravel surface and be 10 m wide, accommodating regular, non-mining vehicle traffic. There will be a total of ≈11.4 km of local roads.

Mining roads will be built between the mining zone, the main crusher zone and the North waste-rock pile zone. Mining roads will have a gravel surface and will be 30 m wide. There will be a total of ≈3.2 km of mining roads.

With the exception of Chemin-des-Passes, the existing paths and/or development roads on site are not adequate for the project's needs during the mining period. As a result, all of the local and mining roads needed for the project will require full construction. With regards to Chemin-des-Passes, 2.5 km of it will be relocated due to the construction of the main crusher, the warehouse and garage platforms, as well as the refuelling area.

- ***Site Buildings*** - In addition to the Crusher and the concentrator buildings which will house grinding, magnetic separation, flotation, concentrate filtering and drying, the site will include these other buildings:
  - Administrative offices, a server room, nursing station and a cafeteria.
  - Laboratory.
  - Worker showers and lockers.
  - Maintenance garage.
  - Fuel storage & distribution.
  - Gatehouse and "war" / emergency response room.
  - Warehouse shelter.
  - Fuel Storage & Distribution - A fueling station including fuel storage and distribution facilities is located close to the crusher. The fuel is transported by tank trucks and stored in fuel tanks with sufficient volume for few days of operation. The above ground fuel tanks will be of the full secondary, double wall containment design as specified in the CAN/ULC-S601-07 standard.
- Site Services – Water Management
  - Fresh Water Supply - Fresh water will be supplied from Lac a Paul from an intake located on the eastern shore. The system will mainly be composed of the water intake, a screening station, a pumping station and a 300-mm diameter outlet pipeline (≈2.5 km in length) delivering the water to the processing plant. The system will have a rated capacity of 500 m^3/hour.
  - Drinking Water Supply - Drinking water will be supplied through two (2) distinct systems: The main station will supply the Work Camp, Plant and Crusher areas. It will be located near the Work Camp area. The station will be equipped with 2 artesian wells, chlorination and other treatment equipment (if required), a 24-hour operating reserve for consumption, a firefighting reserve, and a pumping station for distribution.

    The Explosives area will be serviced by an artesian well and will include a minimum operating reserve.

  - Underground Service Systems - A drinking water distribution system totaling ≈4.6 km of pipelines is planned to service the Work Camp, Plant and Crusher zones.
  - Wastewater Treatment - Wastewater will be treated by three distinct systems.

    One main treatment station will treat wastewater from the Plant and the Work Camp. The wastewater will be sent to the treatment station through the wastewater collection network.

    Temporary equipment will be added during the construction period to increase the capacity. This temporary equipment will be dismantled at the end of the construction period.

    The wastewater from the Crusher and Explosives area will be treated by two septic tank systems.

  - Management and Treatment of Runoff - Runoff from the yards in the industrial area (plant and crusher), service sites (water intake, drinking water, wastewater treatment, explosives, etc.) as well as the Work Camp will be collected by open drainage systems (ditches and culverts). All drainage networks will be directed to the retention and treatment (settling or sedimentation) tanks before being discharged into the various receiving environments. Two runoff measuring and sampling stations are planned: one in the crusher zone and one in the plant zone.

- Site Power and Automation
  - ***Power Supply Facilities*** **-** The overall power demand required for the operation is estimated at 115 MW of which 107 MW is required for the process. Based on the power requirements, three oil type transformers, rated at 161/25 kV, 45/60/75 MVA were selected. Redundancy is designed in so that if one transformer fails, the two others will supply the total load of the plant.

    The 25 kV distribution network, from the main substation to various areas, will be provided by air insulated switchgear installed in a separate prefabricated building. Three harmonic filters will be used to ensure current and voltage quality and to optimize the power factor.

    Three 25 kV overhead lines will be erected from the main substation to supply remote areas.

    As electricity will be needed in the future for the mining area, it is planned to install two mobile substations with a 25/4.16 kV, 7.5 MVA transformer and five outdoor walk-in switchgears near the open-pit mine to supply power to the electrical shovel and the pump house.

    An emergency system including two 2.5 MW standby diesel generator sets and a 4.16 kV synchronization bus will be installed in the main substation.

    The main concentrator building will include four electrical rooms to distribute the power at different voltages to process area through step-down transformers depending on the local requirements. The voltages will be 25 kV, 4.16 kV and 600 V.

- **Automation** - A communication network link between the Lac a Paul mining site and Arianne's other facilities is achieved via microwave and fiber optic links as provided by service providers. A new microwave tower will need to be built near the mining site.

  The Process Control System (PCS) comprises three (3) control rooms (mill, crusher, load-out) and Engineering Workstations.

1.10 Market Studies and Contracts

Two separate market analysis reports were commissioned in support of this Feasibility Study, the first by CRU International Ltd. and the second by Integer Research Limited, both of London, England. Both reports are respectively in appendices 1 and 2.

The CRU report, dated June 2013 with data related to May 2013, focuses on the macro-market outlook for Arianne product, including analyses of the global agricultural markets, the implications for phosphate fertilizer demand, and the expected phosphate production response from existing and new suppliers. The cost analysis of existing and new mining operations factors prominently in CRU's predictions for phosphate rock prices over the life of the Lac a Paul Mine. CRU also provides an analysis of the potential markets for Arianne's phosphate rock, but focuses solely on a competitive pricing model relative to fertilizer producers' value-in-use across global markets in North America, Europe, India and Southeast Asia.

The Integer report, dated July 2013, also analyzes global phosphate fertilizer demand based on a macro-agricultural market outlook and specific new projects that it sees coming into the market. In addition, it focuses more specifically on price premium opportunities available by virtue of Arianne's high-P_2O_5, low-impurity content phosphate rock product, particularly the applications and customers which are known for paying significantly higher prices than those paid for fertilizer products.

Both reports provide a baseline benchmark price forecast for the largest global phosphate rock supply point and dominant commercial force in the industry, the Country of Morocco. Of particular note is the market discipline expected of the key players in an oligopolistic market; it is expected to cause an extended period of time over which constant dollar market prices for standard-grade phosphate rock exports may prevail at a low enough level to minimize investment in new phosphate capacity. It is expected that market prices will remain just below what is required for investment in certain high-cost greenfield phosphate rock mining projects, which is roughly 15-20% below the level of today's market prices of around $150/t FOB Casablanca.

The key aspects highlighted by both reports are Arianne's high-quality product, its proximity to importing markets, and its low geopolitical risks, making its product very desirable to both the fertilizer and high-purity phosphoric acid producers alike.

The reports are relatively consistent in expectations for benchmark Moroccan-quality export concentrate prices over the life of the Lac a Paul Mine, with a relative spread of ±15%. However, the CRU report credits Arianne with a selling price reflecting only P_2O_5 content, freight differentials and the cost of the acid necessary to convert the phosphate rock concentrate into fertilizer products at various consumer destinations. The Integer report also develops a premium based on value-in-use to high-purity phosphate product producers, also across various customer locations such as the US Gulf, Brazil and Northern Europe.

Based on the marketability of the concentrate as discussed in both reports, Arianne has developed a marketing plan for the life of the Lac a Paul Mine. It includes both fertilizer customers and high-purity product customers, across various destinations where demand exists for product with the characteristics verified by the metallurgical testwork included in the product quality sections of this report.

Using the projections from both CRU and Integer reports, Arianne has modeled its sales price forecast (in constant 2013 US$/t) over the life of the Lac a Paul Mine and in summary, the following figures in Table 1.10.1 were used:

Item	Selling Price $USD
Average Benchmark Morocco price for 65-75 BPL rock FOB Morocco	137
Price adjustment for freight, P_2O_5 content and acid to N.A. fertilizer producers	60
Price adjustment for delivery to Brazilian and European high-purity producers	80
Price adjustment for delivery to US and Gulf high-purity producers	91
Average price for sales mix (1/3 to each market zone)	**213**

Table 1.10.1 Selling Price Forecast Summary from Arianne

No sales contract and no letter of intent have been secured at this stage of the project.

1.11 Environment Studies, Permitting and Social or Community Impact

ENVIRONMENT

The Lac a Paul Project is located within the Fjord-du-Saguenay Regional County Municipality (RCM). According to the RCM's applicable zoning regulation, the Feasibility Study area overlaps the 20-2F zone, where industrial mining extraction is authorized.

Arianne holds an exclusive lease to all surface rights for the area covering the Project. The Project footprint avoids lakes and the fish habitat encroachment has been minimized. The Project will have easy access to water and will take advantage of the topography to construct the tailings impoundment in a highly secure manner at a location approximately 2 km from the concentrator. According to Ministère du Développement Durable, de l'Environnement, de la Faune et des Parcs (MDDEFP), Directive 019, Arianne's materials are classified as low risk waste based on leachate results for waste rock, tailings and ore, which will facilitate waste management.

PERMITTING

As part of the summer 2011 environmental assessment of the Lac a Paul Project, Arianne began its baseline study. Data acquisition was completed in spring 2013. It was immediately followed by the preparing and filing of an Environmental Impact Assessment (EIA) with the MDDEFP in June 2013. Arianne is currently working on providing answers and complementary information to the MDDEFP's requests. Once this process has been completed, Arianne will be able to move on to the next step, i.e. the BAPE public hearings (Bureau d'Audiences Publiques sur l'Environnement). The Company's goal is to finalize the entire process by Q4 2014, resulting in a Ministerial Decree.

Based on a federal communication to Arianne dated August 8, 2013, the Mine site of the Lac a Paul Project is not subject to a federal environmental assessment under the Canadian Environmental Assessment Agency CEAA (2012) and the Regulations Designating Physical Activities. In addition, considering the non-metal nature of the ore mined, the Project is not subject to Metal Mining Effluent Regulations (MMER). Arianne must however obtain permits from the federal Authorities in pursuance of the Explosives Act and the Fisheries Act.

COMMUNITY RELATIONS

In 2009, Arianne undertook a voluntary sustainable development process. It implemented a Sustainable Development Policy and a Sustainable Development Strategy/Action Plan. As a key element of the strategy action plan Arianne has been since 2011 organizing meetings with local communities. Also the Company has established an inventory of its greenhouse gas (GHG) emissions. Arianne is one of the few companies of its size to publicly disclose its GHG emissions in its annual and quarterly reports. The Lac a Paul Project, including the out of norms road for phosphate rock concentrate transportation to St-Fulgence, is on the Nitassinan of three First Nations: the Innu of Pessamit, Mashteuiatsh and Essipit. Arianne has had an ongoing relationship with the Mashteuiatsh nation since 2008 and with the Pessamit nation since 2010. Discussions with the Essipit nation are planned since this nation is for the first time impacted by the Project with the new road design traversing their land.

1.12 Capital and Operating Costs

CAPITAL COSTS

The capital costs in Table 1.12.1 are for the Lac a Paul Project based on a beneficiation plant rate of 55,000 metric tonnes per day, and is based on Cegertec WorleyParsons' standard methods applicable for a Feasibility Study. Table 1.12.3 summarizes capital costs for the entire Life Of Mine (LOM), which includes initial capital expenditure (CAPEX), sustaining capital and mine closure/rehabilitation costs. All duties and taxes are excluded from the capital costs, but are considered in the economic analysis. Escalation and interest incurred during construction are excluded from the capital cost. The effective date for the cost estimate is September 5, 2013.

Item	Feasibility Study (US$ M)
Mill	470.8
Project general	108.5
General Mine Site	65.3
Mine Development	42.5
Open Pit Mine	29.6
Temporary Construction Facilities & Services	23.1
Construction Support/Equipment/Consumables	57.7
EPCM	61.7
Contingency	73.9
Owner’s Cost	49.4
TOTAL	**982.5**

Table 1.12.1 Capital Costs - Mine Site

The pre-production initial capital costs for the mine and ore processing facility are US$M 982.5, of which US$M 73.9 is contingency. The open pit mine development, the ore processing facilities and all on-site infrastructure and services necessary to support the mine operation have an estimate accuracy of ±15%.

Item	Feasibility Study (US$ M)
Off-site facilities & infrastructure	167.9
Temporary construction facilities & services	7.7
Construction support/equipment/consumables	3.3
EPCM	20.9
Contingency	18.1
Owner's cost	14.3
TOTAL	**232.2**

Table 1.12.2 Capital Costs - Transport

The pre-production initial capital costs for the mine-to-port transportation scope are US$M 232.2, of which US$M 18.1 is contingency (Table 1.12.2). Capital cost for the transport system is estimated at an accuracy of ±25%.

Item	Feasibility Study (US$ M)
Initial Capital Cost	1,214.7
Sustaining Capital Cost	385.8
LOM Direct Capital Cost	1,599.5
Mine Closure and Rehabilitation	44.8

Table 1.12.3 LOM Capital Costs

OPERATING COSTS

Based on all operating costs outlined in the Feasibility Study, the phosphate rock concentrate annual operating cost at FOB Port of St-Fulgence is US$ 93.7/tonne. Table 1.12.4 shows a breakdown of operating cost per tonne.

Item	Feasibility Study ($/tonne)
Average Extraction Cost	27.3
Average Processing Cost	48.1
Average General and Administrative Cost	4.3
Average Shipping Cost (includes ship loading)	14.0
Total Operating Cost	**93.7**

Table 1.12.4 Estimate of Operating Costs per tonne of concentrate

Item	Feasibility Study (US$M)
LOM Mining Operating Cost	2,069.1
LOM Process Operating Cost	3,642.3
LOM General & Administration Operating Cost	323.2
LOM Concentrate Transport Operating Cost	1,057.0
LOM Operating Cost	**7,091.5**

Table 1.12.5 LOM Estimate of Operating Costs

1.13 Economic Analysis

The main financial assumptions used in the base case are given in Table 1.13.1.

Item	Unit	Base Case Value
Phosphate Rock Concentrate Price	US$/tonne	213
Exchange Rate	CAD$/US$	0.9524
Life of Mine (Paul Zone)	years	25.75
Discount Rate	% per year	8.0%

Table 1.13.1 Macro-Economic Assumptions

The main technical assumptions used in the base case are given in Table 1.13.2.

Item	Unit	Value
Total Ore Mined (Life Of Mine)	M tonnes	472.1
Average Ore Grade to Mill	% P_2O_5	6.88
Concentrate Grade	% P_2O_5	38.60
Total Tonnes of Concentrate Produced	M tonnes	75.7
Processing Design Rate	Tonnes/day	55,000
Average Process Recovery over Mine Life	%	90.00
Average Extraction Cost	(US$ / tonne concentrate)	27.33
Average Processing Cost	(US$ / tonne concentrate)	48.11
Average General and Administrative Cost	(US$ / tonne concentrate)	4.27
Average Shipping Cost	(US$ / tonne concentrate)	13.96
Total Operating Cost	(US$ / tonne concentrate)	93.68

Table 1.13.2 Technical Assumptions

The key financial results of the base case scenario are presented in Table 1.13.3.

Item	Before-Tax	After-Tax
NPV @ 8%	$ 1,910.1	$ 1,065.9
IRR	20.7%	16.7%
Payback Period (years)	4.4	4.8

Table 1.13.3 Financial Results

1.14 Other Relevant Data and Information

The EPCM work is presumed to start in January 2014 with some early work (using bridging funds). This strategy results in an expected project completion by March 2017, an overall project duration of

39 months. The 12-month Early Works period (January 2014 to January 2015) includes critical engineering design for long lead time items and design, procurement and construction work for deforestation, clearing and grubbing and temporary road work and services, and other work permitted prior to obtaining the full environmental approval, expected in October 2014.

Table 1.14.1 summarizes the project schedule major activities.

Activity	Start	Finish
Early Works	January 2014	January 2015
Engineering	January 2014	August 2015
Procurement	January 2014	April 2016
Construction	October 2014	November 2016
Commissioning and ramp up	September 2016	March 2017

Table 1.14.1 EPCM Schedule - Principal Activities Duration

Characterization of Chlorine levels in the concentrate was initiated. Preliminary results showed variability in the Chlorine content for specific rock types and locations within the Paul Zone deposit, in addition to showing significant differences between laboratories and analytical methods for the same concentrate.

Based on these results, it was decided to take advantage of a planned bulk metallurgical test work program in order to better characterize the chlorine variability within the Paul Zone deposit. This test work program was originally required to finalize and optimize the flotation circuit configuration; it represents six (6) bulk samples of 25 tonnes each.

Results of this investigation will be used to determine if a more extensive analysis of the chorine content within the ore body is necessary.

1.15 Conclusion - Study Highlights

The Lac a Paul Property contains significant phosphate mineralization in sufficient quantities and of sufficient grade to be attractive for mining under current market conditions, notwithstanding the risk inherent to proving and developing any mining property. Geologic continuity in the magmatic differentiated unit is strong throughout the Property. The Measured and Indicated Mineral Resources in the Paul Zone alone of 590 million tonnes grading an average of 7.1% P_2O_5 at a 4.0%cut-off grade (does not include 164 million tonnes of the Manouane Zone mineral resources).

As a result of subsequent drilling through 2011 and 2012, the mine life from just the Paul Zone alone stands at 25.75 years (excluding pre-production) for the FS. The Manouane resource could potentially provide an additional 8 years of mine life based on the 2012 PFS study.

The mining method selected is open pit due to the shape of the deposit and its close proximity to the surface. The development of the mine pit was based on Whittle pit optimisations focusing on delivering a maximized net discounted cashflow as far as practical, reducing the stripping ratio of the pit and maximising the grade and recovery. The mining method selected for the project is a shovel and truck operation with a primary crusher station located inside the mine pit.

The results from the various metallurgical testwork campaigns completed during this study have demonstrated that the use of column flotation cells for recovery of the apatite is superior to the use of mechanical flotation cells. The beneficiation plant will produce 75.7 million tonnes of saleable concentrate at 38.6% P_2O_5 from Proven and Probable Mineral Reserves reported at 3.5% P_2O_5 cut-off grade of 472.1 million tonnes at an average grade of 6.9 % P_2O_5 (taken from the Paul Zone Mineral Resource).

The cashflow analysis indicates that the project is economic including the costs for the establishment of a new deep sea port facility on the northern bank of the Saguenay River at St-Fulgence. The discounted cashflow model includes allowances for sustaining capital and rehabilitation costs.

Base Case 55,000 tpd Owner Operated (million US$)	
Initial Capital Cost	$ 1,214.7
Sustaining Capital Cost	$ 384.8
Total Direct Capital Cost	$ 1,599.5
Mine Closure and Rehabilitation	$ 44.8
Total Mining Operating Cost	$ 2,069.1
Total Process Operating Cost	$ 3,642.3
Total General & Administration Operating Cost	$ 323.2
Total Concentrate Transport Operating Cost	$1,057.0
Total Operating Cost	$ 7,091.5
Before-Tax NPV @ 8%	$ 1,910.1
Before-Tax IRR (%)	20.7%
Before-Tax Payback Period (years)	4.4
After-Tax NPV @ 8%	$ 1,065.9
After-Tax IRR (%)	16.7%
After-Tax Payback Period (years)	4.8

Table 1.14.2 Base Case 55,000 tpd Owner Operated (million US$)

The operating costs average US$ 93.7/tonne life of mine. At an 8% discount rate, the project has a Net Present Value (NPV) of US$1,901.1 million pre-tax and US$1,065.9 million after tax and an Internal Rate of Return (IRR) of 20.7% pre-tax and 16.7% after tax. The pre tax payback period is 4.4 years and 4.8 years after tax.

1.16 Recommendations

Arianne Phosphate Inc. should continue with permitting activities, marketing of the phosphate ore, and detailed engineering design for the Lac a Paul Phosphate Rock Project. The following recommendations are mutually independent activities aimed at advancing the Project to development and production. Recommendations are not phased:

- Geology & Exploration
  - Continue definition and exploration drilling on the Property to extend the life of mine (LOM).
- Metallurgical Testing & Processing
  - Complete the planned bulk metallurgical test work program to finalize and optimize the flotation circuit configuration.
  - Commence detailed engineering design of the process plant to advance work on the long lead equipment items.
- Infrastructure
  - Continue design and environmental impact assessment for the 161kV power supply system from Chute-des-Passes to the Lac a Paul mine site.
  - Continue design for the tailings storage facility so as to advance the early construction works needed to establish the tailings storage facility and water recovery system.
  - Continue design for the road/handling/truck wash system associated with the transport of the concentrate from the Lac a Paul mine site to the proposed Saint-Fulgence export facility on the Saguenay River.
- Project Permitting and Regulatory Agencies
  - Arianne must continue with the various permitting processes already underway as detailed in the environmental section of this report.
- Marketing
  - Continue marketing development via negotiations with potential Arianne Phosphate Inc. phosphate consumers to define and pinpoint phosphate rock marketing and sales alternatives.
- Community and Government Stakeholder Relations
  - Continue to foster stakeholder support for development of the Lac a Paul Phosphate Rock Project. Specifically, continue with community meetings to inform the public at local and state levels of project development and plans.

2. INTRODUCTION

In September 2012, Arianne Phosphate Inc. (Arianne) commissioned a team of engineering consultants to complete a Feasibility Study in accordance with National Instrument 43-101 (NI 43-101).

All mines acts regulations with respect to health, safety and environmental considerations have been taken into account and incorporated in the feasibility designs and relevant cost estimates. In addition, the designs take into account the geological location of the Project.

The following consultants were commissioned to complete the component reports for the purposes of the feasibility study:

- Cegertec WorleyParsons - mineral, processing, infrastructure.
- CRU International and Integer Research Ltd – Phosphate rock concentrate marketing studies.
- Dessau – Tailings storage and impoundment water management.
- Ernst & Young – Financial modelling and economic analysis.
- FLSmidth – Drying of apatite.
- Genivar - Environmental studies, permitting and social or community impact.
- GoldMinds Geoservices Inc. – Geology, mineral resource estimate, geological block modelling.
- Hydro-Ressources Inc. - Water management and hydrogeology, mine dewatering.
- Jenike&Johanson – Flow property for phosphate concentrate and ore.
- Journeaux Associates – Mine pit slope design.
- L. Nardella Associates - certification of the capital expenditures as QP
- Outotec – Filtration testing.
- Phosphate Consulting LLC – Mineral processing and metallurgical testing.
- SGS Canada – certification of the economic analysis as QP.
- URSTM – Geochemical evaluation of the mine site residue.

In addition, Jacobs Engineering Group Inc. (Jacobs) and COREM conducted the metallurgical test work including pilot test work for the process design. The L. Nardella Associates Ltd also supported CWP in cost estimating (CAPEX), constructability and project design.

Arianne’s exploration program of 2011-2012 on the Lac a Paul Property, focussed primarily in the conversion of Indicated resources of the Paul Zone to Measured resources.

The FS Report will be prepared by Cegertec WorleyParsons and is expected to be completed in December 2013.

The effective date of the NI 43-101 Technical Report is October 24, 2013.

2.1 Terms of Reference – Scope of Work

Cegertec WorleyParsons (CWP) was mandated by Arianne to provide a Feasibility Study Report for the development of the Lac a Paul phosphate deposits. Cegertec WorleyParsons was to coordinate work and activities for the following needs: the mining, process design, tailings, infrastructure, environmental aspects, compilation of capital and operating cost estimates at a confidence level of ± 15%, economic analysis and report preparation integrating geology, mineral resources and metallurgical testing for which information has been provided by other consultants. However, based on high transportation costs and low project profitability, the former Mine to Port option (concentrate transportation and handling) was discarded late in the Feasibility Study process. As a result, Cegertec WorleyParsons worked on another alternative, seen as more viable and cost effective. However, due to time limitation to carry out the new Mine to Port alternative, the new route and associated logistics level of definition shows an estimate accuracy range of ±25%.

Process flowsheets were developed from a metallurgical testing program performed by COREM in late 2012 and early 2013. The capital cost and the operating cost estimates have been developed for the designed daily throughput of 55, 000 tpd ROM. A series of supplemental testwork programs was conducted by third party vendors. These supplemental testwork packages refer to the third party vendor testwork for thickening, filtration, concentrate drying and bulk material flow.

The FS intended to further refine and enhance the design data and costs to establish the viability of the Project at a production rate of 55,000 tpd feed to the mill in order to justify proceeding with the next phase of project development.

Services from specialized firms were retained in the execution of the scope of work.

Table 2.1.1 provides a list of qualified persons and their respective sections of responsibility. The certificates for people listed as Qualified Persons can be found at the beginning of the Report under Date and Signature – Certificates.

Section	Title of Section	Contributors	Qualified Persons
1.0	Summary	Major: Ewan Wingate, WP Minor (from QPs): Claude Duplessis, GMG Michael Kelahan, PCLLC Pascal Vallée, CWP Hubert Guimont, Dessau Simon Latulippe, Genivar And from several other writers associated to Sections 2 to 26.	Ewan Wingate, WP Claude Duplessis, GMG Michael Kelahan, PCLLC Alex Topalovic, WP Benoit Turgeon, CWP Pascal Vallée, CWP Hubert Guimont, Dessau Simon Latulippe, Genivar Gaston Gagnon, SGS Canada Frédéric Côté, L. Nardella Associates Ltd
2.0	Introduction	Ewan Wingate, WP	Ewan Wingate, WP
3.0	Reliance on Other Experts	Ewan Wingate, WP	Ewan Wingate, WP

Section	Title of Section	Contributors	Qualified Persons
4.0	Property Description and Location	Claude Duplessis, GMG Daniel Boulianne, Arianne Phosphate Inc.	Claude Duplessis, GMG
5.0	Accessibility, Climate, Local Resources, Infrastructure and Physiography	Claude Duplessis, GMG	Claude Duplessis, GMG
6.0	History	Claude Duplessis, GMG	Claude Duplessis, GMG
7.0	Geology Settings and Mineralization	Claude Duplessis, GMG	Claude Duplessis, GMG
8.0	Deposit Types	Claude Duplessis, GMG	Claude Duplessis, GMG
9.0	Exploration	Claude Duplessis, GMG	Claude Duplessis, GMG
10.0	Drilling	Claude Duplessis, GMG	Claude Duplessis, GMG
11.0	Sample Preparation, Analyses and Security	Claude Duplessis, GMG	Claude Duplessis, GMG
12.0	Data Verification	Claude Duplessis, GMG	Claude Duplessis, GMG
13.0	Mineral Processing and Metallurgical Testing	Michael Kelahan, PCLLC Henry Lamb, PCLLC	Michael Kelahan, PCLLC
14.0	Mineral Resource Estimate	Claude Duplessis, GMG	Claude Duplessis, GMG
15.0	Mineral Reserve Estimate	Alex Topalovic, WP John Cairns, WP Amanda Fitch, WP	Alex Topalovic, WP
16.0	Mining Methods (sub-sections 16.1 to 16.5, 16.7)	Alex Topalovic, WP John Cairns, WP Amanda Fitch, WP	Alex Topalovic, WP
16.6	Mining Methods - Mine Dewatering	Michael Verreault, Hydro-Ressources	Michael Verreault, Hydro-Ressources
17.0	Recovery Methods	Ewan Wingate, WP Jessica Dwyer, WP Mike Kelahan, PCLLC Martin Verreault and Alain Veilleux, CWP	Ewan Wingate, WP
18.0	Project Infrastructure (sub-sections 18.1.1, 18.1.2,18.2.5 to 18.2.9)	Serge Gagnon, Gérald Gravel, Edith Laberge, Luc Thériault, Jacques Truchon, CWP	Benoit Turgeon, CWP
18.1.3	Project Infrastructure - Concentrate Transportation and Load-Out Facilities	Pascal Vallée, CWP	Pascal Vallée, CWP
18.2.1	Project Infrastructure - Tailings Storage Facility and Water Management	Hubert Guimont, Dessau	Hubert Guimont, Dessau
18.2.2	Project Infrastructure - Tailings Water Management	Hubert Guimont, Dessau	Hubert Guimont, Dessau
18.2.3	Project Infrastructure - Water Management and Hydrogeology	Michael Verreault, Hydro-Ressources	Michael Verreault, Hydro-Ressources

Section	Title of Section	Contributors	Qualified Persons
18.2.4	Project Infrastructure - Waste Rock Dump	Nathalie Chevé, Ben Plumridge and Simon Latulippe, Genivar	Simon Latulippe, Genivar
19.0	Market Studies and Contracts	Ewan Wingate, WP Jim Cowley/Brian Kenny, Arianne Phosphate Inc.	Claude Duplessis, GMG Ewan Wingate, WP
20.0	Environment Studies Permitting and Social or Community Impact	Simon Latulippe/Nathalie Chevé, Ben Plumridge, Genivar	Simon Latulippe, Genivar
21.0	Capital and Operating Costs	CAPEX: Frederic Eickmeier, WP OPEX: Nawar Catalan, CWP	CAPEX: Frédéric Côté, L. Nardella Associates Ltd OPEX: Pascal Vallée, CWP
22.0	Economic Analysis	Nathalie Ladouceur, E&Y	Gaston Gagnon, SGS Canada
23.0	Adjacent Properties	Claude Duplessis, GMG	Claude Duplessis, GMG
24.1	Other Relevant Data and Information – Project EPCM Schedule	Valérie Valiulis, CWP	Ewan Wingate, WP
24.2	Other Relevant Data and Information - Characterization of Chlorine	Claude Duplessis, GMG	Claude Duplessis, GMG
25.1	Interpretation and Conclusions - Geology	Ewan Wingate, WP	Claude Duplessis, GMG
25.2	Interpretation and Conclusions - Resource Estimate	Ewan Wingate, WP	Claude Duplessis, GMG
25.3	Interpretation and Conclusions - Mineral Reserve Estimate	Ewan Wingate, WP	Alex Topalovic, WP
25.4	Interpretation and Conclusions - Mining Method	Ewan Wingate, WP	Alex Topalovic, WP
25.5	Interpretation and Conclusions - Mineral Processing and Metallurgical Testing	Ewan Wingate, WP	Michael Kelahan, PCLLC
25.6	Interpretation and Conclusions - Infrastructure	Ewan Wingate, WP	Benoit Turgeon, CWP Simon Latulippe; Genivar Hubert Guimont, Dessau
25.7	Interpretation and Conclusions - Market Studies and Contracts	Ewan Wingate, WP	Ewan Wingate, WP Claude Duplessis, GMG
25.8	Interpretation and Conclusions - Capital and Operating Costs	Ewan Wingate, WP	Pascal Vallée, CWP Frédéric Côté, L. Nardella Associates Ltd
25.9	Interpretation and Conclusions - Economic Analysis	Ewan Wingate, WP	Gaston Gagnon, SGS Canada
26.1	Recommendations - Geology and Mineral Resources	Claude Duplessis, GMG	Claude Duplessis, GMG
26.2	Recommendations - Mining	Alex Topalovic, WP John Cairns, WP Amanda Fitch, WP	Alex Topalovic, WP

Section	Title of Section	Contributors	Qualified Persons
26.3	Recommendations - Mineral Processing and Metallurgical Testing	Michael Kelahan, PCLLC	Michael Kelahan, PCLLC
26.4	Recommendations - Tailings Storage Facility and Water Management	Hubert Guimont, Dessau	Hubert Guimont, Dessau
26.5	Recommendations - Infrastructure	Ewan Wingate, WP	Pascal Vallée, CWP Benoit Turgeon, CWP
26.6	Recommendations - Environment	Simon Latulippe, Genivar	Simon Latulippe, Genivar
27.0	References	Ewan Wingate, WP	Ewan Wingate, WP

Table 2.1.1 Qualified Persons and their Respective Sections Responsibility

The aforementioned consultants, in their field of relevant area of responsibilities, have provided Capital and Operating Cost estimates as well as Conclusions and Recommendations for the Study.

2.2 Sources of Information

The information presented in this Technical Report was derived from the CWP Feasibility Study work (writing of FS engineering report was under way at the time of the NI report publication). The Feasibility Study summarizes various studies and fieldwork done by Arianne and its Consultants for the development of the project. References are listed in Section 27.

2.3 Personal Inspection of the Property by Each Qualified Person

The following Qualified Persons visited the site in relation with this work:

- Ewan Wingate, Cegertec WorleyParsons visited the site on the 20th of September 2012.
- Michael Kelahan, PCLLC, visited the site on the 20th of September 2012.
- Alex Topalovic, Cegertec WorleyParsons, visited the site on the 20th of September 2012.
- Michaël Verreault, Hydro-Ressources, visited the site a total of seven (7) times between June and December 2012.
- Henry Lamb, PCLLC, visited the site on November 12, 2012.
- Claude Duplessis, Eng. GMG, visited the Lac a Paul Property site a total of six (6) times: on August 22-23, 2008, November 12-14, 2008, February 1-4, 2009, February 14-17, 2011, February 6-7, 2012, and November 12-15, 2012.

2.4 Units and Currency

In this report, all prices and costs are expressed in US Dollars (US$), except for the Royalties section where Canadian Dollars are used. Quantities are generally stated in Système International d'Unités

(SI) metric units, including metric tonnes (tonnes, t) for weight, and kilometer (km) or meters (m) for distance.

3. RELIANCE ON OTHER EXPERTS

Technical data provided by Arianne Phosphate Inc. for use by Cegertec WorleyParsons in this FS is the result of work conducted, supervised, and/or verified by Arianne's professional staff or their consultants. CWP has not independently verified the legal status or title of the claims or exploration permits, and has not investigated the legality of any of the underlying agreement(s) that may exist concerning the Property.

The Reports forming the basis of this Technical Report are listed in Section 27.

Cegertec WorleyParsons believes the supplied information to be reliable but does not guarantee the accuracy of conclusions, opinions, or estimates that rely on third party sources for information outside the area of technical expertise of CWP. As such, responsibilities for the various components of the Summary, Conclusions and Recommendations are dependent on the associated sections of the Report from which those components were developed.

Cegertec WorleyParsons relied on the following reports and opinions or Table 3.1.1 for information that is outside the area of technical expertise of Cegertec WorleyParsons:

Specialist	Area	Report Title	Report No.
Dessau	Tailings Storage Facility and Water Management	• Mine à ciel ouvert d'apatite Lac à Paul-Inventaire du milieu Rapport principal	• N/Réf. : 068-P041458-0100-EN-R100-00 PRÉFINAL 21 Décembre 2012
Genivar	Environmental studies, permitting and social or community impact	Projet de Mine d'Apatite du Lac a Paul Étude d'Impact sur l'Environnement	Report No. 121-24005-00 Juin 2013
Goldminds Geoservices Inc. (GMG)	• Property description and location • Accessibility, climate, local resources, infrastructure and physiography • History • Geology settings and mineralization • Deposit types • Exploration • Drilling • Sample preparation, analysis and security • Data verification	Technical Report Phosphate Resource Estimation Update 2013 of the Lac a Paul Property Deposit, Saguenay Lac St-Jean, Quebec, Canada	207090-19468-CLN-GOL-REP-0001 22 April 2013

Specialist	Area	Report Title	Report No.
	• Mineral resource estimates		
Hydro-Ressources Inc.	• Water management and hydrogeology • Mine dewatering	Services professionnels – Étude hydrogéologique Les Ressources d'Arianne Rapport Technique – Dossier PR12-117	207090-19468-CLN-REP-PR12-117 Juin 2013
Journeaux Associates	Mine pit slope design	Report on Pit Slope Design The Lac a Paul apatite-ilmenite report Arianne Resources Inc.	Report No. L-12-1558 March 28, 2013
CRU International	• Marketing study	The Lac a Paul Phosphate Project: Market Outlook and Competitive Position	CS Reference number: 430571 21 June 2013
Integer Research Ltd.	• Marketing study	Study in support of bankable feasibility for Arianne's Phosphate Lac a Paul phosphate rock deposit in Canada	207090-19468-CLN-INT-REP-0001-R0 July 2013
Ernst & Young	• Economic analysis		
Phosphate Consulting LLC	• Phosphate mineral processing		
Jacobs / COREM	• Phosphate beneficiation testwork	COREM: Validation of Apatite flowsheet using column flotation. Jacobs: Interim Testing Report Jacobs: RDA Interim Bench-Scale Status Report Jacobs: Final Beneficiation Test Work Report for Lac a Paul Apatite Project	Report NO.T1446, 24 May 2013 PN 28LB0200 October, 2012 PN 28LB0200 March, 2013 PN28LB0200, July 2013

Table 3.1.1 List of Reports and References

The Qualified Person Claude Duplessis (GMG) also relied on the independent survey company for the differential GPS topographic survey and the positioning of the holes in the field in addition to the Gyro survey carried out on most of the drill holes PAU-08-01 to PAU-12-97by IOS Services Géoscientifiques Inc. and other geological subcontractors of Arianne. Hand held GPS spot checks for diamond drill holes position and azimuth verification were done during site visits and have proven to be adequate in relation to drill hole database position and drill hole orientation.

This Report is intended to be used by Arianne Phosphate Inc. as a Technical Report with Canadian Securities Regulatory Authorities pursuant to provincial securities legislation. Except for the purposes contemplated under provincial securities laws, any other use of this Report by any third party is at the party's sole risk.

Permission is given to use portions of this Report to prepare advertising, press releases and publicity material, provided such advertising, press release and publicity material does not impose any additional obligations upon, or create liability for Cegertec WorleyParsons.

4. PROPERTY DESCRIPTION AND LOCATION

4.1 Location and Access

The Lac a Paul Property is located north of the Lac-Saint-Jean area and the nearest city with all major services is the city of Alma, located about 200 km south (see Figure 4.1.1). The village of Saint-Ludger-de-Milot is located at about 175 km south. The Lac a Paul Property is located at 35 km east of the Chute-des-Passes Hydro-Power complex of RioTintoAlcan.The Property is also located at 237 km north from the future loading dock of St-Fulgence, which will be a good connection to the open sea via the Saguenay and the St-Lawrence River.

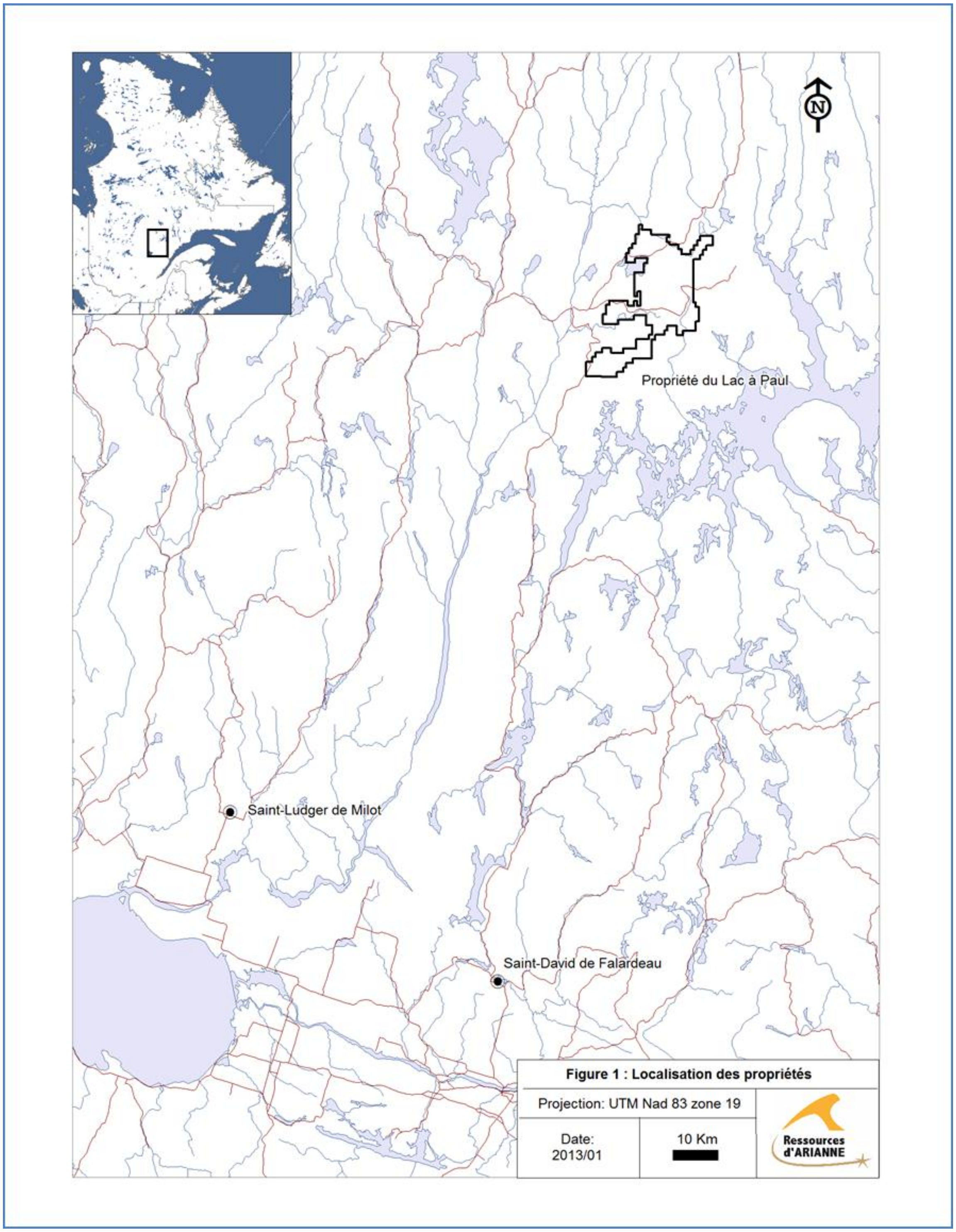


Figure 4.1.1 Location of the Lac a Paul Property in the Province of Quebec

The Property sits at latitude 49º 47' North and longitude 70º 50' west approximately. In the SNRC system, the references maps are 22E/10 and 22E/15.

4.2 Property Description

The Lac a Paul Property consists of 498 contiguous CDC (map-staked claims) with a total area of approximately 27,617 hectares on NTS Sheets 22E10 and 22E15.

All claims of the Lac a Paul Property are registered with the Ministry of Natural Resources of Quebec (GESTIM) and are not grafted with any environmental liabilities. The list of claims constituting the Property is presented in the following tables of this section.

Other blocks of claims belonging to Arianne, are also present in the NTS Sheets 22E10 and 22E15 as well as in neighboring 22E09 and 22E14. They constitute other phosphorus and titanium projects for Arianne (Zone 4; Pipmuacan; Duhamel and Chutes des Passes). The main Lac a Paul claim block has received all the required work and attention and is the purpose of this report.

The claims are registered in the Province of Quebec electronic system (GESTIM); they are in good standing at the moment of writing this report. There are no environmental liabilities of which we are aware.

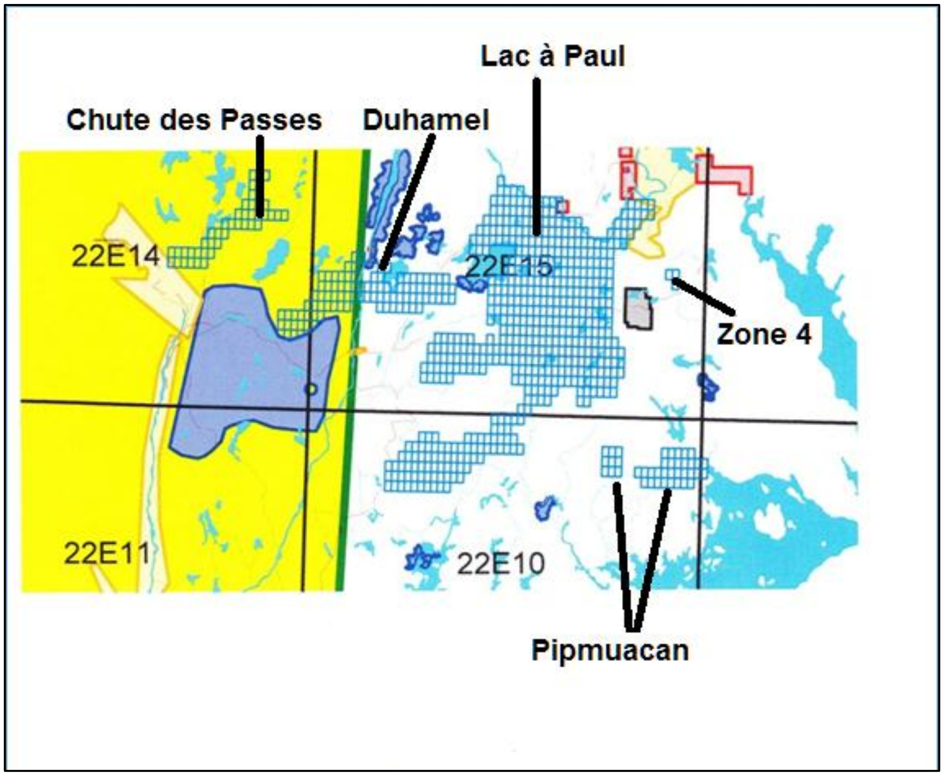


Figure 4.2.1 Lac a Paul Property Claims with Other Claim Blocks from GESTIM in 2013

All claims and the claims of interest for this study are under the EPOG (“Entente de Principe d’Ordre Général” or Agreement-in-Principle of General Nature) with the Nistassinan of Betsiamites native group.

4.3 Mineral Rights

Map designated cells, which define mineral titles according to the Québec mining law, are pre-established parcels of land, half a minute of arc by half a minute of arc on the NAD-83 projection, the limits of which are predefined by their longitude and latitude. These titles are almost irrevocable by the government, and unchallengeable by a third party. Their limits being defined by law, they do not need land surveying to be officialized. The map designated mineral titles confers exclusive rights to the owner to carry out mineral exploration, and to acquire the mining lease in the eventuality of exploitation. However, mineral rights do not include surface rights, nor does it include rights over resources other than mineral, such as forestry, surface and groundwater, cynegetic, halieutic, or hydroelectric. However such surface rights are included within the mining lease if the project is located on Crown land.

Claims have to be renewed every two years. Renewal date is dictated by the anniversary dates of individual claims. Claims are considered in good standing.

The Claims of Arianne Resources Inc. have been validated on the MNR Quebec GESTIM website and are listed in Tables 4.3.1 to 4.3.9.

Type de titre	No titre	Statut du titre	Détenteur(s) (Nom, Numéro et Pourcentage)	Feuillet	Date d'inscription	Date d'expiration	Superficie (Ha)	Seq Num
CDC	2190361	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2009-09-30	2014-05-01	55,65	1
CDC	2190362	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2009-09-30	2014-05-01	55,65	2
CDC	2274276	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-17	2014-05-01	55,66	3
CDC	2274277	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-17	2014-05-01	55,66	4
CDC	2274278	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-17	2014-05-01	55,66	5
CDC	2274280	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-17	2014-05-01	55,65	6
CDC	2274281	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-17	2014-05-01	55,65	7
CDC	2275077	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,71	8
CDC	2275078	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,71	9
CDC	2275079	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,71	10
CDC	2275080	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,71	11
CDC	2275081	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,71	12
CDC	2275083	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,7	13
CDC	2275084	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,7	14
CDC	2275085	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,7	15
CDC	2275086	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,7	16
CDC	2275087	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,7	17
CDC	2275088	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,7	18
CDC	2275089	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,7	19
CDC	2275090	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,7	20
CDC	2275091	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,7	21
CDC	2275092	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,7	22
CDC	2275093	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,7	23
CDC	2275094	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,69	24
CDC	2275097	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,69	25
CDC	2275098	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,69	26
CDC	2275099	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,69	27
CDC	2275100	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,69	28
CDC	2275101	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,69	29
CDC	2275102	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,69	30
CDC	2275103	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,69	31
CDC	2275104	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,68	32
CDC	2275105	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,68	33
CDC	2275106	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,68	34
CDC	2275107	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,68	35
CDC	2275108	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,68	36
CDC	2275109	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,68	37
CDC	2275110	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,68	38
CDC	2275111	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,68	39
CDC	2275112	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,68	40
CDC	2275113	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,68	41
CDC	2275114	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,68	42
CDC	2275115	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,67	43
CDC	2275116	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-24	2014-05-01	55,67	44
CDC	2275350	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,72	45
CDC	2275351	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,71	46
CDC	2275352	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,71	47
CDC	2275357	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,71	48
CDC	2275360	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,7	49
CDC	2275364	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,69	50
CDC	2275365	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,68	51
CDC	2275366	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,68	52
CDC	2275368	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,67	53
CDC	2275369	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,67	54
CDC	2275370	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,67	55

Table 4.3.1 Mining Titles List (1) from MNR GESTIM Mining Title Management System

Type de titre	No titre	Statut du titre	Détenteur(s) (Nom, Numéro et Pourcentage)	Feuillet	Date d'inscription	Date d'expiration	Superficie (Ha)	Seq Num
CDC	2275373	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,67	56
CDC	2275374	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,67	57
CDC	2275375	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,67	58
CDC	2275376	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,67	59
CDC	2275380	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,67	60
CDC	2275381	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,66	61
CDC	2275382	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,66	62
CDC	2275383	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,66	63
CDC	2275384	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2011-02-25	2014-05-01	55,66	64
CDC	2355377	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,72	65
CDC	2355378	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,72	66
CDC	2355379	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,71	67
CDC	2355380	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,71	68
CDC	2355381	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,71	69
CDC	2355382	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,71	70
CDC	2355383	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,71	71
CDC	2355384	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,7	72
CDC	2355385	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,7	73
CDC	2355386	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,69	74
CDC	2355387	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,69	75
CDC	2355388	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,69	76
CDC	2355389	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,69	77
CDC	2355390	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,69	78
CDC	2355391	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,68	79
CDC	2355392	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,67	80
CDC	2355393	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,67	81
CDC	2355394	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,67	82
CDC	2355395	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,67	83
CDC	2355396	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,67	84
CDC	2355397	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E10	2012-07-17	2014-07-16	55,65	85
CDC	1024230	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-09-04	2014-05-01	55,55	86
CDC	1024231	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-09-04	2014-05-01	55,55	87
CDC	1024232	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-09-04	2014-05-01	55,55	88
CDC	1024233	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-09-04	2014-05-01	55,54	89
CDC	1024234	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-09-04	2014-05-01	55,54	90
CDC	1024235	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-09-04	2014-05-01	55,54	91
CDC	1024236	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-09-04	2014-05-01	55,54	92
CDC	1024237	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-09-04	2014-05-01	55,53	93
CDC	1024238	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-09-04	2014-05-01	55,53	94
CDC	1024239	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-09-04	2014-05-01	55,53	95
CDC	1025896	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-11-02	2014-05-01	55,6	96
CDC	1025897	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2001-11-02	2014-05-01	55,6	97
CDC	1038320	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2002-01-24	2014-05-01	55,61	98
CDC	1038321	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2002-01-24	2014-05-01	55,61	99
CDC	1038322	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2002-01-24	2014-05-01	55,6	100
CDC	2121340	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-09-13	2014-05-01	55,48	101
CDC	2121341	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-09-13	2014-05-01	55,48	102
CDC	2125492	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,53	103
CDC	2125493	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,52	104
CDC	2125494	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,52	105
CDC	2125495	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,52	106
CDC	2125496	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,52	107
CDC	2125497	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,51	108
CDC	2125498	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,51	109
CDC	2125499	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,51	110
CDC	2125500	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,51	111
CDC	2125501	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,51	112

Table 4.3.2 Mining Titles List (2) from MNR GESTIM Mining Title Management System

Type de titre	No titre	Statut du titre	Détenteur(s) (Nom, Numéro et Pourcentage)	Feuillet	Date d'inscription	Date d'expiration	Superficie (Ha)	Seq Num
CDC	2125502	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,5	113
CDC	2125503	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,5	114
CDC	2125504	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,5	115
CDC	2125505	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,5	116
CDC	2125506	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,5	117
CDC	2125507	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,5	118
CDC	2125508	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,49	119
CDC	2125509	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,49	120
CDC	2125510	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,49	121
CDC	2125511	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,49	122
CDC	2125512	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,49	123
CDC	2125513	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,49	124
CDC	2125514	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,48	125
CDC	2125515	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,48	126
CDC	2125516	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,48	127
CDC	2125517	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,48	128
CDC	2125518	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,47	129
CDC	2125519	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,47	130
CDC	2125520	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,47	131
CDC	2125521	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,47	132
CDC	2125522	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,47	133
CDC	2125523	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-02	2014-05-01	55,47	134
CDC	2129818	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-16	2014-05-01	55,47	135
CDC	2129819	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2007-10-16	2014-05-01	55,47	136
CDC	2167400	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,59	137
CDC	2167401	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,59	138
CDC	2167402	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,58	139
CDC	2167403	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,58	140
CDC	2167404	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,58	141
CDC	2167451	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,56	142
CDC	2167452	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,56	143
CDC	2167453	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,56	144
CDC	2167454	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,55	145
CDC	2167455	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,54	146
CDC	2167456	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,53	147
CDC	2167457	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,49	148
CDC	2167458	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,48	149
CDC	2167459	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,48	150
CDC	2167460	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,48	151
CDC	2167461	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,47	152
CDC	2167462	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,47	153
CDC	2167463	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,47	154
CDC	2167464	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,47	155
CDC	2167465	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,47	156
CDC	2167466	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,47	157
CDC	2167467	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,47	158
CDC	2167468	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,47	159
CDC	2167469	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,47	160
CDC	2167470	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,47	161
CDC	2167471	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,47	162
CDC	2167472	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,46	163
CDC	2167473	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,46	164
CDC	2167474	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,46	165

Table 4.3.3 Mining Titles List (3) from MNR GESTIM Mining Title Management System

Type de titre	No titre	Statut du titre	Détenteur(s) (Nom, Numéro et Pourcentage)	Feuillet	Date d'inscription	Date d'expiration	Superficie (Ha)	Seq Num
CDC	2167475	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,46	166
CDC	2167476	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,46	167
CDC	2167477	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,46	168
CDC	2167478	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-24	2014-05-01	55,46	169
CDC	2167817	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-28	2014-05-01	55,61	170
CDC	2167818	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-28	2014-05-01	55,61	171
CDC	2167819	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-28	2014-05-01	55,61	172
CDC	2167820	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-28	2014-05-01	55,61	173
CDC	2167822	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-28	2014-05-01	55,61	174
CDC	2167823	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-28	2014-05-01	55,6	175
CDC	2167824	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-28	2014-05-01	55,6	176
CDC	2167825	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-07-28	2014-05-01	55,6	177
CDC	2169733	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,56	178
CDC	2169734	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,56	179
CDC	2169735	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,56	180
CDC	2169736	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,56	181
CDC	2169737	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,56	182
CDC	2169738	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,56	183
CDC	2169739	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,56	184
CDC	2169740	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,56	185
CDC	2169741	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,56	186
CDC	2169746	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	187
CDC	2169747	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	188
CDC	2169748	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	189
CDC	2169749	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	190
CDC	2169750	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	191
CDC	2169751	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	192
CDC	2169752	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	193
CDC	2169753	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	194
CDC	2169754	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	195
CDC	2169755	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	196
CDC	2169756	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	197
CDC	2169757	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	198
CDC	2169758	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,55	199
CDC	2169759	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,54	200
CDC	2169760	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,54	201
CDC	2169761	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,54	202
CDC	2169762	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,53	203
CDC	2169763	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,53	204
CDC	2169764	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,53	205
CDC	2169765	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,52	206
CDC	2169766	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,52	207
CDC	2169767	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,52	208
CDC	2169768	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-08	2014-05-01	55,51	209
CDC	2170444	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,59	210
CDC	2170445	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,59	211
CDC	2170446	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,59	212
CDC	2170447	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,59	213
CDC	2170448	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,59	214
CDC	2170449	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,59	215
CDC	2170450	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,59	216
CDC	2170451	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,59	217
CDC	2170452	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,59	218
CDC	2170453	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,59	219
CDC	2170454	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,59	220
CDC	2170455	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,58	221
CDC	2170456	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,58	222
CDC	2170457	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,58	223
CDC	2170458	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,58	224
CDC	2170459	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,58	225

Table 4.3.4 Mining Titles List (4) from MNR GESTIM Mining Title Management System

Type de titre	No titre	Statut du titre	Détenteur(s) (Nom, Numéro et Pourcentage)	Feuillet	Date d'inscription	Date d'expiration	Superficie (Ha)	Seq Num
CDC	2170460	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,58	226
CDC	2170461	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,58	227
CDC	2170462	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,58	228
CDC	2170463	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,58	229
CDC	2170464	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,58	230
CDC	2170465	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,58	231
CDC	2170467	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,57	232
CDC	2170468	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,57	233
CDC	2170469	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,57	234
CDC	2170470	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,57	235
CDC	2170471	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,57	236
CDC	2170472	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,57	237
CDC	2170473	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,57	238
CDC	2170474	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,57	239
CDC	2170475	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,57	240
CDC	2170476	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,57	241
CDC	2170477	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2008-08-22	2014-05-01	55,57	242
CDC	2183184	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-11	2014-05-01	55,61	243
CDC	2183185	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-11	2014-05-01	55,61	244
CDC	2183186	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-11	2014-05-01	55,6	245
CDC	2183188	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-11	2014-05-01	55,6	246
CDC	2183189	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-11	2014-05-01	55,6	247
CDC	2183190	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-11	2014-05-01	55,6	248
CDC	2183191	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-11	2014-05-01	55,6	249
CDC	2183192	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-11	2014-05-01	55,6	250
CDC	2183193	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-11	2014-05-01	55,59	251
CDC	2183404	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-27	2014-05-01	55,62	252
CDC	2183405	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-27	2014-05-01	55,62	253
CDC	2183406	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-27	2014-05-01	55,61	254
CDC	2183407	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-27	2014-05-01	55,61	255
CDC	2183408	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-27	2014-05-01	55,61	256
CDC	2183409	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-27	2014-05-01	55,61	257
CDC	2183411	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-05-27	2014-05-01	55,6	258
CDC	2190169	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-29	2014-05-01	55,48	259
CDC	2190170	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-29	2014-05-01	55,48	260
CDC	2190171	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-29	2014-05-01	55,48	261
CDC	2190172	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-29	2014-05-01	55,48	262
CDC	2190173	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-29	2014-05-01	55,48	263
CDC	2190363	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,64	264
CDC	2190364	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,61	265
CDC	2190365	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,6	266
CDC	2190366	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,6	267
CDC	2190367	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,6	268
CDC	2190368	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,6	269
CDC	2190369	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,6	270
CDC	2190370	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,6	271
CDC	2190371	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,59	272
CDC	2190372	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,59	273
CDC	2190373	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,59	274
CDC	2190374	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,59	275
CDC	2190375	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,58	276
CDC	2190376	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,58	277
CDC	2190377	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,58	278
CDC	2190378	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,57	279
CDC	2190379	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,54	280
CDC	2190380	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-09-30	2014-05-01	55,53	281
CDC	2190738	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,64	282
CDC	2190739	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,63	283
CDC	2190740	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,63	284
CDC	2190741	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,63	285

Table 4.3.5 Mining Titles List (5) from MNR GESTIM Mining Title Management System

Type de titre	No titre	Statut du titre	Détenteur(s) (Nom, Numéro et Pourcentage)	Feuillet	Date d'inscription	Date d'expiration	Superficie (Ha)	Seq Num
CDC	2190742	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,63	286
CDC	2190743	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,62	287
CDC	2190744	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,62	288
CDC	2190745	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,62	289
CDC	2190746	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,62	290
CDC	2190747	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,62	291
CDC	2190748	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,61	292
CDC	2190749	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,61	293
CDC	2190750	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,61	294
CDC	2190751	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,59	295
CDC	2190752	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,59	296
CDC	2190753	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,59	297
CDC	2190754	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,59	298
CDC	2190755	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,59	299
CDC	2190756	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,58	300
CDC	2190757	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,58	301
CDC	2190758	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,58	302
CDC	2190759	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,58	303
CDC	2190760	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,58	304
CDC	2190761	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,57	305
CDC	2190762	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,57	306
CDC	2190763	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,57	307
CDC	2190764	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,57	308
CDC	2190765	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,57	309
CDC	2190766	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,56	310
CDC	2190767	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,56	311
CDC	2190768	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,56	312
CDC	2190769	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,56	313
CDC	2190770	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,56	314
CDC	2190771	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,54	315
CDC	2190772	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,54	316
CDC	2190773	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,54	317
CDC	2190774	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,54	318
CDC	2190775	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,53	319
CDC	2190776	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,52	320
CDC	2190777	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2009-10-05	2014-05-01	55,52	321
CDC	2205947	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,61	322
CDC	2205948	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,53	323
CDC	2205949	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,52	324
CDC	2205950	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,51	325
CDC	2205951	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,51	326
CDC	2205952	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,5	327
CDC	2205953	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,5	328
CDC	2205954	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,49	329
CDC	2205955	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,48	330
CDC	2205956	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,48	331
CDC	2205957	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,48	332
CDC	2205958	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,47	333
CDC	2205959	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,46	334
CDC	2205960	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,46	335
CDC	2205961	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,46	336
CDC	2205962	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,46	337
CDC	2205963	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,46	338
CDC	2205964	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,46	339
CDC	2205965	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,46	340

Table 4.3.6 Mining Titles List (6) from MNR GESTIM Mining Title Management System

Type de titre	No titre	Statut du titre	Détenteur(s) (Nom, Numéro et Pourcentage)	Feuillet	Date d'inscription	Date d'expiration	Superficie (Ha)	Seq Num
CDC	2205966	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,46	341
CDC	2205967	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,45	342
CDC	2205968	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-02-18	2014-05-01	55,45	343
CDC	2208073	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-03-01	2014-05-01	55,6	344
CDC	2208074	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-03-01	2014-05-01	55,6	345
CDC	2208075	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-03-01	2014-05-01	55,6	346
CDC	2208076	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-03-01	2014-05-01	55,6	347
CDC	2215082	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-04-16	2014-05-01	55,58	348
CDC	2215083	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-04-16	2014-05-01	55,57	349
CDC	2246474	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,61	350
CDC	2246475	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,61	351
CDC	2246476	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,61	352
CDC	2246477	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,6	353
CDC	2246478	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,6	354
CDC	2246479	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,6	355
CDC	2246480	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,59	356
CDC	2246481	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,59	357
CDC	2246482	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,59	358
CDC	2246483	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,59	359
CDC	2246484	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,59	360
CDC	2246485	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,59	361
CDC	2246486	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,59	362
CDC	2246487	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,59	363
CDC	2246488	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,58	364
CDC	2246489	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,58	365
CDC	2246490	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2010-08-17	2014-05-01	55,58	366
CDC	2273982	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,54	367
CDC	2273983	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,54	368
CDC	2273984	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,54	369
CDC	2273985	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,54	370
CDC	2273986	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,54	371
CDC	2273987	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,53	372
CDC	2273988	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,53	373
CDC	2273989	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,53	374
CDC	2273990	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,53	375
CDC	2273991	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,52	376
CDC	2273992	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,51	377
CDC	2273993	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,51	378
CDC	2273994	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,51	379
CDC	2273995	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,51	380
CDC	2273996	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,5	381
CDC	2273997	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,5	382
CDC	2273998	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,5	383
CDC	2273999	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,5	384
CDC	2274000	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,49	385
CDC	2274001	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,49	386
CDC	2274002	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,49	387
CDC	2274003	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,49	388
CDC	2274004	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,49	389
CDC	2274005	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,49	390
CDC	2274006	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,48	391
CDC	2274007	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,48	392
CDC	2274008	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,47	393
CDC	2274009	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,47	394
CDC	2274010	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,46	395
CDC	2274011	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,46	396
CDC	2274012	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,45	397
CDC	2274013	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,45	398
CDC	2274014	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,45	399
CDC	2274015	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,45	400

Table 4.3.7 Mining Titles List (7) from MNR GESTIM Mining Title Management System

Type de titre	No titre	Statut du titre	Détenteur(s) (Nom, Numéro et Pourcentage)	Feuillet	Date d'inscription	Date d'expiration	Superficie (Ha)	Seq Num
CDC	2274016	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,45	401
CDC	2274017	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,45	402
CDC	2274018	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,45	403
CDC	2274019	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,45	404
CDC	2274020	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,45	405
CDC	2274021	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-16	2014-05-01	55,45	406
CDC	2274282	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,61	407
CDC	2274283	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,61	408
CDC	2274284	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,6	409
CDC	2274285	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,6	410
CDC	2274286	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,58	411
CDC	2274287	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,58	412
CDC	2274288	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,58	413
CDC	2274289	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,58	414
CDC	2274290	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,57	415
CDC	2274291	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,57	416
CDC	2274292	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,57	417
CDC	2274293	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,57	418
CDC	2274294	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,57	419
CDC	2274295	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,57	420
CDC	2274296	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,57	421
CDC	2274297	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,55	422
CDC	2274298	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,54	423
CDC	2274299	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,53	424
CDC	2274300	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,53	425
CDC	2274301	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,53	426
CDC	2274302	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,53	427
CDC	2274303	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,52	428
CDC	2274304	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,52	429
CDC	2274305	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,52	430
CDC	2274306	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,52	431
CDC	2274307	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,52	432
CDC	2274308	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,52	433
CDC	2274309	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,52	434
CDC	2274310	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,52	435
CDC	2274311	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,51	436
CDC	2274312	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,51	437
CDC	2274313	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,51	438
CDC	2274314	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,51	439
CDC	2274315	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,5	440
CDC	2274316	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,5	441
CDC	2274317	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,5	442
CDC	2274318	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,5	443
CDC	2274319	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,49	444
CDC	2274320	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,49	445
CDC	2274321	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-02-17	2014-05-01	55,49	446
CDC	2343516	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-07	2014-05-06	55,43	447
CDC	2343517	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-07	2014-05-06	55,42	448
CDC	2345779	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,51	449
CDC	2345780	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,49	450

Table 4.3.8 Mining Titles List (8) from MNR GESTIM Mining Title Management System

Type de titre	No titre	Statut du titre	Détenteur(s) (Nom, Numéro et Pourcentage)	Feuillet	Date d'inscription	Date d'expiration	Superficie (Ha)	Seq Num
CDC	2345781	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,49	451
CDC	2345782	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,48	452
CDC	2345783	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,48	453
CDC	2345784	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,48	454
CDC	2345785	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,47	455
CDC	2345786	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,46	456
CDC	2345787	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,45	457
CDC	2345788	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,45	458
CDC	2345789	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,45	459
CDC	2345790	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,44	460
CDC	2345791	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,44	461
CDC	2345792	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,44	462
CDC	2345793	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,44	463
CDC	2345794	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,44	464
CDC	2345795	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,44	465
CDC	2345796	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,44	466
CDC	2345797	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,44	467
CDC	2345798	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,44	468
CDC	2345799	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,44	469
CDC	2345800	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,43	470
CDC	2345801	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-05-22	2014-05-21	55,43	471
CDC	2351633	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-06-15	2014-06-14	55,51	472
CDC	2351634	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-06-15	2014-06-14	55,51	473
CDC	2351635	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-06-15	2014-06-14	55,43	474
CDC	2351830	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-06-15	2014-06-18	29,69	475
CDC	2351831	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2012-06-15	2014-06-18	30,88	476
CDC	2315180	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,61	477
CDC	2315181	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,6	478
CDC	2315182	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,47	479
CDC	2315183	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,47	480
CDC	2315184	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,47	481
CDC	2315185	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,46	482
CDC	2315186	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,46	483
CDC	2315187	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,46	484
CDC	2315188	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,46	485
CDC	2315189	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,45	486
CDC	2315190	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,45	487
CDC	2315191	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,45	488
CDC	2315192	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,45	489
CDC	2315193	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,44	490
CDC	2315194	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,44	491
CDC	2315195	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,44	492
CDC	2315196	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,44	493
CDC	2315197	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,44	494
CDC	2315198	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,43	495
CDC	2315199	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,43	496
CDC	2315200	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,43	497
CDC	2315201	Actif	Arianne Phosphate inc. (92297) 100 % (responsable)	SNRC 22E15	2011-10-03	2015-10-02	55,32	498

Table 4.3.9 Mining Titles List (9) from MNR GESTIM Mining Title Management System

Titulaire

Définir le titulaire:

Nom : Arianne Phosphate inc. (92297)
Adresse : 30, Racine Est, suite 160
Ville : Chicoutimi
Province : Québec
Pays : Canada
Code postal : G7H 1P5

Figure 4.3.1 Screen Capture Validation Window of Owner's Status of the Titles on Line from GESTIM

The claims are 100% owned by Arianne Phosphate Inc.

4.4 Royalties

To the Author's knowledge the identified royalties are:

- All claims of the Lac a Paul Property are grafted with a CAD $12M mortgage at an annual interest rate of 25% since August 2012 (act 54 736 on the GESTIM site, MNR); Net Smelter Return (NSR) of CAD $1/ton production fee is attached to all phosphate rock concentrate sales from the Project. The production fee can be repurchased at anytime for a lump sum payment of CAD $6 million.
- All claims of the Lac a Paul Property are now grafted with an additional CAD $3M mortgage at an annual interest rate of 25% since August 2013 (act 55 270 on the MNR GESTIM site); NSR of CAD $0.25/tonne production fee is attached to all phosphate rock concentrate sales from the Project. The production fee can be repurchased at anytime for a lump sum payment of CAD $1.5 Million.
- Arianne is the owner of 100% of the mining claims that make up the Property. A dozen claims (CDC 1024230 to 1024239 on Zone No. 1 and CDC1025896 and 1025897 on Zone No. 2), previously held by the Fond Minier du Saguenay-Lac-Saint-Jean (FMSLSJ), are however subject to a 1.5% NSR royalty; an additional 0.5% NSR is applicable over a 2 km radius around the latter claims. These two NSR royalties, for which the recipient is the FMSLSJ, remain applicable and may be repurchased at any time for CAD $500,000.
- Finally, four (4) other claims, two on the Paul Zone (CDC 212818 and 212819) and two on the Manouane Zone (CDC 2121340 and 2121341), are grafted with a 0.75% NSR. This is redeemable at any time for the sum of CAD $500,000; the recipient is Mr. James L. Dierzen.

There is no additional royalties applied to other property claims. In order to maintain an active status of their claims, Arianne is required to perform exploration work meeting the standards established by the Ministry of Natural Resources of Quebec (see map-staked claims or CDC).

Important clarification in relation to financing attached to the mortgages:

Arianne, as borrower, entered into agreement with the Lender with two (2) credit agreements: the CAD $10,000,000 credit agreement dated as of August 21, 2012, and the CAD $2,500,000 credit agreement dated as of July 29, 2013.

The interest rate for both credit agreements can be simplified as: The Borrower shall pay the Lender interest on the Loan on the basis of 3 month CDOR (Canadian Dealer Offered Rate) plus 500 basis points (5%), which is approximately a 6.9% annual rate.

The existing terms and conditions of financing attached to the Property in relation to mortgage in favor of Mercury Financing Corporation, could put at risk the continuation of the Property ownership by Arianne Phosphate Inc. in 2015, should the company fail to comply with its financial obligations.

4.5 Organization and restrictions

The Property is located on Crown land ("Territoires non organisés", non organized territories), within the Fjord du Saguenay Regional County Municipality RCM), Saguenay-Lac-St-Jean administrative division (02).

Many mining constraints are found along the Lac a Paul Property. However, they do not go against the project as such, but must be taken into account. These are shown in the next figure and are described below. It is appropriate to note that none of these are within the area covered by all the claims of the mining Property.

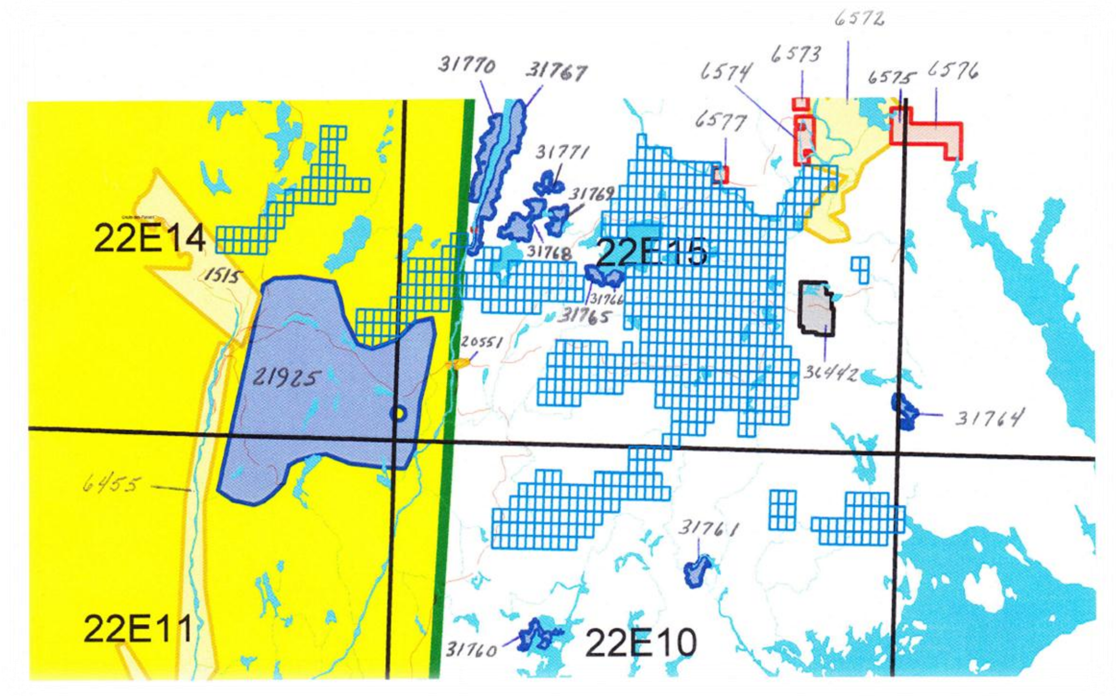


Figure 4.5.1 Mining Constraints in the Area of the Lac a Paul Property

Following is a description of each constraint located in the mining sector of the Lac a Paul Property and sourced from the GESTIM MNR Quebec site.

Constraints **6572 to 6577** are issued pursuant to the **Ministerial Order 2004-028**: subtraction from staking, map designation, mining exploration or mining and reserve to the State for the purposes of land hydroelectric project Betsiamites, MRC Le Fjord-du-Saguenay, Chicoutimi division (in the reserve to the State, prior consultation with Hydro-Québec is required for the exploration and exploitation).

Number	Type of constraint	Name	Effective date	Mining Activities	Sand and Gravel permitted
6572 to 6577	Hydroelectric development	Betsiamites	2004/07/28	Exploration permitted under conditions	Yes

Constraints 31760, 31761, 31764 to 31771 are issued pursuant to the temporary suspension of the granting of mining 20111208-A (Temporary suspension for land designated as biological refuges).

Number	Type of constraint	Name	Effective date	Mining Activities	Sand and Gravel permitted
31760, 31761, 31764 to 31771	Biological Refuge	Biological Refuge 02452R014 - 15 and 18 to 25	2011/12/08	Exploration prohibited	No

Constraint 20551 is issued in accordance with the Mining Act L.R.Q., c. M-13.1; legal reference c. III a. 70 (When on land in the domain of the State, before the registration of a claim, if there is already a plan prescribed by law or where the land is already subject to an assignment or lease under section 239, the holder of the claim must obtain permission from the Minister and comply with the Ministry's prevailing conditions prior to performing work).

Number	Type of constraint	Name	Effective date	Mining Activities	Sand and Gravel permitted
20551	Experimental Forest	Rivière-Manouane A	1997/06/11	Exploration permitted under conditions	Yes

Constraint 21925 is issued in accordance with the temporary suspension of the granting of mining titles • 20080827-A (Temporary suspension for the territories of interest TI-C62 (expansion) and IT-D41 for the purposes of protected area projects (NTS Sheets 22E/10, 22E/11, 22E/14, 22E/15, 21M/12, 31P/08 and 31P/09)).

Number	Type of constraint	Name	Effective date	Mining Activities	Sand and Gravel permitted
21925	Protected area project	T1-D41	2008/08/27	Exploration prohibited	No

Constraint 1515 is issued in accordance with the Mining Act L.R.Q., c. M-13.1; legal reference c. III a. 32, para. 4° (Whoever's stakes must have been previously Authorized by the Minister in the case of land: 4° reserved to the State by ministerial order under section 1° of the first paragraph of Article 304;).

Number	Type of constraint	Name	Effective date	Mining Activities	Sand and Gravel permitted
1515	Hydroelectric development		1988/11/24	Exploration permitted under conditions	No

Constraint 6455 is issued following the Ministerial Order 2004-046 (the state reserve land for the purposes of hydroelectric project Péribonka, Division of Chicoutimi (Consultation with Hydro-Québec for work exploration and exploitation)).

Number	Type of constraint	Name	Effective date	Mining Activities	Sand and Gravel permitted
6455	Hydroelectric development	Rivière Péribonka	2004/11/10	Exploration permitted under conditions	No

Constraint 36442 is issued in accordance with the Mining Act L.R.Q., c. M-13.1; legal references c. III, a. 58 (The Minister may make any decision concerning the amount of land that is the subject of a claim, where there is overlap or when the land surface, the orientation or the side length of the field is not consistent with this Act or its implementing regulations).

Displacement of a stake: for the purposes of the first paragraph, the Minister may give permission to move, disturb or replace a post that defines a staked field. It may also order a survey of the Property that is the subject of a claim. c. III, a. 29 (No stake or map designation, subject to Article 92, a Property that is the subject of an exploration license or mining land that is the subject of a mining concession, a mining lease, a mining lease application or an application for conversion of mining rights referred to in sub-section 5 of section III of this chapter). c. III, a. 58.1 (The Minister may make any decision regarding the conversion of a staked into map designated claim, merger or substitution map-designated claims).

Number	Type of constraint	Name	Effective date	Mining Activities	Sand and Gravel permitted
36442	Referral to minister	Referral to min. art.58-ss, conversion:2012-11-29, req.1255283	2012/11/29	Staking and map designation prohibited	No

Also, small cabins constructed and used by hunters are scattered over the territory covered by the claims of the Property. However, no inventory of these cabins has been made by Arianne. They are permitted by the MNR and are not permanent; these can be moved if necessary.

The Pourvoirie du Lac a Paul, an outfitting camp, owned the exclusive fishing and hunting rights over an area which encompasses the northern part of the Arianne's Property, including the Paul occurrence. No infrastructures belonging to this outfitter was located within the Property. It was considered that the presence of this outfitter shall not be a hindrance to Arianne's exploration work, assuming that Arianne did not conduct any work during moose hunting season. However, in the event of a mining development on the Paul Zone, interference with the outfitter's activities was expected. Arianne therefore decided in November 2011 to purchase the outfitter's camp so that it is no longer considered as a hindrance to the Project.

4.6 Native rights

The Lac a Paul Property lies within the ancestral territories (Nitassinan) claimed by the First Nations of Pessamit under the 2004 Agreement in Principle of General Nature. The concentrate transportation road should take place within the Nitassinan of Pessamit, Mashteuiatsh and Essipit.

Land claims from the Montagnais nation were partly resolved by the Agreement in Principle (EPOG) signed with the Québec government. Arianne must request authorization from community councils prior to proceeding with exploration work or logging; authorization is embedded within the government permit.

There are likely to be ancestral trap lines within the project area. Arianne was able to meet with the following tallymen: Mr. Alain Nepton, located north of the Property, Mr. Camil Valin on the south west and Mr. Adelard Benjamin on the north east. There are no known trap lines on the deposit sector.

Arianne is conducting information sessions and consultations with Native Nations representatives in relation to the Project.

5. ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 Accessibility

It is possible to access the Property by two well-maintained gravel roads used by large lumber trucks. The first access road, called “Chemin-des-Passes”, begins at the village of Saint-Ludger-de-Milot, north of Alma city. This road was built by the Alcan Company (now RioTintoAlcan) during the “Chute des Passes” dam construction in the southern boundary of the Péribonka reservoir (see Figure 5.1.1). Since then, forestry companies have added a multitude of other paths to provide good access to the region. The main road goes through the forest from the SW region to the NE. The second access road begins at the Saint-David-de-Falardeau village north of Chicoutimi.

There are no communities in the vicinity of the Project. A small settlement exists at Chute des-Passes, about 35 km from the Property, where a logging camp, some conveniences and a few cabins are present. Some services are also available at Alcan's Chutes-des-Passes and Hydro-Québec's

Péribonka hydro-electric complexes, at various logging camps as well as at outfitters and floatplane bases.

Arianne currently has a basic exploration camp located within the Property with services (see Figure 5.1.2).

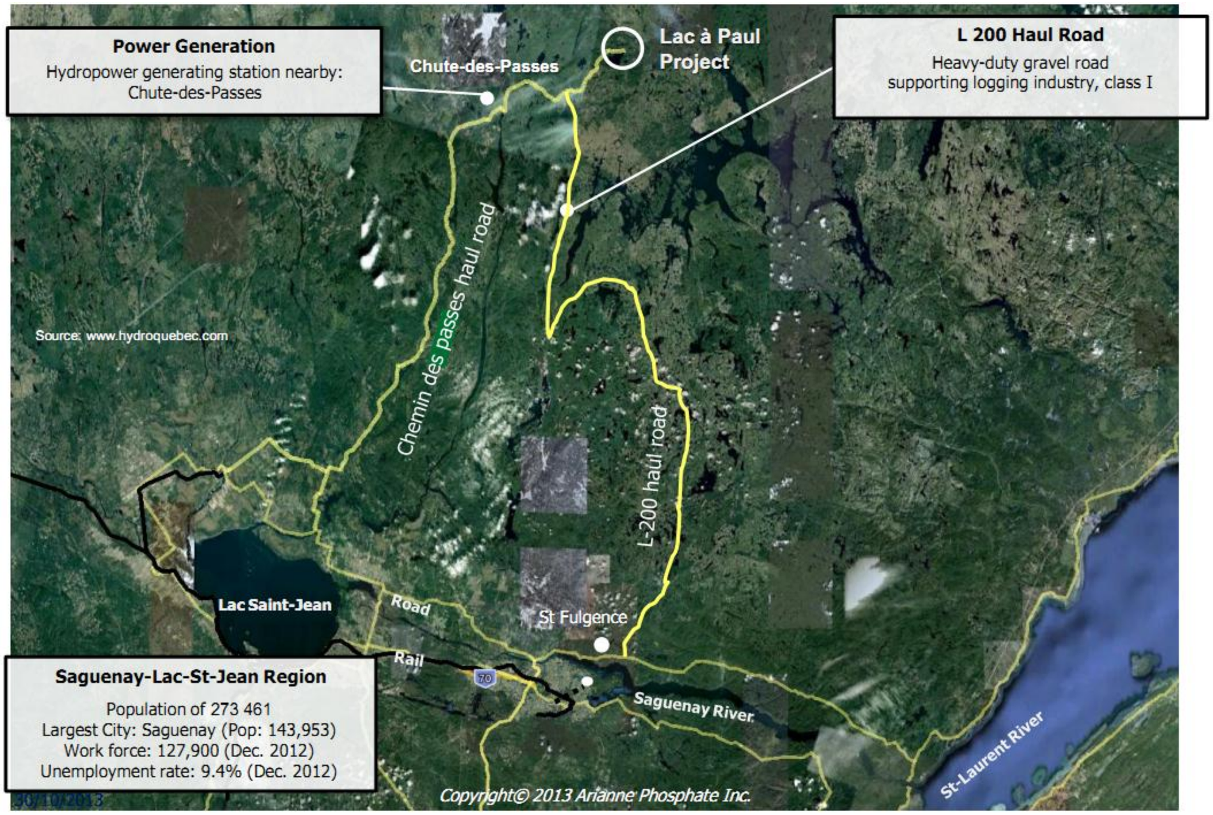


Figure 5.1.1 Main Access Roads to the Lac a Paul Project

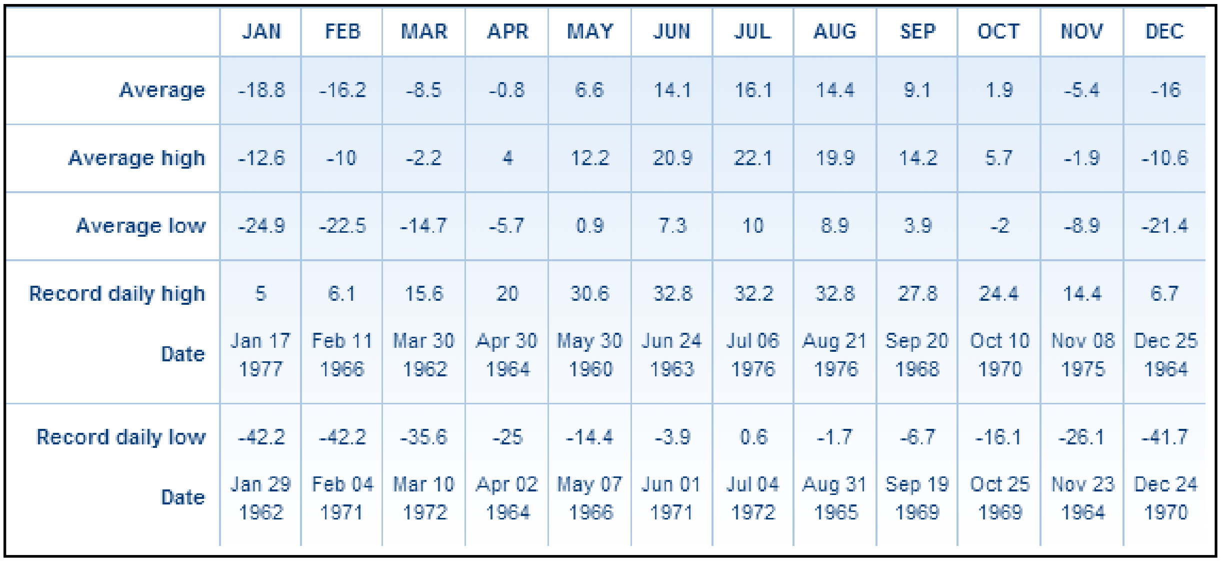
Figure 5.1.2 Lac a Paul Camp during Site Visit in November 2012

5.2 Climate

Statistics from the Météomédia website, on Tuesday, January 22, 2013, for the Chute-des-Passes sector are presented below. Latitude: 49.80°N, Longitude: 071.20°W, Altitude: 398.2 m.

The weather statistics presented in Tables 5.2.1 to 5.2.6 below show the average values of various meteorological parameters on a monthly basis over a 30 year period. Record maximum and minimum values are updated annually.

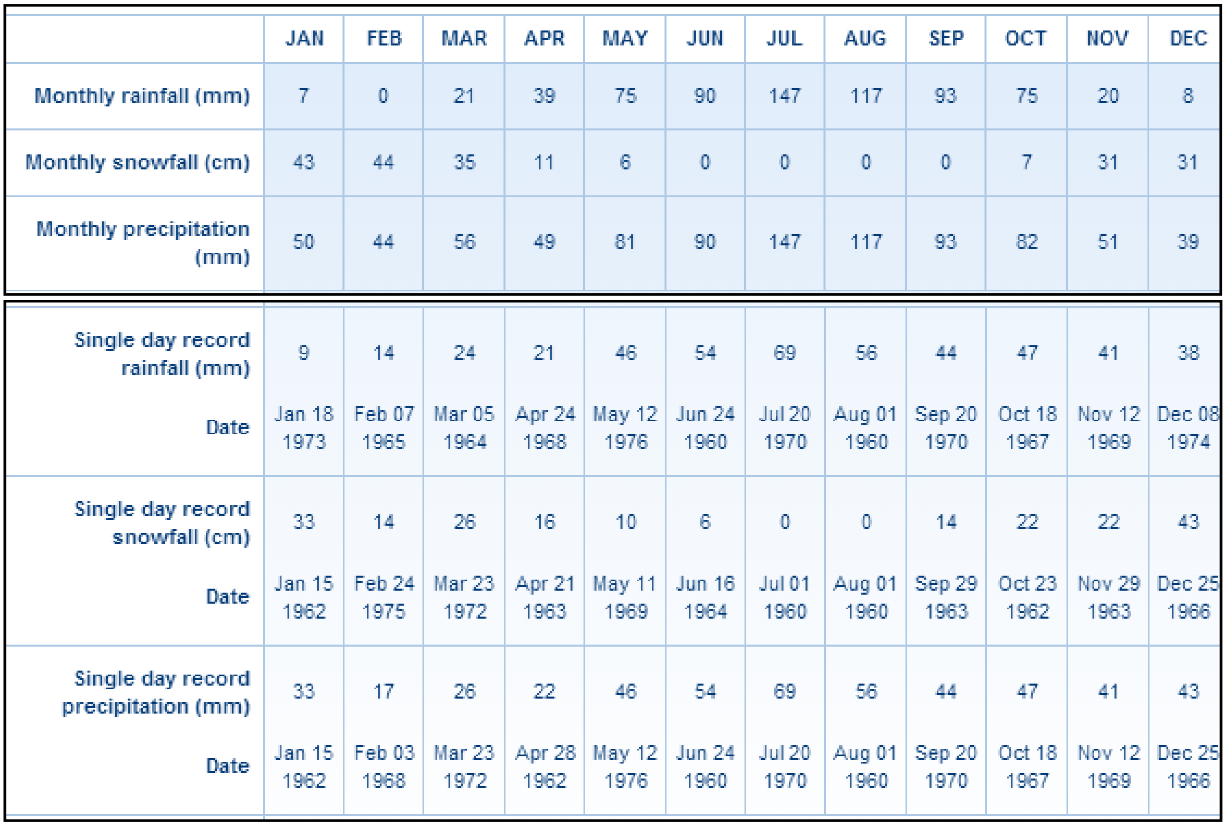
Temperature



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average	-18.8	-16.2	-8.5	-0.8	6.6	14.1	16.1	14.4	9.1	1.9	-5.4	-16
Average high	-12.6	-10	-2.2	4	12.2	20.9	22.1	19.9	14.2	5.7	-1.9	-10.6
Average low	-24.9	-22.5	-14.7	-5.7	0.9	7.3	10	8.9	3.9	-2	-8.9	-21.4
Record daily high	5	6.1	15.6	20	30.6	32.8	32.2	32.8	27.8	24.4	14.4	6.7
Date	Jan 17 1977	Feb 11 1966	Mar 30 1962	Apr 30 1964	May 30 1960	Jun 24 1963	Jul 06 1976	Aug 21 1976	Sep 20 1968	Oct 10 1970	Nov 08 1975	Dec 25 1964
Record daily low	-42.2	-42.2	-35.6	-25	-14.4	-3.9	0.6	-1.7	-6.7	-16.1	-26.1	-41.7
Date	Jan 29 1962	Feb 04 1971	Mar 10 1972	Apr 02 1964	May 07 1966	Jun 01 1971	Jul 04 1972	Aug 31 1965	Sep 19 1969	Oct 25 1969	Nov 23 1964	Dec 24 1970

Table 5.2.1 Monthly Average Temperature Statistics over a 30 Year Period

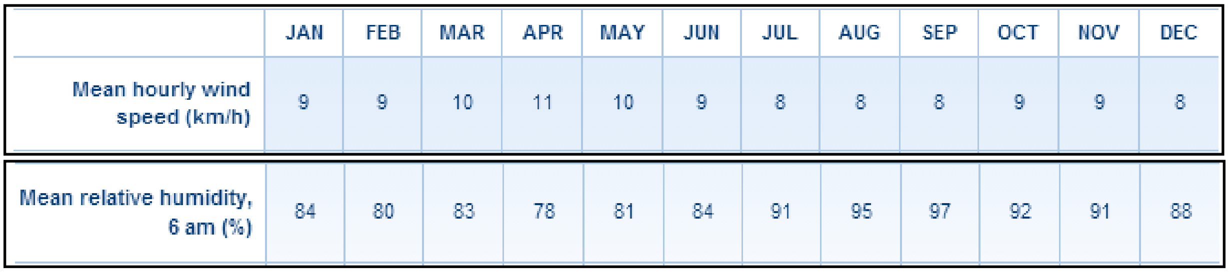
Precipitations



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Monthly rainfall (mm)	7	0	21	39	75	90	147	117	93	75	20	8
Monthly snowfall (cm)	43	44	35	11	6	0	0	0	0	7	31	31
Monthly precipitation (mm)	50	44	56	49	81	90	147	117	93	82	51	39
Single day record rainfall (mm)	9	14	24	21	46	54	69	56	44	47	41	38
Date	Jan 18 1973	Feb 07 1965	Mar 05 1964	Apr 24 1968	May 12 1976	Jun 24 1960	Jul 20 1970	Aug 01 1960	Sep 20 1970	Oct 18 1967	Nov 12 1969	Dec 08 1974
Single day record snowfall (cm)	33	14	26	16	10	6	0	0	14	22	22	43
Date	Jan 15 1962	Feb 24 1975	Mar 23 1972	Apr 21 1963	May 11 1969	Jun 16 1964	Jul 01 1960	Aug 01 1960	Sep 29 1963	Oct 23 1962	Nov 29 1963	Dec 25 1966
Single day record precipitation (mm)	33	17	26	22	46	54	69	56	44	47	41	43
Date	Jan 15 1962	Feb 03 1968	Mar 23 1972	Apr 28 1962	May 12 1976	Jun 24 1960	Jul 20 1970	Aug 01 1960	Sep 20 1970	Oct 18 1967	Nov 12 1969	Dec 25 1966

Table 5.2.2 Monthly Average Precipitations Statistics over a 30 Year Period

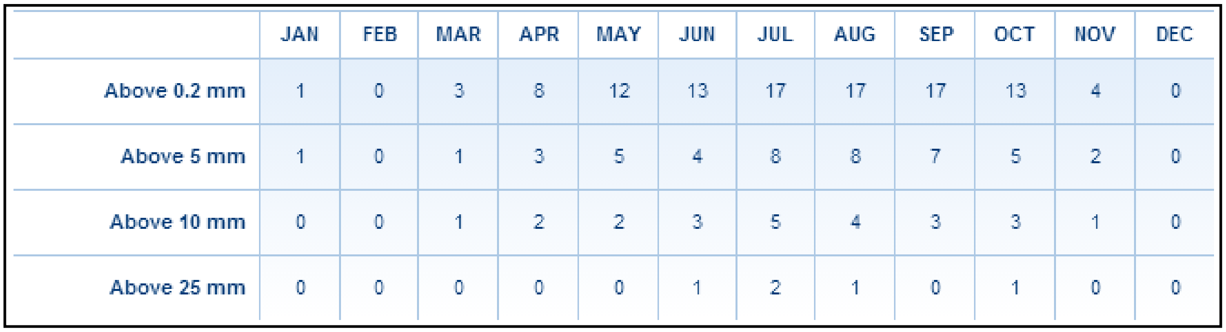
Other Parameters



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean hourly wind speed (km/h)	9	9	10	11	10	9	8	8	8	9	9	8
Mean relative humidity, 6 am (%)	84	80	83	78	81	84	91	95	97	92	91	88

Table 5.2.3 Monthly Wind and Relative Humidity Means over a 30 Year Period

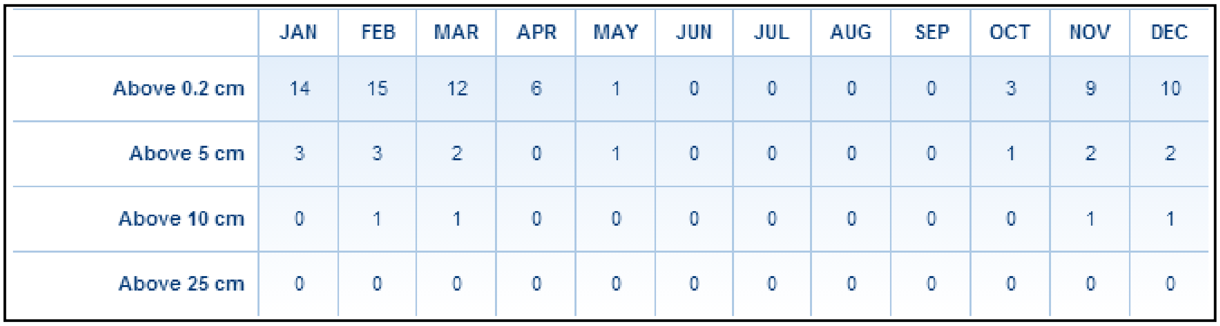
Days with Rainfall



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Above 0.2 mm	1	0	3	8	12	13	17	17	17	13	4	0
Above 5 mm	1	0	1	3	5	4	8	8	7	5	2	0
Above 10 mm	0	0	1	2	2	3	5	4	3	3	1	0
Above 25 mm	0	0	0	0	0	1	2	1	0	1	0	0

Table 5.2.4 Monthly Average Days with Rain over a 30 Year Period

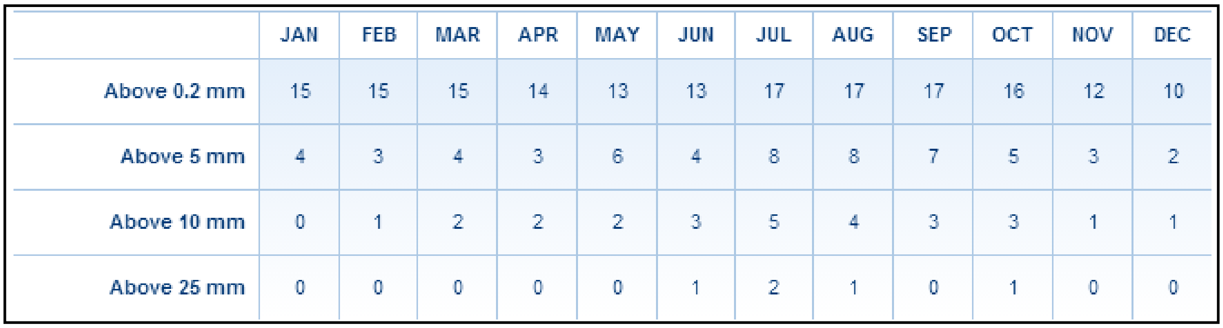
Days with Snowfall



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Above 0.2 cm	14	15	12	6	1	0	0	0	0	3	9	10
Above 5 cm	3	3	2	0	1	0	0	0	0	1	2	2
Above 10 cm	0	1	1	0	0	0	0	0	0	0	1	1
Above 25 cm	0	0	0	0	0	0	0	0	0	0	0	0

Table 5.2.5 Monthly Average Days with Snow over a 30 Year Period

Days with Precipitation



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Above 0.2 mm	15	15	15	14	13	13	17	17	17	16	12	10
Above 5 mm	4	3	4	3	6	4	8	8	7	5	3	2
Above 10 mm	0	1	2	2	2	3	5	4	3	3	1	1
Above 25 mm	0	0	0	0	0	1	2	1	0	1	0	0

Table 5.2.6 Monthly Average Days with Precipitation over a 30 Year Period

5.3 Local Resources

The region of Lac Saint-Jean has an extensive agricultural and forestry industry; it also has a significant hydro-power dam system to supply electricity to the aluminum producers and transformation industry. The mining operations are mainly quarries for aggregates and dimensional stone. A world reknown underground Niobium mine located in the Saint-Honoré village, north of Chicoutimi, is owned by Iamgold.

Even if the region is not qualified as a mining area, qualified personnel may be found in the region. The University of Quebec in Chicoutimi has a well developed geological department. The Chibougamau area is around 230 km from the Lac a Paul Project and also offers mine services. The city of Alma offers basic needs such as food and accommodations, as well as equipment repair and equipment design/fabrication services. Several surrounding cities host distinct services able to provide extensive contractor services and supplies within 200 km.

5.4 Infrastructure

The current main infrastructure at the site is the access roads which are generally in good condition. The Property area is large enough to support all of the mining operations, infrastructures, processing facilities, waste dumps and tailings. The nearest power lines are the major transmission lines from Chute-des-Passes and the Péribonka power generation complex. Another power line exists at the former wollastonite project (Orleans Resources) near Saint-Ludger-de-Milot. Finally, the Lac a Paul Project has access to facilities remaining from past forestry activities and the Property is in the neighbourhood of the Betsiamites' related hydroelectric projects.

5.5 Physiography

The hills in the region are usually between 425 and 675 meters above sea level. The Property is adjacent to lakes and rivers. The claims are limited in the north by the Manouane River. The Manouane River crosses from east to west in the north of the region and north to south in the west region.

In the NW part of the Property, the main lake is Lac a Paul which is approximately 400 meters above sea level.

Figure 5.5.1 General Drilling Conditions at Paul in February and November 2012

The photographs included in Figure 5.5.1 illustrate the nature of topography and forestation. The photos were taken by Claude Duplessis between February 6 and 7 and November 12 to 15, 2012, site visits. The image on the left depicts Mr. Daniel Boulianne, Vice-President of Exploration, and Mr. Hugues Guérin Tremblay, a geologist from Arianne, discussing drill alignment.

Figure 5.5.2 Drill Access Winter Trail and Drilling on the Manouane Zone, Winter 2011

The photographs included in Figure 5.5.2 also depict the relatively flat topography and forestation (photos also taken by Claude Duplessis during the February 14 to17, 2011, site visit).

The forest consists mainly of black spruce but forest fires and exploitation have decimated much of the vegetation. Vegetation also includes white spruce, balsam fir and jack pine. There are also birch, poplar and pine bankesians **(**Levé électromagnétique et magnétique héliporté, région de Chute-des-Passes, Lac St-Jean, 1997, St-Hilaire, C., Archer, P). White cedar is very common along the lakeshores and rivers. Bogs are also observed in certain topographic lows.

Photographs in Figure 5.5.3 were taken by Claude Duplessis during a site visit in August 2008. Arianne geologist, Nadège Tollari, can be seen observing the Nelsonite rock on the left. Images on the right display coarse apatite mineralization observed near Zone No. 2.

Figure 5.5.3 Typical Surface Texture Enhanced by Surface Weathering Near Zone No. 2

6. HISTORY

6.1 The Pre-1994 Period

Mineral exploration interest in the Chutes-des-Passes area was initiated by Mr. Lionel Lefebvre, a local prospector, in the 1970's. Some exploration activity for copper and nickel mineralization was recorded by Imperial Oil (GM-27460 and 27031) and N.Q.N. Mines (GM-27033, 27034, 28000, 26105, 26106). Little activity was recorded in the 1980's after the discovery of the Lac du Poisson Blanc deposit.

Mineral exploration in the Lac a Paul area was initiated by the Fonds Minier du Saguenay–Lac Saint-Jean (FMSLSJ) in 1994 (Barrette, 1994; GM-57004, GM-57006). In the following years, prospector's training camps were set-up in the area (GM-57007, 58152), which lead to the discovery of copper and nickel occurrences (GM-57007), high purity quartz veins (GM-53478, 52422), and subsequently to apatite and ilmenite.

6.2 After 1994 - Virginia and Soquem Copper-Nickel Exploration

Starting in 1995, Virginia Gold Mines initiated a reconnaissance program for nickel- copper in the area and subsequently acquired an option for the Fonds Minier claims. Within the same period, Soquem initiated a similar program in the same area, which was promptly merged with Virginia into a single joint-venture. Large properties from this project are still active in the area, notably adjacent and east of Arianne. Abundant assessment literature is on file:

- GM-56023: 1998; 18 drill holes, FMSLSJ option.
- GM-56024: 1997; Mag and HLEM surveys, FMSLSJ option.
- GM-56149: 1997; Airborne Mag and EM surveys, FMSLSJ option.
- GM-56382: 1998; Mag and HLEM surveys, FMSLSJ option.
- GM-56422: 1998; Mag and HLEM surveys.
- GM-56578: 1998; Mapping and prospecting.
- GM-57008: 1998; Mapping and prospecting.
- GM-57184: 1997; Airborne Mag and EM surveys.
- GM-58190: 2000; 7 Drill holes, including three with apatite-ilmenite intersections.
- GM-58232: 2000; 3 Drill holes, Apatite-ilmenite.
- GM-58806: 2000; HLEM Survey.
- GM-58807: 2001; 11 Drill holes.
- GM-58815: 2001; 12 Drill holes, MHY occurrence.
- GM-59143: 2001; 11 Drill holes.
- GM-60717: 2002; Soquem, SIROTEM, time domain EM survey.
- GM-60730: 2003; 8 Drill holes, MHY occurrence.
- GM-60731: 2003; Gravimeter survey, MHY occurrence.
- GM-61185: 2004; 6 Drill holes, MHY occurrence.

Part of the Virginia-Soquem exploration effort included the Arianne's Properties. The discovery of ilmenite and apatite in the Manouane and Paul Zones was accidental and occurred in the course of evaluating magnetic and electromagnetic anomalies for their copper-nickel potential. Ground and heliborne geophysics as well as two drill holes in both occurrences are now available to Arianne.

6.3 The FMSLSJ-Arianne Period

In 1998, the Québec Department of Energy and Resources (QDER, actually MNR) carried out geological mapping of the 222E map-sheet (Hébert, 1998; Hébert et al, 2009; Hébert et Beaumier, 2000). Mapping was undertaken in collaboration with a prospector training camp organized by the Fond Minier Saguenay-Lac-St-Jean (FMSLSJ) (Tremblay, 1998), which lead to the first apatite discovery of the area. Interest in this commodity was triggered by the discovery of the Sept-Îles deposits two years before by the QDER (Cimon, 1996) and by the fast development of the project by SOQUEM. The FMSLSJ and its prospectors staked their discoveries (zones no1 to no3), in which claims were granted for option to Les Ressources d'Arianne (now Arianne Phosphate Inc.). Some of these initial claims are still active. Arianne, in collaboration with the FMSLSJ, carried out a limited amount of work until 2002:

- GM-57004; 1995; Prospecting.
- GM-57006; 1995, Compilation work.
- GM-57007; 1997; Prospecting.
- GM-58151; 1999; Prospecting.
- GM-58152; 1998; Prospecting.
- GM-58767: 2001; 10 Drill holes.
- GM-58768: 2000; 2 Drill holes.
- GM-58769: 2000; Metallurgical testing.
- GM-58774: 2000; Metallurgical testing.
- GM-59784: 2002; 12 Drill holes.

Due to a lack of interest from the capital market, Arianne abandoned the exploration for apatite and ilmenite in 2002, allowing most claims to lapse.

6.4 Recent Arianne involvement

Arianne's interest in the project resumed in 2008 and was stimulated by a surge in the phosphate rock price. Arianne re-staked Virginia's Manouane and Lac a Paul occurrence (Arianne took an option on 4 claims with two prospectors: P. Morisette and J. Dierzen) and initiated prospecting and drilling work. Arianne's work consisted of:

- Summer 2008: Prospecting and surface sampling.
- Fall 2008: Ground magnetometer survey over Zone No. 2.
- Fall 2008: 22 drill holes in the Paul and Zone No. 2 occurrences.
- Winter 2009: 13 drill holes in the Manouane occurrence.

- Spring 2009: Resource estimates by SGS Canada Inc.
- Spring 2009: Apatite beneficiation test, SGS-Lakefield.
- Summer 2009: Geophysical ground survey (Mag) on Paul and Nicole Zones.
- Summer 2009: Prospecting and surface sampling, processing of geophysical data.
- Fall 2009: 11 Drill holes for exploration purposes.
- Late Fall 2009: 18 drills holes in the Paul Zone.
- May 2010: Preliminary Economic Assessment IOS Services Géoscientifiques inc. SGS Canada Inc.
- 2011: The Lac a Paul Apatite-Ilmenite Project, NI-43-101 Compliant Technical Report by Met-Chem and SGS-Canada (Pre-Feasibility Study).
- July 2012: NI 43-101 Technical Report on the Pre-Feasibility Study Update (50 Ktpd Milling Rate) Lac a Paul Apatite Project by SGS-Canada and Met-Chem.
- April 2013: Phosphate Resource Estimation Update 2013 of the Lac a Paul Property Deposit by GoldMinds Geoservices Inc.

6.5 Previous Resource Estimates

Following the 2008 and 2009 drilling campaigns, a first resource estimate was performed in 2009 by SGS Geostat with the following results:

- Paul Zone: 99.30 M tonnes of inferred resources at 7.84% P2O5 and 8.24% TiO2.
- Manouane Zone: 140.60 M tonnes of inferred resources at 5.77% P2O5 and 9.01% TiO2.
- Zone No. 2: 64.10 M tonnes of inferred resources at 4.52% P2O5 and 4.51% TiO2.
- Total for 3 zones: 304 million tonnes of inferred resources at 6.18% P2O5 and 7.81% TiO2.

* The inferred resource estimate was provided by SGS Geostat in May 2009 and yielded the following results (cut-off grade of 2% P_2O_5).[1, 2, 3]

1. The resource estimate is taken from a NI 43-101 Technical Report entitled "*Phosphate and Titanium resource estimation of the Lac a Paul Property Deposit*, Saguenay-Lac-St-Jean Quebec Canada", Authored by Claude Duplessis and dated May 8, 2009.
2. This resource estimate does not take into account drill holes completed on the Paul Zone for which results were released in early 2010.
3. The scoping study mentioned in this document was a preliminary assessment. It was based on inferred resources which were considered too speculative from a geological standpoint to have economic considerations applied to these, which would have enabled these to be categorized as mineral reserves. There was no certainty that this preliminary assessment would yield expected results.

Following this first resource estimate, the NI 43-101 Preliminary Economic Assessment (Scoping Study) by IOS Services Géoscientifiques Inc. was completed on January 2010.

A revised NI 43-101 compliant resource estimate by SGS Geostat Ltd following definition drilling campaigns completed in 2009 and 2010 on the Paul Zone was performed in 2010. Results were published in May 2010 (see Table 6.5.1).

Surveyed Area	Category	Tonnage	%P_2O_5	%TiO_2
Lac a Paul	Indicated	78 343 000 t	7.24%	7.84%
Lac a Paul	Inferred	58 249 000 t	6.97%	8.00%
Manouane	Inferred	137 652 000 t	5.71%	8.92%
Zone No. 2	Inferred	64 247 000 t	4.54%	4.56%
Total	**Inferred**	**260 148 000 t**	**5.70%**	**7.64%**

Table 6.5.1 May 2010 Statement of Mineral Resources (NI 43-101 Compliant)

6.6 2011 Lac a Paul Phosphate Project Prefeasibility Study Results

A preliminary feasibility study report (PFS) of the Lac a Paul Project was prepared at the end of 2011 on the basis of the Indicated and Measured resources of the Paul and Manouane Zones by SGS Canada Inc. and dated November 8, 2011.

The Study, in compliance with NI 43-101, considered the principal economic factors of building and operating the Lac a Paul phosphate rock mining project (the “Project”) and selling apatite concentrate for production of phosphoric acid and fertilizer products. The Study is posted on SEDAR and on the Arianne Website.

6.6.1 Highlights of the Prefeasibility Study ($US):

- Measured and Indicated resources quadrupled to 348 million tonnes of 6.50% P_2O_5.
- Additional Inferred resources of 114 million tonnes at 5.46% P_2O_5 were not included in the Study.
- Combined Paul and Manouane Proven and Probable Mineral Reserves totalled 307 Mt at an average grade of 6.59% P_2O_5 at an average stripping ratio of 0.83 (Cut-off grade of 2.43% P_2O_5).
- Annual production to average 2 million tonnes of 38% P_2O_5 phosphate rock concentrate.
- 25 year mine life at 33,000 tonnes/day with average mill recovery of 89%.
- Average price of $175/tonne (comparable to 85 BPL FOB Russia which recently sold at $223/tonne).
- Cash operating cost $98/tonne of concentrate (FOB rail Dolbeau-Mistassini).
- Total Direct CAPEX Cost: $454 M.
- Indirect CAPEX Cost: $121 M and Contingency: $74 M.
- Total Initial CAPEX: $649 M.
- Pre-tax IRR: 19.2%.

- Pre-tax NPV 8%: $684 M.
- Pre-tax Capital payback: 4.7 years.

The all-in cost (CAPEX plus OPEX) estimate of $118 per tonne demonstrates that the Lac-a-Paul Project is a world-class phosphate rock project with robust economics. The Study also confirmed that, due to the significant increase in ore resources, a 3 million tonnes/year P_2O_5 concentrate operation could further enhance the project economics by as much as 50%.

6.6.2 Expanded Mineral Resource (Compliant with NI 43-101)

A revised resource estimate was calculated by SGS Canada Inc.-Geostat Group following the completion of the most recent drilling campaigns at the Paul and Manouane Zones in December 2010 and March 2011 respectively. The resulting increase in Measured and Indicated resource (M&I) was incorporated into the 2011 Prefeasibility Study report.

The Measured and Indicated resource totalled 348 million tonnes (see Table 6.6.1 for details). An additional 114 Mt of inferred resource in the Paul and No. 2 Zones was not included in the Study.

	Paul			Manouane			Zone No. 2			TOTAL*		
	Mt	P_2O_5 (%)	TiO_2 (%)	Mt	P_2O_5 (%)	TiO_2 (%)	Mt	P_2O_5 (%)	TiO_2 (%)	Mt	P_2O_5 (%)*	TiO_2 (%)
Measured (M)	22.1	6.82	7.89	136.9	5.93	8.77	-	-	-	159	6.05	8.65
Indicated (I)	161.8	7.1	8.21	26.9	5.64	8.46	-	-	-	188.7	6.89	8.24
Total (M&I)	183.9	7.06	8.17	163.8	5.88	8.72	-	-	-	347.7	6.50	8.43
Add'l Inferred	50.3	6.61	8.25	-	-	-	64	4.55	4.57	114.3	5.46	6.19

*Cut-off grade of 2.43% P_2O_5

Table 6.6.1 PFS Mineral Resources Estimate (November 2011)

6.6.3 Mining/Concentrating PFS 2011 Report

Mining will be a conventional open pit truck and shovel operation. Paul Zone will first be mined for 14 years with the Manouane Zone to follow. The average mining/milling rate at full production will be 12.3 M tonnes/year. Metallurgical testing determined that an average 89% P_2O_5 recovery is feasible by conventional milling process, yielding concentrate production averaging approximately 2 Mt/y. The pit designs for the Paul and Manouane deposits resulted in combined Paul and Manouane Proven and Probable mineral reserves totaling 307.1 Mt at an average grade of 6.59% P_2O_5 and 8.51%TiO_2, as indicated in Table 6.6.2.

Category	Ore (Mt)	P_2O_5 (%)	TiO_2 (%)	Waste (Mt)	Strip Ratio
		Paul Zone			
Proven	21.4	6.85	7.94		
Probable	140.3	7.21	8.29		
Sub-Total	161.7	7.16	8.25	170.8	1.1
		Manouane Zone			

Category	Ore (Mt)	P_2O_5 (%)	TiO_2 (%)	Waste (Mt)	Strip Ratio
Proven	123.3	5.99	8.84		
Probable	22.1	5.72	8.54		
Sub-Total	145.4	5.95	8.79	85.0	0.6
Total Reserves					
Proven	144.7	6.12	8.71		
Probable	162.4	7.01	8.33		
Grand-Total	307.1	6.59	8.51	255.8	0.8

Table 6.6.2 PFS Mineral Reserves Estimate 2011

Mining and concentrating costs were estimated at $2.24/tonne mined and $8.33/tonne milled. General & Administration costs, which include costs to support the men camp, security, safety, training, environmental and laboratory costs, were estimated at $5.85/tonne of P_2O_5 concentrate.

6.6.4 Phosphate Rock Concentrate

Table 6.6.3 shows the chemical composition of the phosphate rock concentrate produced from an eight tonne bulk sample of the Paul Zone. The product quality is very high, with a 39% P_2O_5 content (85 BPL), very low contaminant content and a low CaO/ P_2O_5 ratio of 1.3. The high P_2O_5 content allows very efficient shipping ($/tonne of P_2O_5 content). Low contaminant content yields non-hazardous gypsum by-products. Low CaO/P_2O_5 ratio means lower sulphuric acid use/cost in production of phosphoric acid, MAP (Mono-Ammonium Phosphate) and DAP (Di-Ammonium Phosphate).

	Content	Constituent	Content
P_2O_5 (%)[1]	39.1	Total SiO_2 (%)[1]	2.49
CaO (%)[1]	52.1	Acid Insoluble SiO_2 (%)[2]	1.81
MgO (%)[1]	0.96	Acid Soluble SiO_2 (%)[2]	0.59
Fe_2O_3 (%)[1]	1.67	Organic C (%)[2]	0.91
Al_2O_3 (%)[1]	0.84	H_2O (%)[2]	0.30
Na_2O (%)[1]	0.28	CaO/P_2O_5 Analytical Ratios[1]	1.33
K_2O (%)[1]	0.15	F/Soluble SiO_2[1]	2.88
F (%)[1]	1.70	$F/(SiO_2+Al_2O_3+MgO)$[1]	0.40
		$(Fe_2O_3+Al_2O_3)/P_2O_5$[1]	0.064
Cl ppm (water soluble)[2]	108	$(Fe_2O_3+Al_2O_3+MgO)/P_2O_5$ (MER)[1]	0.089
Cl ppm (total)[1]	860		
SO_3 (%)[2]	0.12	Cd ppm[1]	< 0.5
CO_2 (%)[2]	2.38	Hg ppm[1]	< 0.02
INSOL (%)[2]	1.75	As ppm[1]	< 0.05
Loss of Ignition (LOI)(%)[1]	0.51	U mg/l[1]	< 0.02

1 Analysis from COREM
2 Analysis from Jacobs Engineering Inc.

Table 6.6.3 Chemical Composition

6.6.5 Phosphoric Acid, MAP and DAP

Phosphoric acid and derivative fertilizers MAP and DAP were tested on the Paul Zone concentrate by a leading global phosphate rock and fertilizer testing facility. No corrosivity was found during production of 28% P_2O_5 phosphoric acid, the standard grade feedstock for MAP and DAP production. Other features noted were high acid filtration rates, no need for froth control reagents and low gypsum by-product production. Most notably, the fertilizers produced exceeded generally recognized industry specifications for DAP (18%N/46%P_2O_5) and MAP (11%N/52%P_2O_5) (see Table 6.6.4).

Fertilizer Component	Unit	DAP	MAP
Nitrogen	%N	19.3	11.4
Phosphorous	%P_2O_5	48.9	55.3
Moisture content	Crushed %H_2O	1.9	1.2
Moisture content	Non-crushed %H_2O	0.8	0.6
Hardness	lbs.	7.9	9.1

Table 6.6.4 Fertilizer Component Analysis

6.6.6 Location

The Lac a Paul Project is located in one of the most dynamic natural resource-rich areas of the Province of Quebec.

Access to the Project is via well-maintained gravel roads (Chemin-des-Passes) presently used for the logging industry. The 165 tonne capacity bridges on this road will support trucks capable of transporting 115 tonne loads of phosphate rock concentrate. A rail train loading facility at Dolbeau-Mistassini, approximately 210 km to the south was part of the Project. The phosphate rock concentrate transport cost from the mine to FOB railcars in Dolbeau was estimated by Met-Chem at $10.90/tonne. The rail access at Dolbeau-Mistassini connects with the North American Rail Network (via Canadian National railroad) and also provides access to the year-round accessible deep water Port of Saguenay (Grande-Anse Port).

Hydro-electric power is available to the Project just 30 km away, from the 750 MW Chute-des-Passes Power Plant owned by Rio Tinto/Alcan. The Project is located 60 km from the 405 MW Peribonka IV power dam owned by Hydro-Quebec. Both options are capable of providing sufficient power to the Project.

6.6.7 Socio-Economic

With a population of 275,000, a well-educated work force is available to the Project. Discussions with the First Nation of Mashteuiatsh and Pessamit and local Authorities of the Fjord-du-Saguenay/Maria-Chapdelaine and Lac-Saint-Jean-Est RCM were in progress. The mine will create about 340 permanent jobs and more than 400 indirect jobs and generate substantial direct economic benefits to the region. Environmental and socio-economic impact studies were underway.

6.6.8 Potential for Enhanced Project Economics

The study identified potential enhancements to project economics through expanded production rates, now feasible given the significant increase in Measured and Indicated resources. Arianne commissioned an initial economic assessment of these options for completion in Q1 2012, with the goal of determining the most efficient course of action. Scaled up production scenarios under consideration included:

- Annual phosphate rock concentrate production of 2.5 million tonnes (40,000 tonne/day ore processing);
- Annual phosphate rock concentrate production of 3.0 million tonnes (50,000 tonne/day ore processing);
- Recovery and sale of titanium (ilmenite) concentrate.

Preliminary results indicated that economics were expected to improve at these production rates, as estimates of pre-tax NPV8 increased to $1B at a production rate of 50,000 tonnes/day, with requirements of additional initial CAPEX of about 20% and mine life of about 17 years.

6.6.9 Sensitivity of Project Economics to Concentrate Price and Operating Costs - 2011 Report

Project economics sensitivity was reviewed by Met-Chem for concentrate price and operating costs on a pre-tax basis. The analysis showed a breakeven pre-tax $NPV_{8\%}$ at $135/tonne, a price 23% below the long-term average price for 85 BPL concentrate of $175/tonne in constant 2011 dollars. For comparative purposes, the price of 85 BPL concentrate FOB Russia was $223/tonne.

The sensitivity analysis showed that for each $1/tonne improvement in cash margin, either through higher price or lower operating cost, the pre-tax $NPV_{8\%}$ increases by approximately $17 million.

6.7 2012 Lac a Paul Phosphate Project PFS Update Results - Summary

The following information was taken from the PFS Update (50 ktpd milling rate) and corresponding NI 43-101 Technical Report dated July 13, 2012.

The Paul Zone has a higher grade than the Manouane Zone; emphasis should therefore be made on the Paul Zone deposit. It shows potential to increase the quality of the mineral resource in addition to increasing its size on lateral extension. It also appears to be open at depth.

In 2012, Proven and Probable mineral reserves were developed from the pit design of the Paul and Manouane deposits. These mineral reserves, which account for ore loss, formed the basis of the mine plan that was being prepared.

The Paul pit included 21.4 Mt of Proven mineral reserves and 140.3 Mt of Probable mineral reserves for a total of 161.7 Mt. The grade of the Paul deposit was 7.16 % P_2O_5. In order to access to these reserves, 7.6 Mt of overburden and 163.2 Mt of waste rock must be removed, resulting in a waste to ore stripping ratio of 1.1:1. At the planned production rate of 18.6 Mt of ore per year, the pit contained roughly 9 years of mineral reserves.

The Manouane pit includes 123.3 Mt of Proven mineral reserves and 22.1 Mt of Probable mineral reserves for a total of 146.0 Mt. The grade of the Manouane deposit is 5.95% P_2O_5. In order to access these reserves, 14.7 Mt of overburden and 70.3 Mt of waste rock must be removed, resulting in a waste to ore stripping ratio of 0.6:1. At the planned production rate of 18.6 Mt of ore per year, the pit yields roughly 7 years of mineral reserves.

The objective of reaching an apatite concentrate grading > 38% P_2O_5 and with recovery > 90%, was achieved for both the bench scale laboratory work and the locked cycle tests. The pilot plant was unable to meet the objective for three main reasons:

- The pilot plant feed was ground too finely, resulting in a poor selectivity;
- Due to grind fineness, the sodium silicate depressant, Na_2SiO_3, was used frequently in dosage amounts that depressed the apatite as well as the silicates and aluminates;
- Closed circuits made reagent dosage control much more difficult and often resulted in high depressant concentrations.

It is expected, with a suitable grind and proper depressant dosages, that flotation performance of the pilot plant can achieve an apatite grade of 38.3% and a recovery of 90.7%.

The processing plant was designed to process an average of 50,000 tpd of ore, allowing for the production of approximately 8,500 t/d of phosphate concentrate grading at about 38.0% P_2O_5 and based on a concentrate recovery of 90%. A suitable process flowsheet included crushing, grinding, magnetic separation, flotation, and concentrate thickening, filtering and drying. Mining equipment, tailings storage facility, concentrate transportation and load-out facilities as well as infrastructure and services were added to complete the investment cost of the Project.

The total capital cost for the Project life, at an accuracy level of ± 25%, was estimated at US$ 1,121.3 M; the pre-production initial capital cost was evaluated at US$ 813.9 M, while the sustaining capital requirement was US$ 307.4 M.

The average operating cost estimate throughout the life of mine was evaluated at 90.50 $/tonne of concentrate.

Preliminary environment considerations were addressed and legislative framework, environmental sensitive areas, issues and project stakeholders were identified. Geochemical testing was conducted on mine rock and tailings samples to give a preliminary assessment of the metal leaching (ML) and acid rock drainage (ARD), as well as radioactivity potential of the tailings generated by the project. Testing results show that radioactivity will not be an issue for the Project and preliminary environmental characterization indicated that only the magnetic fraction of the tailings can be considered potentially acid generating.

Mine closure and rehabilitation cost were estimated at US$ 22.8 M. The economic analysis of the project demonstrated positive results at an estimated sale price of phosphate concentrate of $175/tonne. The financial results indicated a before-tax Net Present Values (NPV) of US$ 745.4 M and US$ 985.1 M at discount rates of 10% and 8% per year, respectively. The before-tax Internal Rate of Return was 23.2% with a payback period of 3.9 years.

6.7.1 Highlights of the Pre-Feasibility Study Update ($US)

- Measured and Indicated resources remain at 348 million tonnes @ 6.50% P_2O_5
- Additional Inferred resources of 114 million tonnes @ 5.46% P_2O_5 are not included in the Study
- Combined Paul and Manouane proven and probable Mineral Reserves remain at 307 million tonnes, with average grade of 6.59% P_2O_5 and average stripping ratio of 0.83 (Cut-off grade of 2.43% P_2O_5)
- Annual production will average 3 million tonnes of 38% P_2O_5 apatite concentrate with low impurities
- 17 year mine life at 50,000 tonnes ore/day production rate with average mill recovery of 90%
- Average concentrate price of $175/tonne FOB rail
- Cash operating cost $80/tonne concentrate mine site ($90/tonne FOB rail)
- Total Direct CAPEX Cost: $583.3 million
- Indirect CAPEX Cost: $136.1 million and Contingency: $94.5 million
- Total Initial CAPEX: $813.9 million
- Pre-tax IRR: 23.2%
- Pre-tax NPV 8%: $985.1 million
- Pre-tax Capital payback: 3.9 years

7. GEOLOGY SETTINGS AND MINERALIZATION

7.1 Regional geology

This section was extracted from previous reports done in the MRN sheet 22E/15 by Geology Quebec (Cimon, J., and Hébert, C., MB 98-09; Hébert, C. and Beaumier, M., RG 99-05); the most relevant information was translated from French to English mainly from that report.

The Lac Saint-Jean anorthositic complex is the largest in the world, occupying an area of nearly 20,000 km^2. The entire Property is covered by Proterozoic rocks of the Grenville Province. It is part of a polycyclic tectonic division according to Rivers et al., 1989. The Property lithology consists mainly of intrusive rocks subsequently associated with anorthositic rocks of the Lac Saint-Jean complex (see Figure 7.1.1).

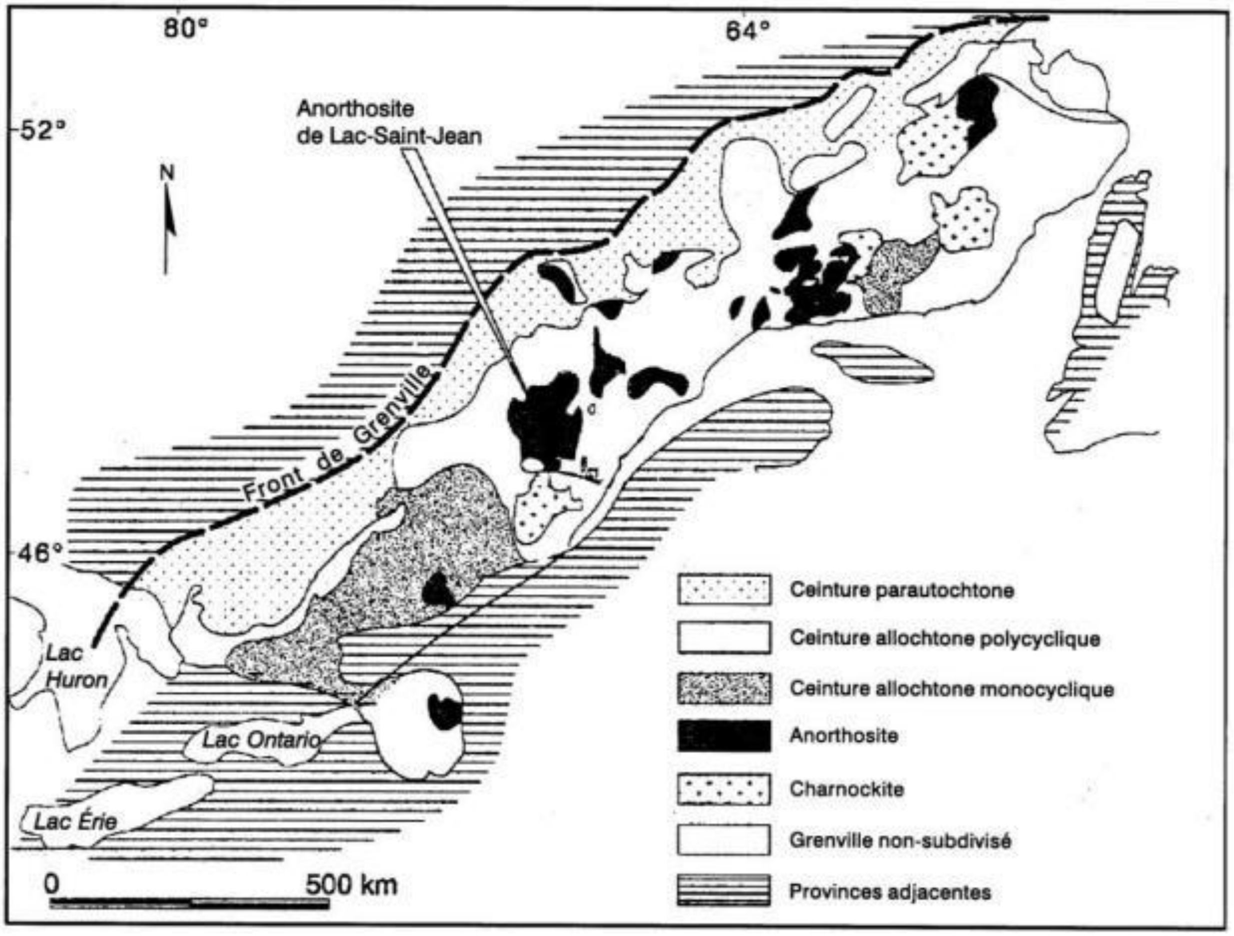


Figure 7.1.1 Regional Geology and Location of the Anorthosite Suite of Lac Saint-Jean within the Grenville Geological Province Map (Cimon, J. and Hebert, C., 1998, PRO 98-06)

The rocks are displayed in the form of coalescing lobes of leuconorites, anorthosite, norite, gabbronorite, gabbro with olivine, and gabbro. The lower pyroxenite contains dunites, peridotites, Fe-Ti oxides, apatite, jotunites and mangerites. In general, the morphology of the anorthosite lobes is quite similar; the core of the body contains relatively pure anorthosite.

Rocks surrounding the gneissic complex contain hornblende with quartz-biotite, gneiss, granulitic gneiss, and gabbroic ribbon gneiss. These rocks were later injected by the intrusion of felsic granite, monzonite and hypersthene (Hébert, C. and Beaumier, M., RG 99-05). The metamorphic phase is upper amphibolite facies to granulites.

In a structural sense the deformed SALSJ (Suite Anorthositique du Lac Saint-Jean or Lac St-Jean Anorthositic Complex) originated from three major events (Hébert et al., 1998; Turcotte, 2001):

- Event D1, associated with the Grenvillian thrust fault; generated an East-West oriented fabric.

- Event D2, folding of D1 generating important north-east south-west deformation corridors with oblique movement and dextral reverse thrust.
- Event D3, sinistral en echelon faulting of D1 and D2 are likely responsible for generating the brittle-ductile faults oriented north-south to north-northeast/south-southwest.

Moreover, a major shear crosses the SALSJ, the Lac-Saint-Jean-Pipmuacan fault, is oriented north-east south-west. This fault and associated shearing has potentially played a role in the setting of the SALSJ within the Grenville Province. (Hébert et Lacoste, 1998a; Fredette, 2006).

The anorthositic rocks of Lac Saint-Jean represent an assembly of scales (or sheets) that straddle the older gneissic units. Anorthositic massifs are particularly abundant in the Grenville Province. Its economic potential is usually limited to deposits of Fe-Ti-P.

The Property is located in the central region of the Grenville geological province.

7.2 Property Geology

The Lac a Paul Property is located in the MNR sheets 22E/15 and 22/10. Its basement contains rocks which belong to the Grenville geological province. The region lies in the allochthonous polycyclic belt according to suggested subdivisions by Rivers et al., 1989.

The dominant rocks are a sequence of mafic to ultramafic rocks, which contain anorthosite, leuconorite, norite, gabbronorite, gabbro with olivine, gabbro, pyroxenite and locally peridotite, dunite and magnetite.

The anorthosite, norite and the leuconorite occupy the most important area of the southern half of map sheet 22E/15. Ultramafic rocks are associated mainly with the norite. The northern part of the anorthosite suite is occupied by a large area of coronitic gabbronorite while the SE corner of the region is occupied by a massive gabbro. The host rock is derived from quartzo-feldspathic gneiss with biotite and hornblende, granulitic gneiss, gray and pink gneiss, and gabbroic gneiss. Figure 7.2.1 presents the regional geology including the 2010 Arianne's claim blocks.

The youngest outcropping rocks lie in the SW corner. These belong to the granite of La Carpe (≈35 km^2), which contains granite (charnockite) and monzonite (mangerite) with or without hypersthenes. This pluton is named like the La Carpe Lake located east of Chute-des-Passes (22E/l4) (Hébert, C., and Beaumier, M., 1999 RG 99-05). The rocks of the anorthositic suite overlap the gneiss, which previously had been exposed to one or more phases of deformation. Sub-horizontal shear zones are observed at different scales. A penetrating mass developed simultaneously and is orthogonal to the plane of overlap with an orientation parallel to the transport direction of the different layers to the ESE or WNW. The mass is a congregation of folds and boudins of nelsonite, which provides a concentrated layer of phosphate enrichment. The mylonite zone orientated SSW-NNE is located immediately to the west of Paul Lake (see Figure 7.2.1) and represents the bottom of one of these concentrated layers. A later episode of deformation is represented by sub-vertical ductile shear lineations, which plunge to the north (a trend could not be determined). The zone width is on the order of kilometers and is orientated NNE-SSW with an abrupt dip to SE. Finally, Duhamel Lake is parallel to a roughly N-S trending lineament; however there is no shear or apparent movement observed along it.

The work done by Arianne in 2000 and 2001 (GM 58768, GM 58767 and GM 59784) confirmed the presence of anorthosite, anorthositic gabbros, and some gneissic horizons in the Lac a Paul area. The master's thesis from Sophie Turcotte indicates a general 30° dip to the north; sub-horizontal stratum is frequently observed. This structure is observed in Zone No. 2 but the Paul Zone appears to be sub-vertical.

Figure 7.2.1 is an extract map from a previous technical report and does not reflect the recently updated claim boundaries.

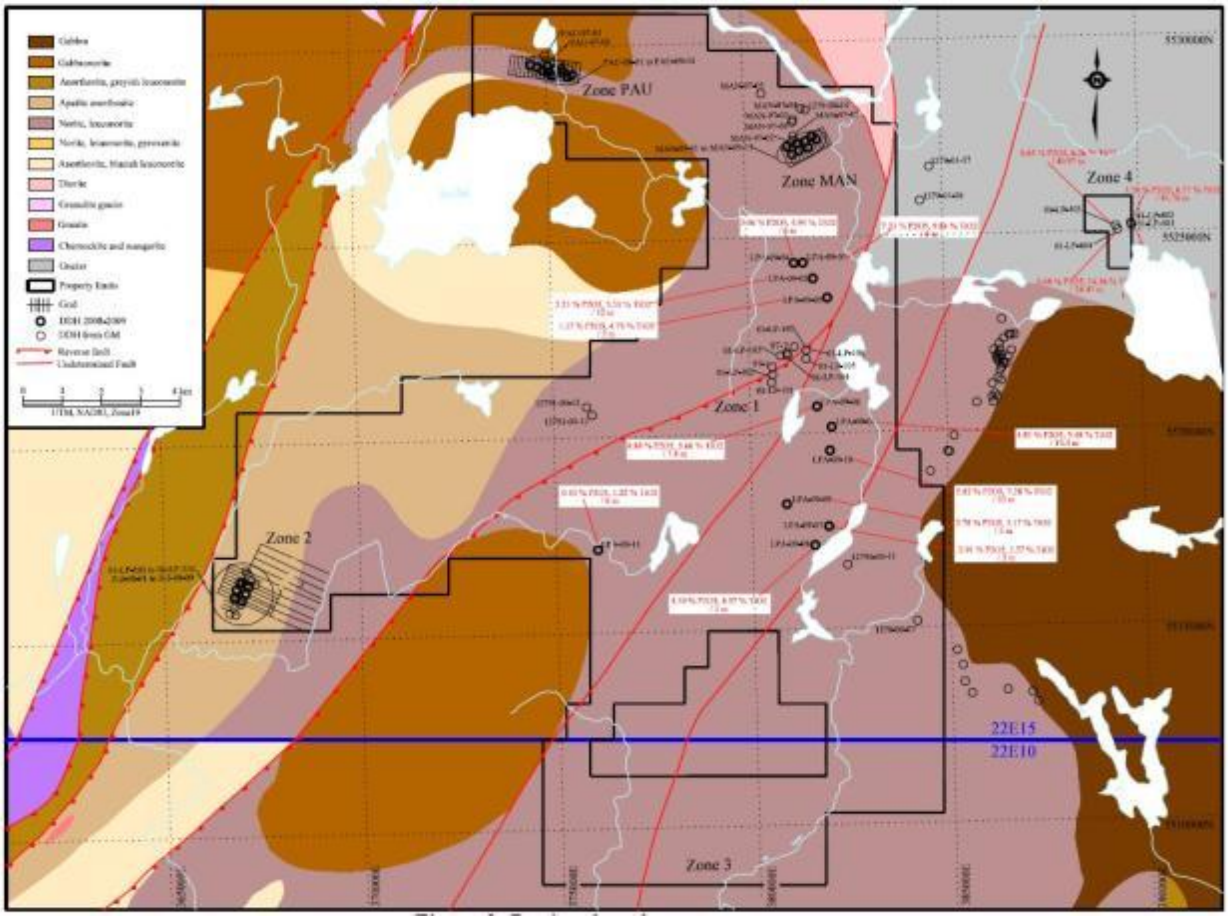


Figure 7.2.1 Geological Map of the Lac a Paul Property (Claims Position in 2010)

Grenvillian geology of the Lac Saint-Jean area was first described by Laurin and Sharma (1968) at a scale of 1: 250 000 and compiled by Avramtchem and Piché (1981).

Information given on this map is limited. It indicates that the Lac a Paul area is included in an anorthosite lobe flanked by gabbros and hosted in quartzo-feldspathic grey gneiss and granites. The area was mapped in greater details by Hébert (Hébert and Beaumier, 2000; RG-99-05), at a scale of 1: 50,000. The Property geology map is taken from Hébert and Beaumier (2000). It remains the most accurate geologic map available. According to this map, the vast majority of the Property is underlain by norite and leuconorite, with some pyroxenite and gabbronorite. Three north-northeast trending faults have been reported. Lithofacies vary on a small scale and are more diverse than what is indicated on the Hébert and Beaumier (2000) map.

7.3 Mineralization

Mineralization at the Lac a Paul Project originated from magmatic sedimentation and segregation within the anorthositic complex. The main geological unit of interest is a Nelsonite consisting of apatite and ilmenite-magnetite rich layers (see Figure 7.3.1).

Many apatite mineralized zones are reported within the Arianne's Lac a Paul Project. Zones No.1 and No. 2 are low-grade apatite-ilmenite bearing gabbros discovered by the FMSLSJ and will only be discussed briefly. Only Zone No. 2 has been explored significantly with diamond drilling. Zone No 3 is no longer part of the land package; Arianne did not renew the claims due to the low grades encountered. Most of the other zones, i.e. Manouane, Paul, Nicole, Lucie, Lise, Intersection and La Traverse (which does not appear in the Figure 7.3.1) have been drilled, are considered nelsonites, and show a good potential. The Paul Zone is the central interest of this report.

Figure 7.3.1 Typical Appearance of Mineralization on the Property (2012)

Figure 7.3.2 presents the position of each mineralized zones.

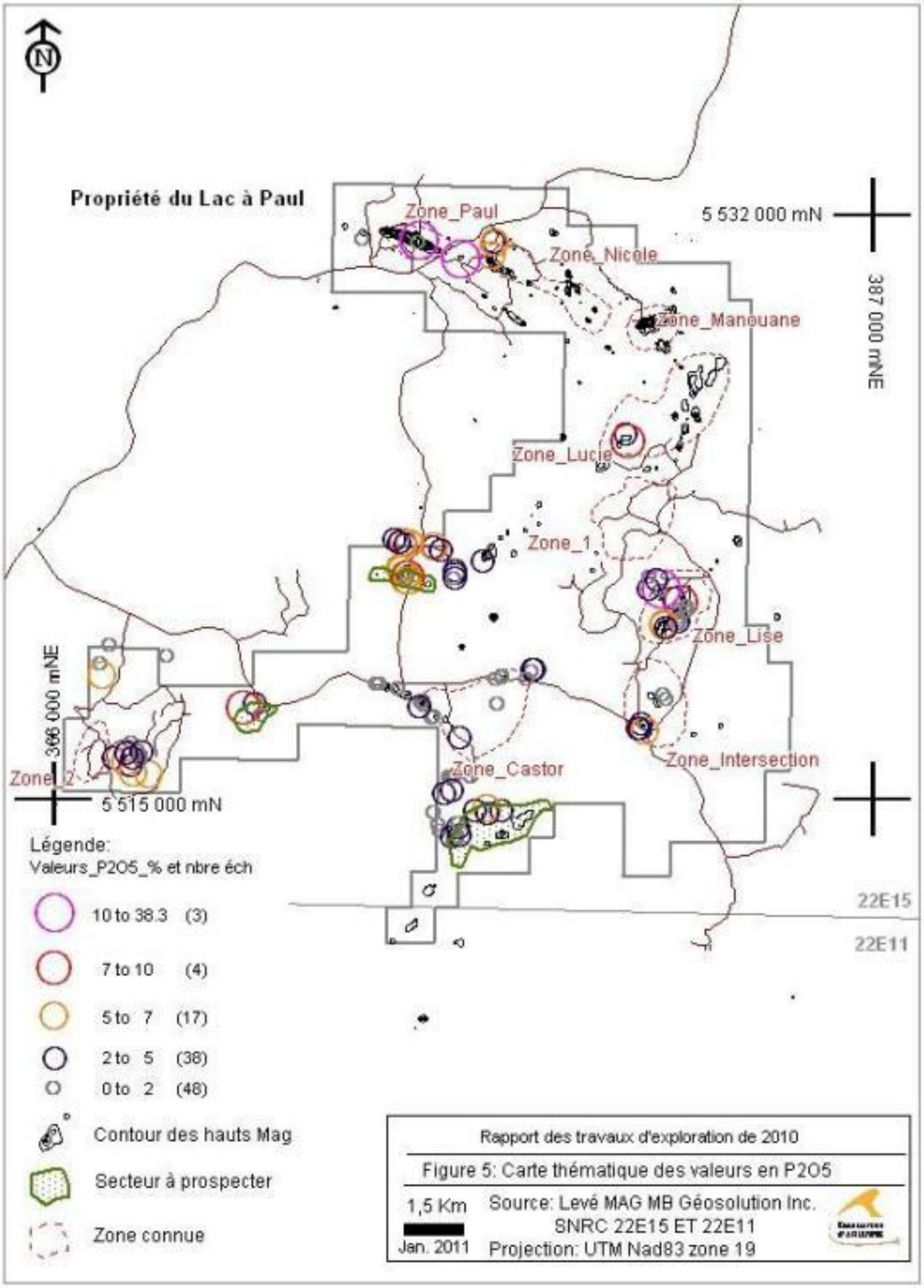


Figure 7.3.2 Position of Zones within the Lac a Paul Main Block (Claims from 2010)

7.3.1 Paul Zone

The Paul Zone is Arianne's prime target. It is located in the northern part of the Property on claims no. 2129818, no. 2129818 and no. 2167470. The Zone occupies a hillcrest adjacent to the north of Lac a Paul (UTMX: 374000; UTMY: 5529000). It is easily accessible via various logging trails connecting to the road leading to the Manouane River. Less than 10 meters of overburden has been reported.

The rocks consist of an olivine nelsonite, composed of similar proportions of apatite, ilmenite, magnetite and olivine, plus accessory pyroxene, feldspar and biotite as reported and validated by Réjean Girard from IOS. Depending on mineral proportions, this layered rock can vary between a genuine nelsonite, a troctolitic nelsonite, a troctolite (olivine-plagioclase rock), a pyroxenite, a gabbroic anorthosite, etc.

These facies are intricate or layered in a disorderly fashion. This Zone is embedded in apatite-free gabbroic to anorthositic host rock. The difference between the various facies is subtle, and detailed correlation between drill holes remains tricky. The Paul Zone is known to extend at least 2,700 meters, aligned east-southeast. Ovoid in shape, its width is not constant, between 150 and 300 meters (presumed thickness of the Zone). The Zone is open at depth (400 vertical meters) and presumed true thickness range from 150 to 300 meters.

The Zone is open to the east and to the west although the magnetic survey indicates it is pinched. The magnetic survey also indicates a complex internal structure, likely involving folding and stacking. Attitude of the lithology is now fairly well known. Lithological contacts are more or less diffused. Knowledge delineating the geometry of the Zone is fairly completed.

7.3.2 Manouane Zone

The Manouane Zone is located in flat terrain, 5.5 km east of Lac a Paul, 2 km south of the bight on the Manouane River (UTMX: 381300, UTMN: 5527000). Access required the logging of a 3 km trail by SOQUEM in 1998. The Zone is situated under poorly drained muskeg; outcrop is therefore limited and summer access for drilling is impeded. Thick overburden is reported (10-28 m).

The Manouane Zone is dominated by a magnetite-bearing nelsonite, similar to the Paul Zone. This nelsonite is interbedded with gabbros, anorthosite and tonalite layers. Again, no detailed correlation was attempted between holes. The exact attitude of layering is uncertain. The Zone is currently known to extend to 1000 meters in length, trend northeast-southwest and be open at both ends. It has an apparent width of about 250 meters. The Manouane Zone is characterized by two apatite-enriched zones within the sector. These Zones are connected in the Eastern region and have variable inclination going west. This current outline approximately mimics the aeromagnetic anomaly. The Zone has been tested to a depth of almost 400 meters where it is still open, it is also open at both the east and west ends. Depth is constrained down to 125 meters at the east end.

7.3.3 Zone No. 2

Zone No. 2 is the only zone acquired from the FMSLSJ upon which significant exploration effort was spent. It is located about 10 km south-southwest of Lac a Paul, in an area with rugged topography near the Castor-Qui-Cale River (UTMX: 366500,UTMY: 5516500). Scattered anorthosite outcrops were located in the area, with the typical crumbling weathering style. The Zone No. 2 occurrence is made up of apatite-ilmenite bearing homogeneous anorthositic gabbro, with minor variable gabbro and anorthosite. Nelsonite and troctolite are reported as small pods.

The Zone is known to extend about 1200 meters trending northeast and has a known width of up to 300 meters. It has been tested by drilling to a depth of about 100 meters. It is overlain by a thin layer of overburden averaging about 3 meters in thickness. The rock is rather massive. Differences between facies are subtle and detailed correlation between drill holes is difficult. The attitude of the layer is suspected to be sub-horizontal. The Zone can be regarded as open in every direction. The magnetic pattern over the Zone is irregular and of little help in delineating mineralization.

7.3.4 Zone No. 1

Little exploration has been done in Zone No. 1, one of the areas initially discovered by FMSLSJ. It is located 6 km south-east of Lac a Paul, by UTMX 380600 and UTMY 5521700. It consists of an apatite-bearing gabbro which is displayed as friable outcrops along road cuts. Aside from prospecting, two (2) short surface holes were drilled in 2000, followed by an additional seven (7) holes in 2001 to a depth of 30 meters. The Zone is open in all directions and at depth. A preliminary inferred resource estimate was calculated by Arianne at the time, not NI-43-101 compliant.

7.3.5 Other zones (Nicole, Castor, Intersection, Lise and Lucie)

The Nicole, Castor, Intersection, Lise and Lucie Zones are zones of prospection and only current limited surface sampling data is available with limited drilling of 2009. During the Fall 2009 drilling campaign, four (4) holes were drilled near the south-western part of the Lucie Zone, three (3) others near the Lise Zone and finally, three (3) were located around the Intersection Zone. The best result is an intersection of 99 meters with 5.31% P_2O_5 along the hole LPA-09-10 drilled on the Lise Zone.

Surface exploration and some mechanical stripping were done in several targets inside the Lac a Paul Project. Many of the P_2O_5 results are promising.

Additional drilling was done and can be found in the drilling section of this report, but no resources are derived from these drillings at the moment.

8. DEPOSIT TYPES

Deposits originate from magmatic sedimentation and segregation within the anorthositic complex. The main geological unit is a Nelsonite.

Two types of apatite-ilmenite occurrences (nelsonite and anorthositic gabbro) are present within the Lac a Paul Project. Both are magmatic in origin and form specific facies of the Lac Saint-Jean Anorthositic complex. Although these kinds of deposits are known to be associated with various anorthosite complexes around the world, none are currently being mined for their phosphate content. However, similar deposits with dominant ilmenite are currently mined at Lac Tio (Rio Tinto Iron Titanium, Havre St-Pierre, Québec) and Tellnes (Norsk Hydro, Norway). Numerous occurrences are currently under evaluation in the Province of Québec for their iron and titanium content.

8.1 Nelsonite type

Nelsonites are scarce intrusive igneous rocks. They are also known as FTP rocks, in reference to their composition (Fe-rich, Ti-rich, P-rich igneous rocks). Nelsonites are principally composed of dark gray to blackish, metallic-lustered magnetite (Fe_3O_4) and ilmenite ($FeTiO_3$) (or ilmenomagnetite; titanian magnetite), plus apatite ($CaPO_4$). Minor minerals reported in nelsonites include spinel, olivine, pyrrhotite, and graphite.

These rocks typically occur as Fe-Ti-oxide concentrations in complexes. They appear to form as cumulates in cooling batholiths.

Manouane and Paul Zones are made of layered, medium-grained, olivine nelsonite. These are layered sequences composed of various proportions of ilmenite, magnetite, apatite and olivine minerals. Nelsonites, first described from Nelson County in Virginia, are usually defined as ilmenite-apatite, apatite, sometimes as rutile, although biotite, olivine and pyroxene may be present. Most known occurrences are described from gabbroic and anorthositic intrusions, although some are reported from granites and carbonatites. Genesis of anorthosite-related nelsonite is still debated, but usually accepted as a liquid segregation from a titanium-iron-phosphorus saturated mafic-anorthositic silicate magma. Segregation is considered to be triggered by silica polymerization caused by wall-rock contamination. This explains why such deposits are typically found in the proximity of anorthosite-gneiss contacts. A simple differentiation-accumulation process cannot be invoked to generate these unusual rocks.

Most nelsonite occurrences described in literature are ilmenite dominated, and occur either as pods or layered sequences. Examples are known in the Sept-Îles Complex, Lac De La Blache Anorthosite, St-Urbain Anorthosite, and in various locations within the Lac Saint-Jean Anorthosite, as well as in the Archean Lac Doré and Bell River complexes.

8.2 Gabbroic type

The Zone No. 1 to Zone No. 2 occurrences, which initially attracted Arianne's attention, are apatite-ilmenite-magnetite bearing, coarse-grained gabbros. Coarse-grained, granular, idiomorphic gabbroic rocks with millimetric sized grains host disseminated apatite, ilmenite and magnetite. Their abundance is lower than nelsonite, and suggests that titanium and phosphorus did not reach saturation in the magma. They form large volumes extending for kilometers. Outcrops in the Lac a Paul area are heavily weathered, with the rock crumbling into gravel due to frost dislocation along straight grain boundaries.

8.3 Carbonatite type

Most apatite currently mined in the world (Ontario, Kola Peninsula, Brazil and South Africa) is from carbonatite complexes. It should be noted that Lac a Paul deposits are not carbonatite hosted.

Carbonatite hosted deposits have higher apatite contents, typically 30-70%. However, carbonatite deposits present difficulties such as lower apatite recovery, carbonate contamination of the concentrate, and higher harmful contaminants such as uranium and fluorine, amongst other complications.

9. EXPLORATION

The 2010 to 2012 exploration program has mainly consisted of a sampling campaign performed on select claims of the Property. Geophysical surveys are used in the exploration process. The surface exploration is usually followed by a diamond drilling campaign which is presented in the next section of this report.

9.1 Prospecting 2010

Prospecting occurred from July 27 to August 10, 2010. The purpose of this work was to map and sample outcrops located over magnetic signatures similar to those of the Paul and Manouane Zones. For this reason the magnetic survey data had been reprocessed and used.

A total of two hundred and ten (210) outcrops were visited. From these, one hundred and eight (108) rock samples were taken and sent to ALS Chemex Laboratory in Val d'Or. Thirteen (13) major elements under oxide forms were analyzed by lithium borate fusion with XRF (ALS code ME-XRF06).

P_2O_5 and TiO_2 are the main components of interest. Figure 9.1.1 presents the prospection work of summer 2010. The work performed was supervised by Patricia Néron, Eng., and Arianne's supervisor.

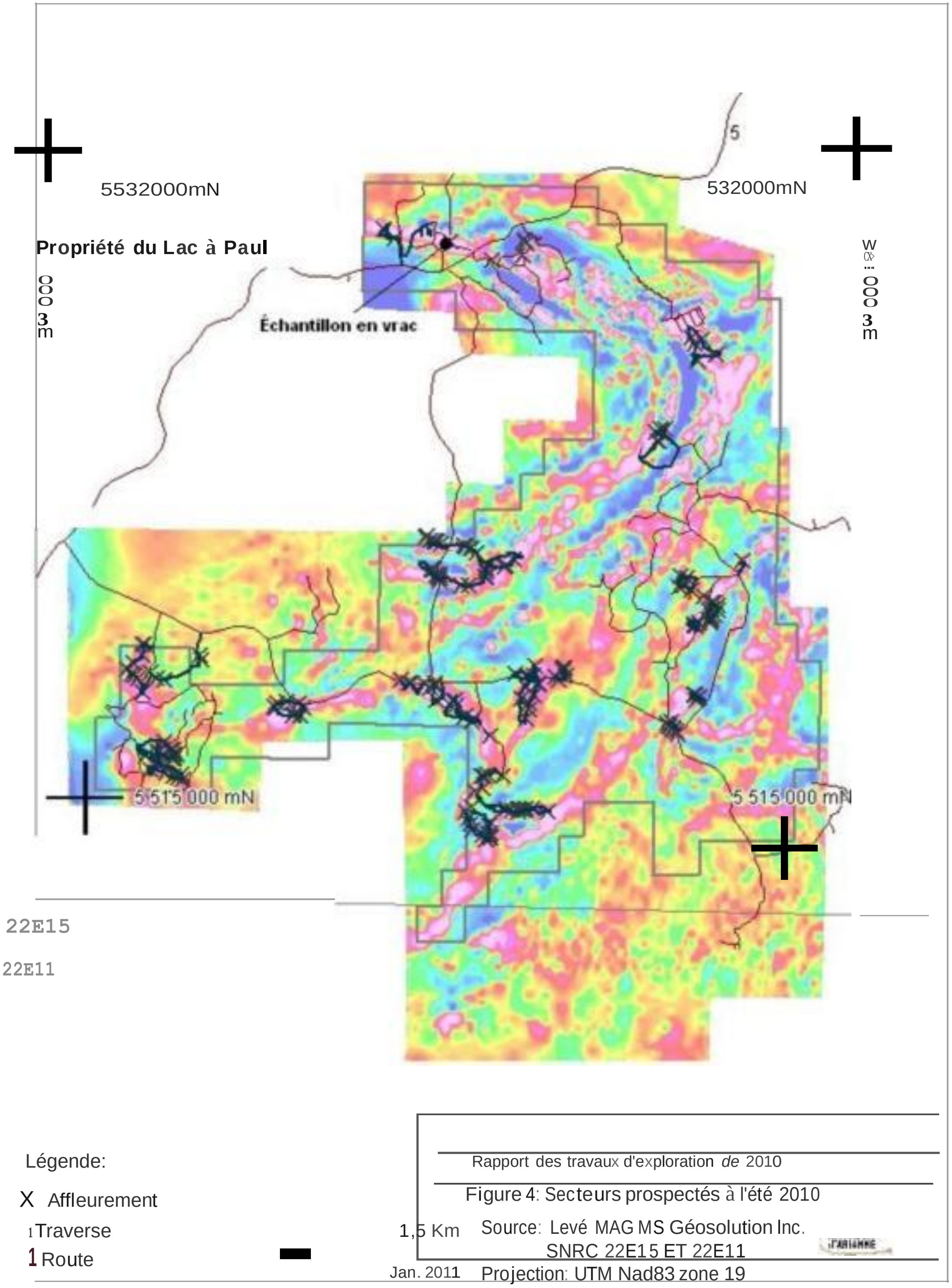


Figure 9.1.1 Mag with Position of Investigated Outcrops in Summer 2010 (Claims in 2010)

9.2 Bulk Sampling 2010

A bulk sample was taken on July 26, 2010, north of the stripped zone on Paul. The blasting, excavation and reclamation work were performed by Location ALR Inc. from Alma.

9.3 Cleaning of the 2009 Stripping Area

From May 26 to 28, 2010, restoration work was completed on the stripping area from October 2009. The area is roughly 900 m² (30 x 30 m), easily accessible, and is located south of hole PAU-09-18 and west of hole PAU-09-17.

9.4 2010 Results

Most of the outcrops were made of anorthosites, gabbros, ferrogabbros and pyroxenites. Some nelsonites, massive oxides, diorites, tonalites, granites and granodiorites were also observed. No geological map has been produced from this data yet.

Out of the one hundred and ten (110) samples, twenty-four (24) returned values above 5% P_2O_5, with three (3) exceptional values of 12.30%, 13.79% and 38.3% P_2O_5. The value of 38.3% P_2O_5 was explained by the nature of the sample, which was a natural concentrate of coarse apatite crystals. With regards to titanium, forty-eight (48) samples showed values above 5% TiO_2, with seven (7) between 10 and 30% TiO_2. These grades were observed in massive oxide lithologies. Figures 9.4.1 and 9.4.2 present the P_2O_5 and TiO_2 compilations.

This work generated new drilling targets.

Part (20 kg) of the one tonne “bulk sample” was crushed and ground at the IOS Laboratory in Chicoutimi for use as an internal standard. The rock was not milled nor processed as a standard understanding of a bulk sample.

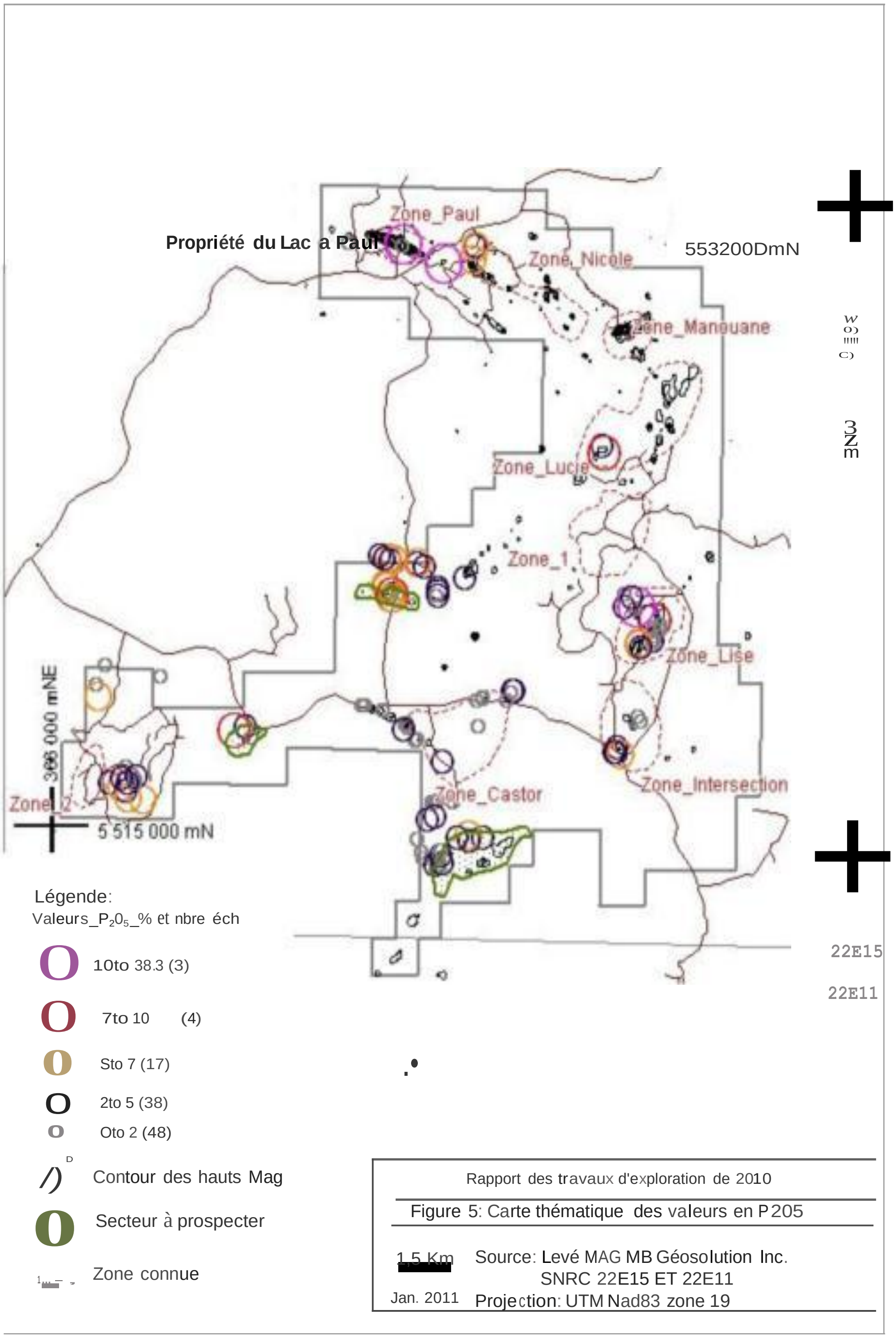


Figure 9.4.1 Surface Outcrops P_2O_5 Grades Compilation of 2010 Work (Claims in 2010)

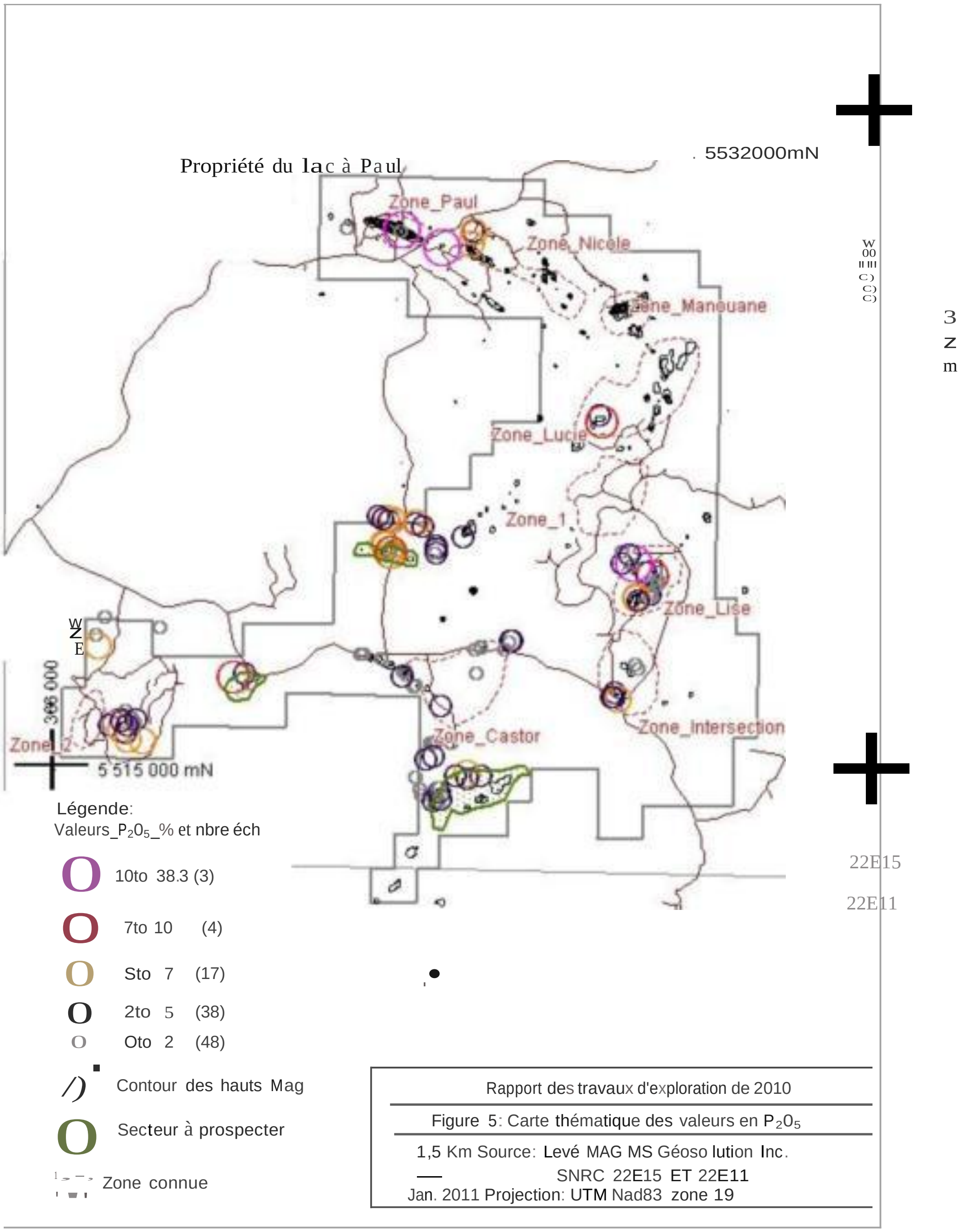


Figure 9.4.2 Surface Outcrops TiO_2 Grades Compilation of 2010 Work (Claims in 2010)

9.5 2011 Exploration Work

Prospection work occurred in summer 2011. The purpose of this work was to map and sample outcrops in newly acquired claims and sectors not previously investigated.

Figures 9.5.1 and 9.5.2 present prospection work of summer 2011. Work was performed under supervision of Christian Tremblay, Arianne's Senior Geologist and supervisor.

A total of 434 outcrops were visited and 234 samples were shipped to the Laboratory. Main lithologies observed were: gabbros, ferro-gabbros, anorthositic gabbros, anorthosites and nelsonites. Sixty one (61) samples showed results above 5% P_2O_5.

A new outcrop was stripped, mapped and sampled just to the north of the 2009 stripping area. Intersections reported up to 10.4% P_2O_5 over 12.7 meters long. Finally, a 50 tonnes bulk sample was taken for ore processing.

An airborne gravity survey covering the whole Lac a Paul Property was done by Canadian Micro Gravity LTD, supervised by Geophysique GPR International Inc. and MB Geosolutions during fall of 2011. This survey investigated whether there was correlation between the magnetic survey and the gravity survey.

In December 2011, geochemical description (EDX analysis) of drill cores from the Paul Zone (associated with an undergraduate project by Guillaume Lefebvre), was performed by Photonic Knowledge.

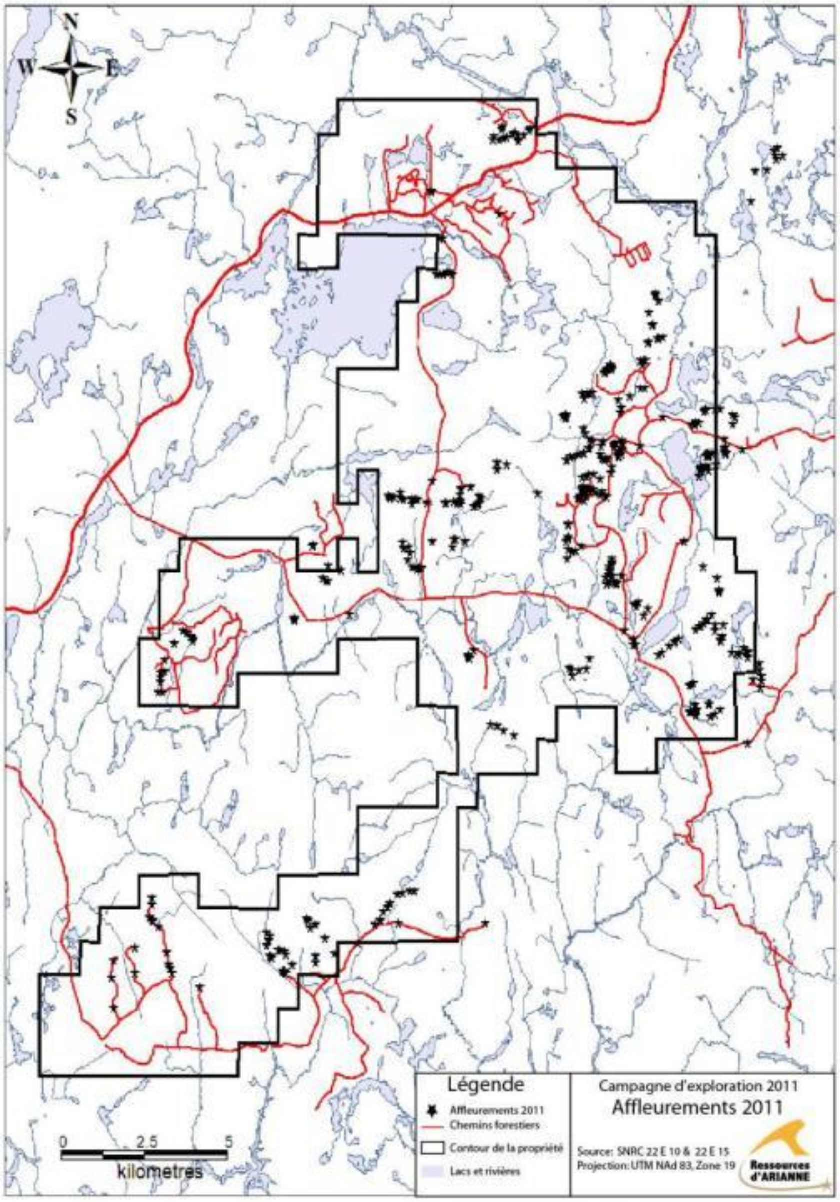


Figure 9.5.1 Position of Investigated Outcrops in Summer 2011 (Claims in 2011)

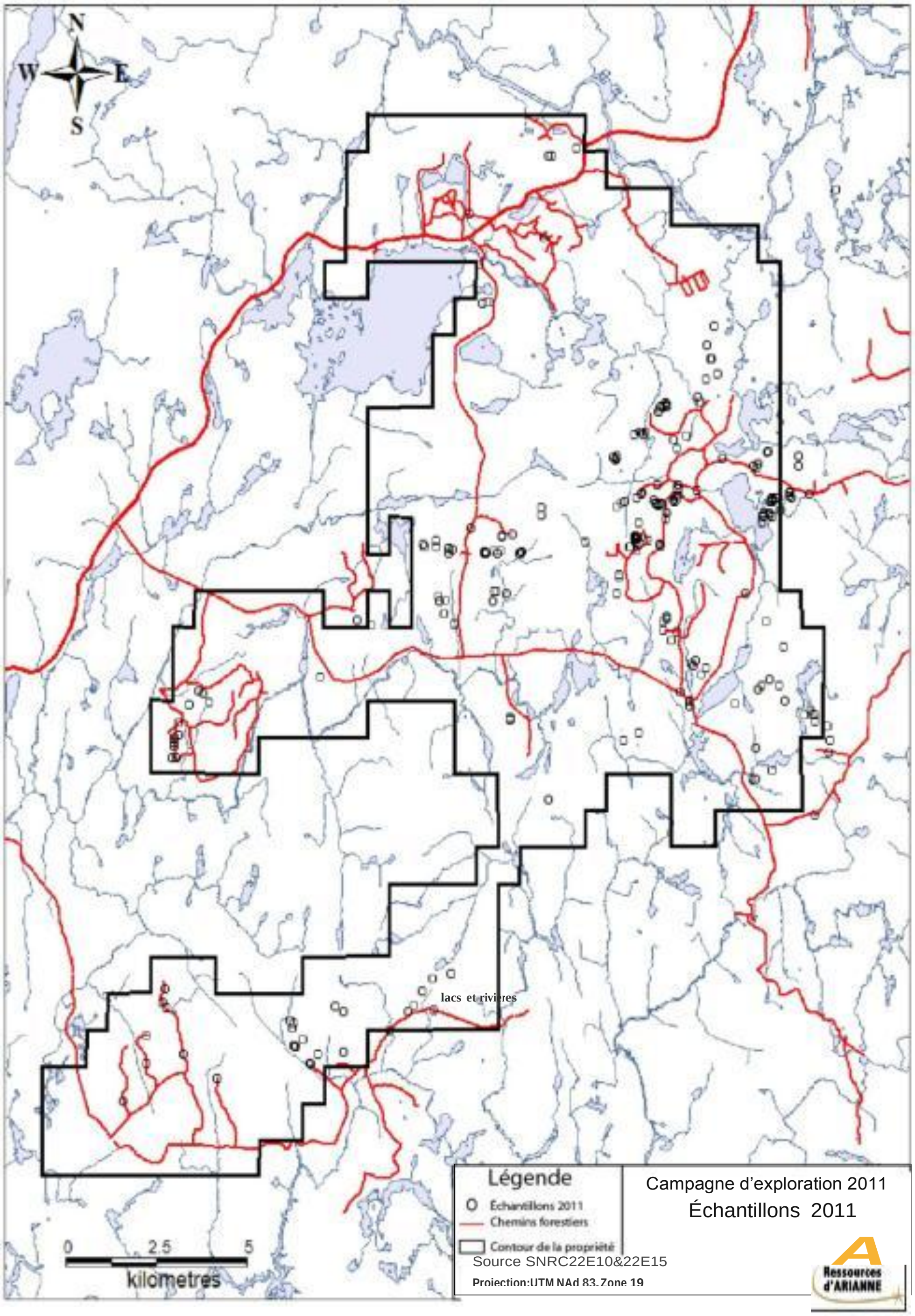


Figure 9.5.2 Position of Samples Taken from Outcrops in Summer 2011 (Claims in 2011)

9.6 2012 Exploration Work

It is worth noting that all traverses were performed with a geophysical device called a BeepMat. This device is capable of detecting the presence of conductive or magnetic rock up to one (1) meter in depth.

Exploration work on the Lac a Paul Property focused on one area located in the center of the Property. There were a total of six (6) working days for exploration between the 3rd and 29th of August 2012. This area had previously been identified internally for its geological and geophysical features which are similar to those of the Paul Zone. There were a few traverses (see Figure 9.6.1 below) performed as well as a small manual stripping. In total, eighteen (18) outcrops were described and fifteen (15) samples were analyzed for major elements by the ME-XRF06 method, seven (7) of these samples were also analyzed for metals by the ME-XRF21u method.

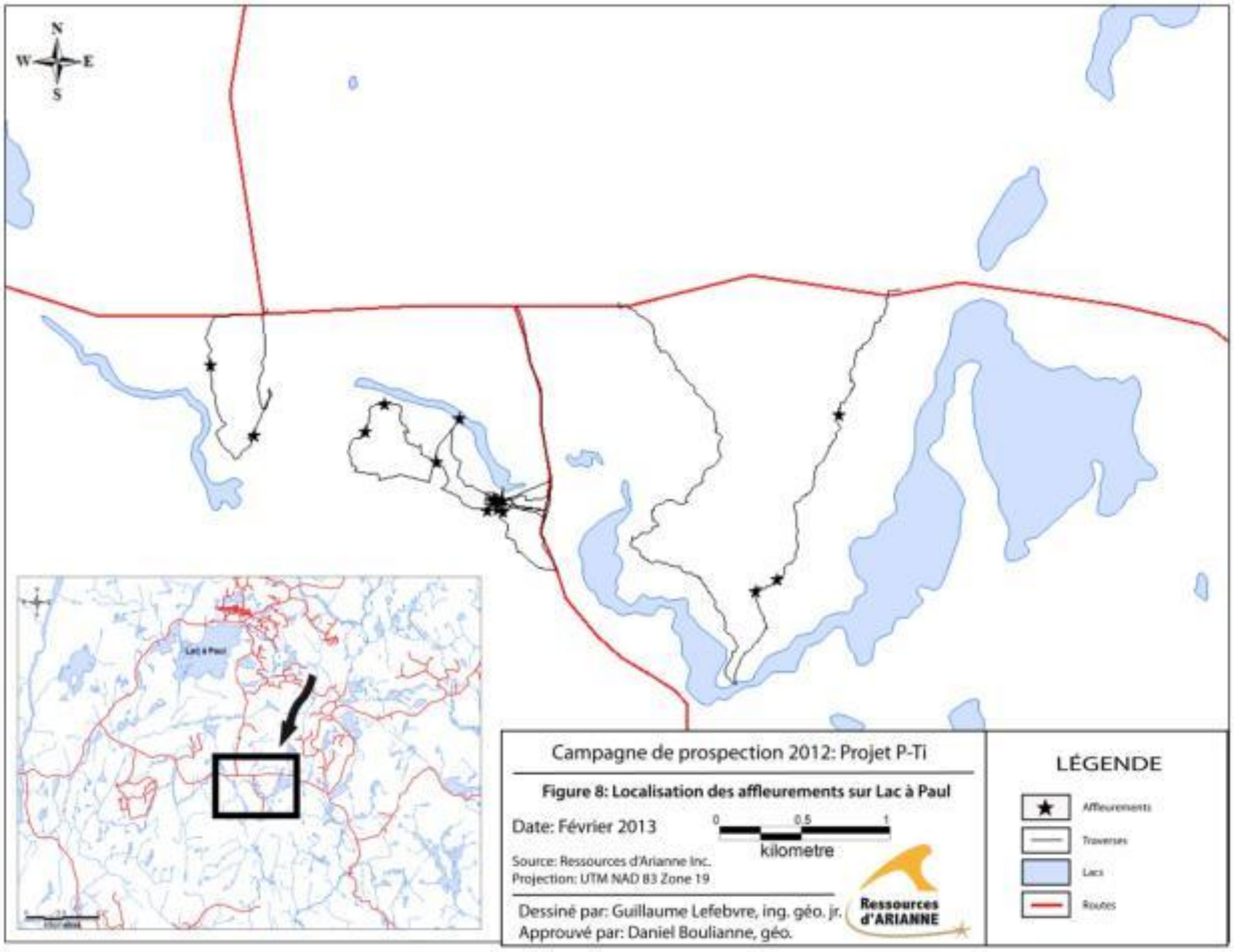


Figure 9.6.1 Location of Outcrops and Traverses, Part of Lac a Paul Property

Outcrops visited on the central sector of the Lac a Paul Property showed very good potential. Indeed, five (5) of the fifteen (15) samples showed a greater than 5% P_2O_5 content, with three (3) higher than 10%. Samples N142959, N141954, and N141953 returned values of 10.02%; 12.12% and 12.37% P_2O_5 respectively. All three (3) cases are in nelsonite. As far as titanium, fourteen (14) of the fifteen (15) samples showed a percentage greater than 10% TiO_2 and six (6) were above 20% TiO_2. The highest value comes from an outcrop of massive oxides. Sample N142958 resulted in a value of 25.01% TiO_2.

This preliminary work suggests the presence of a one kilometer-long band of massive oxides. The northern contact is a lens of nelsonite with a WNW-ESE orientation, easily detected on the airborne magnetic survey. However, the exploration campaign did not identify the nelsonite as long in length as the lens of massive oxides.

The seven (7) samples which were sent for analysis using the ME-XRF21u method returned no interesting values (see Table 9.6.1). Figures 9.6.2 to 9.6.5 show the location of the different samples with thematic maps for the values of TiO_2 and P_2O_5.

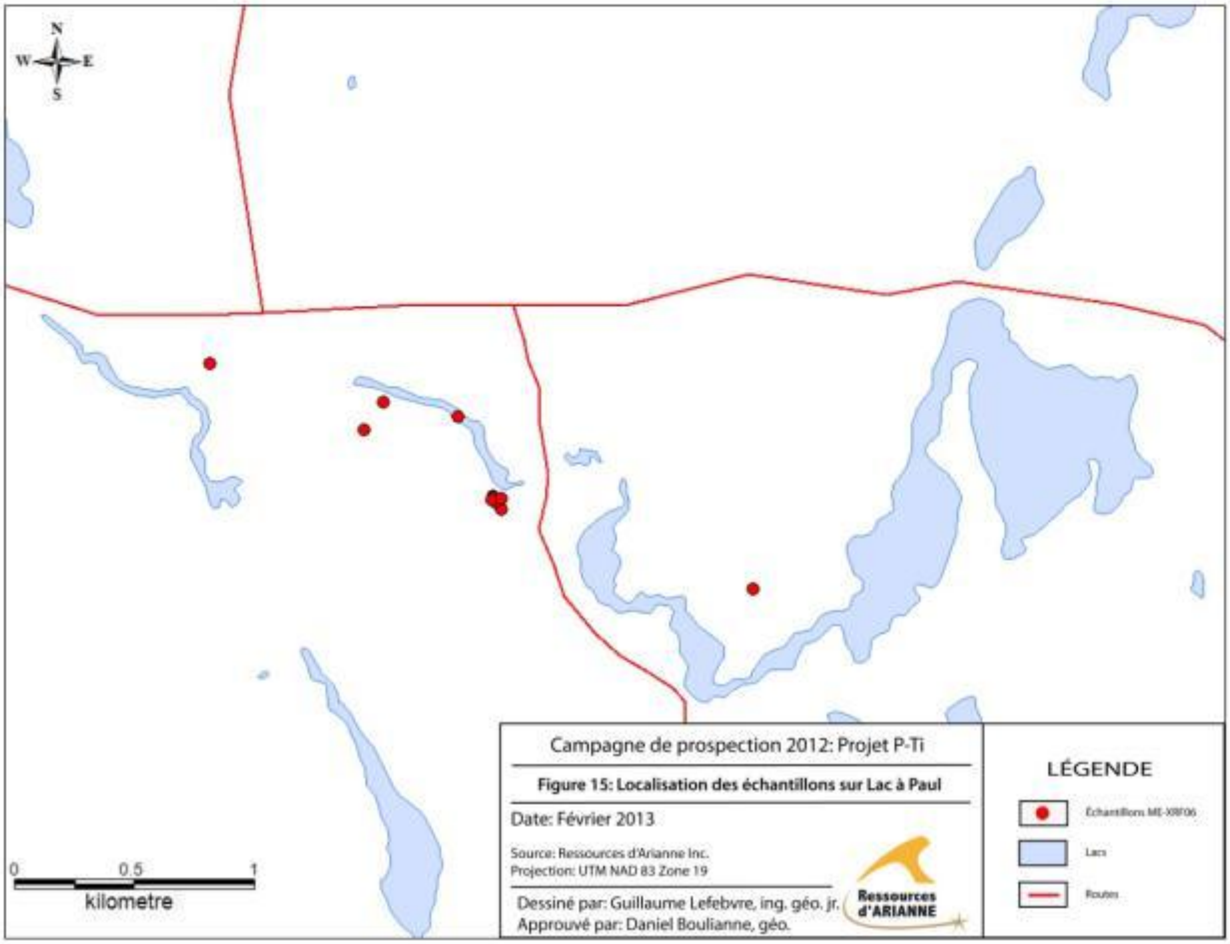


Figure 9.6.2 Location of Samples Analyzed by ME-XRF06 Method, Part of Lac a Paul Property

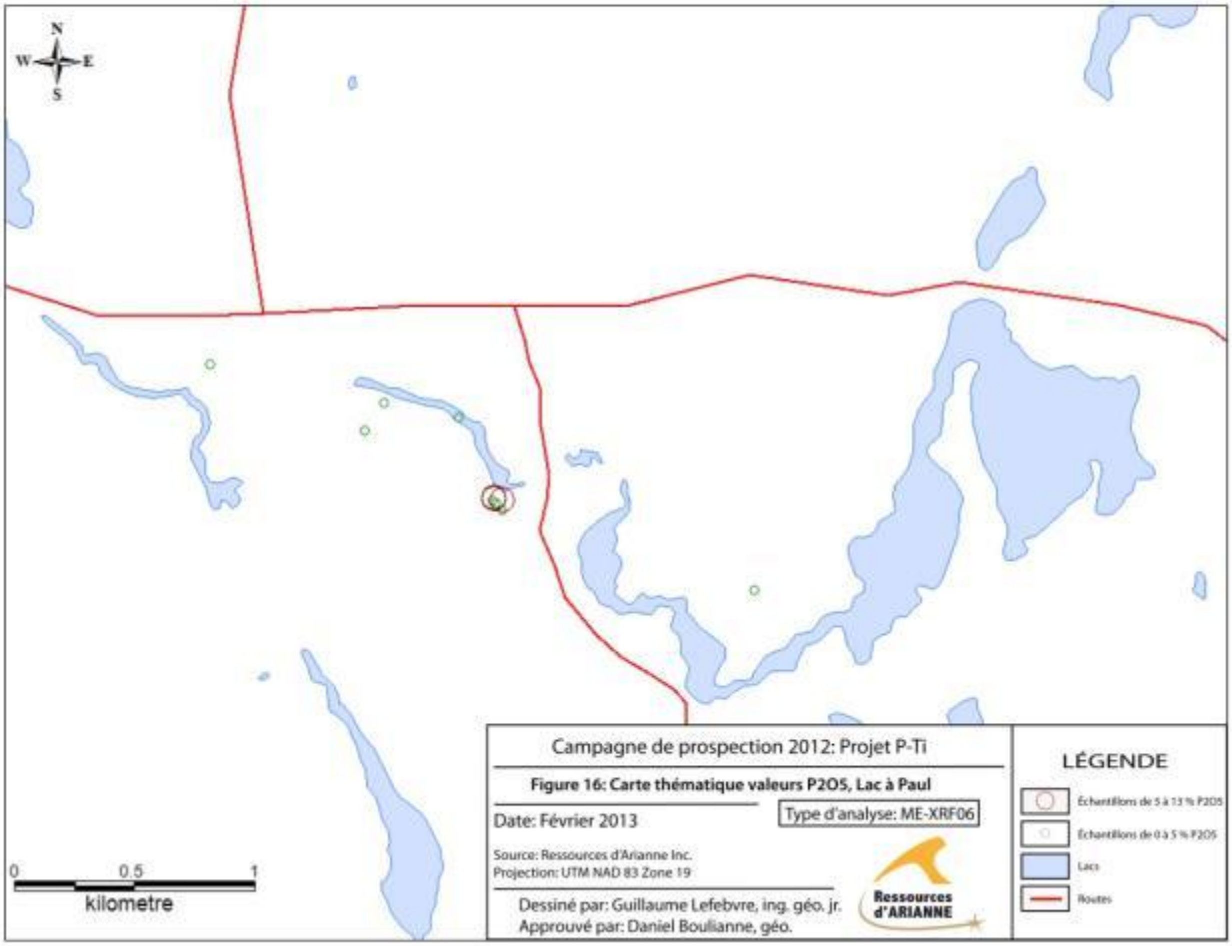


Figure 9.6.3 Thematic Map of P_2O_5 Values, Part of Lac a Paul Property

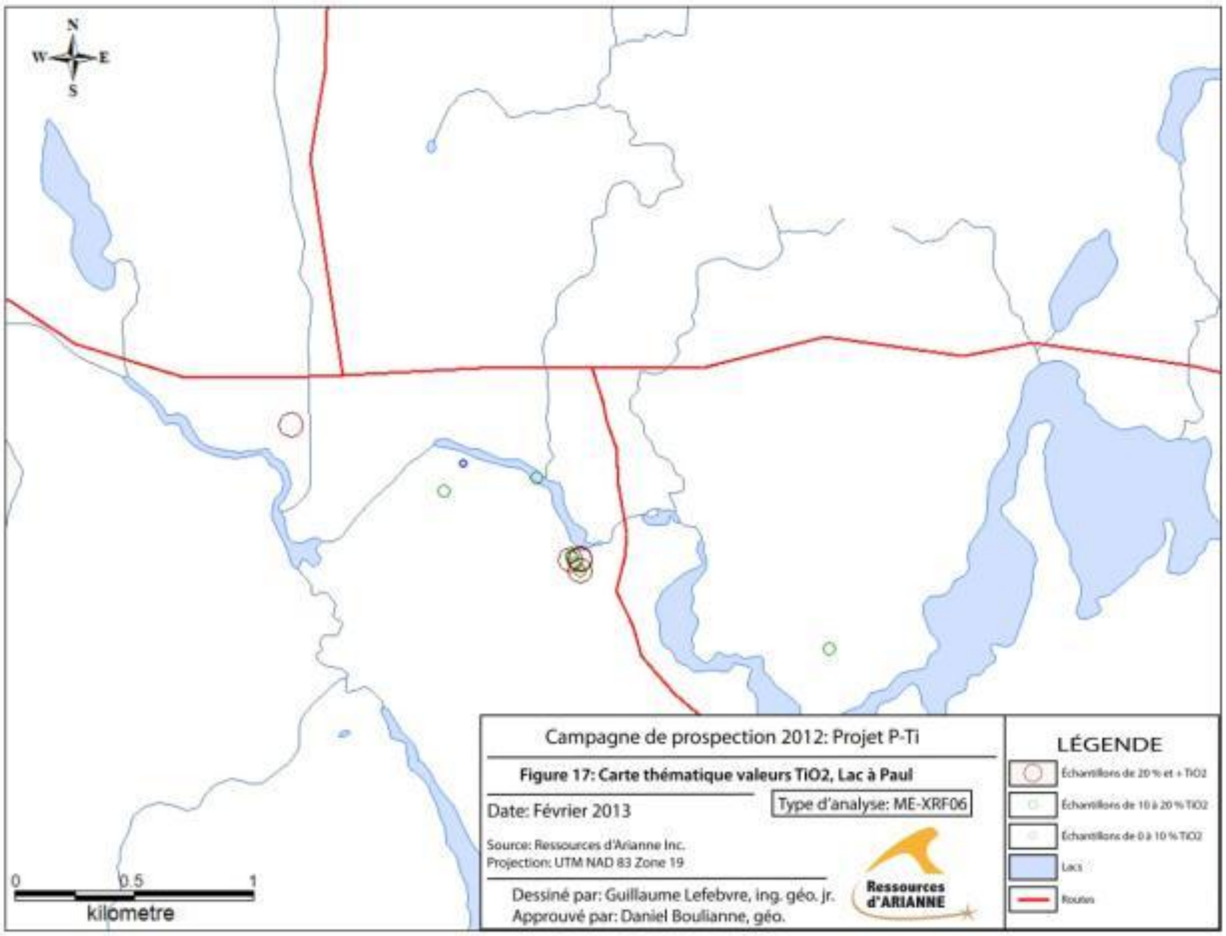


Figure 9.6.4 Thematic Map of TiO_2 Values, Part of Lac a Paul Property

Outcrop Name	Sample_ID	P_2O_5 (%)	TiO_2 (%)	Fe_2O_3 (%)
12-LAP-5002	N141952	5.416	23.78	52.91
12-LAP-5003	N141953	12.366	14.94	35.39
12-LAP-5003	N141954	12.124	17.62	43.24
12-LAP-5006	N141955	0.165	15.23	59.79
12-LAP-4001	N142951	0.161	22.38	45.01
12-LAP-4001	N142952	0.221	16.32	46.66
12-LAP-4001	N142953	0.079	22.91	42.61
12-LAP-4004	N142954	4.301	4.57	11.9
12-LAP-4005	N142955	0.118	12.63	55.93
12-LAP-4006	N142956	0.678	15.17	59.33
12-LAP-4007	N142959	10.024	18.69	46
12-LAP-4008	N142957	0.144	15.81	36.37
12-LAP-4009	N142958	0.025	25.01	60.52
12-LAP-4011	N142960	0.118	22.04	44.24
12-LAP-4012	N142961	6.34	23.39	51.45

Table 9.6.1 Analytical Results by ME-XRF06 Method, Lac a Paul Property

The 2012 exploration campaign performed by Arianne was designed to increase the geological knowledge on properties where the potential for phosphate mineralization and/or titanium had already been identified.

The field work updated a new mineralized sector in the centre of the Lac a Paul Property. These new indices allowed Arianne to follow the nelsonite lens over a length of at least 50 meters and follow the lens of massive oxides along 1,400 meters. It is believed that it would be possible to follow the lens of nelsonite along a length equivalent to that of the massive oxides.

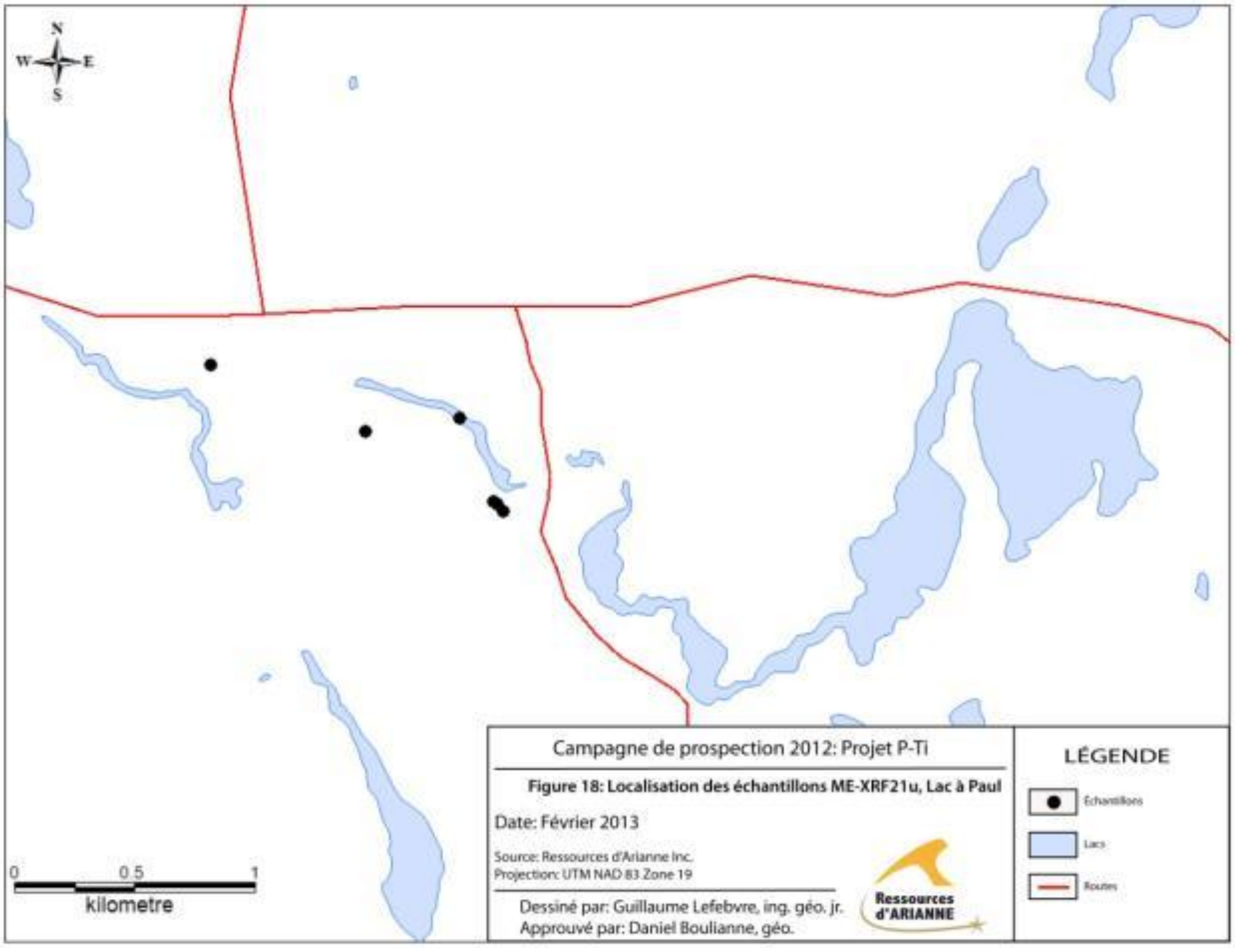


Figure 9.6.5 Location of Samples Analyzed by the ME-XRF21u Method, Lac a Paul Property

Outcrop Name	Sample_ID	Co (%)	Cr_2O_3 (%)	Cu (%)	Ni (%)	Pb (%)	V (%)	Zn (%)
12-LAP-4001	N142951	0.018	0.164	0.006	0.017	0.018	0.171	0.041
12-LAP-4001	N142952	0.020	0.167	0.002	0.019	0.013	0.144	0.036
12-LAP-4005	N142955	0.025	0.258	0.003	0.035	0.013	0.181	0.052
12-LAP-4006	N142956	0.023	0.528	0.01	0.032	0.015	0.214	0.063
12-LAP-4008	N142957	0.011	0.118	0.002	0.012	0.004	0.137	0.023
12-LAP-4009	N142958	0.022	0.216	0.006	0.022	0.008	0.246	0.050
12-LAP-4011	N142960	0.024	0.080	0.003	0.025	0.016	0.09	0.030

Table 9.6.2 Analytical Results by ME-XRF21u Method, Lac a Paul Property

In March 2012, Geosig released the report on the Gravity ground survey conducted on 22El5 for Arianne. Figure 9.6.6 presents the claims on which the survey was made. These ground surveys were made to see the correlation with the 2011 airborne survey.

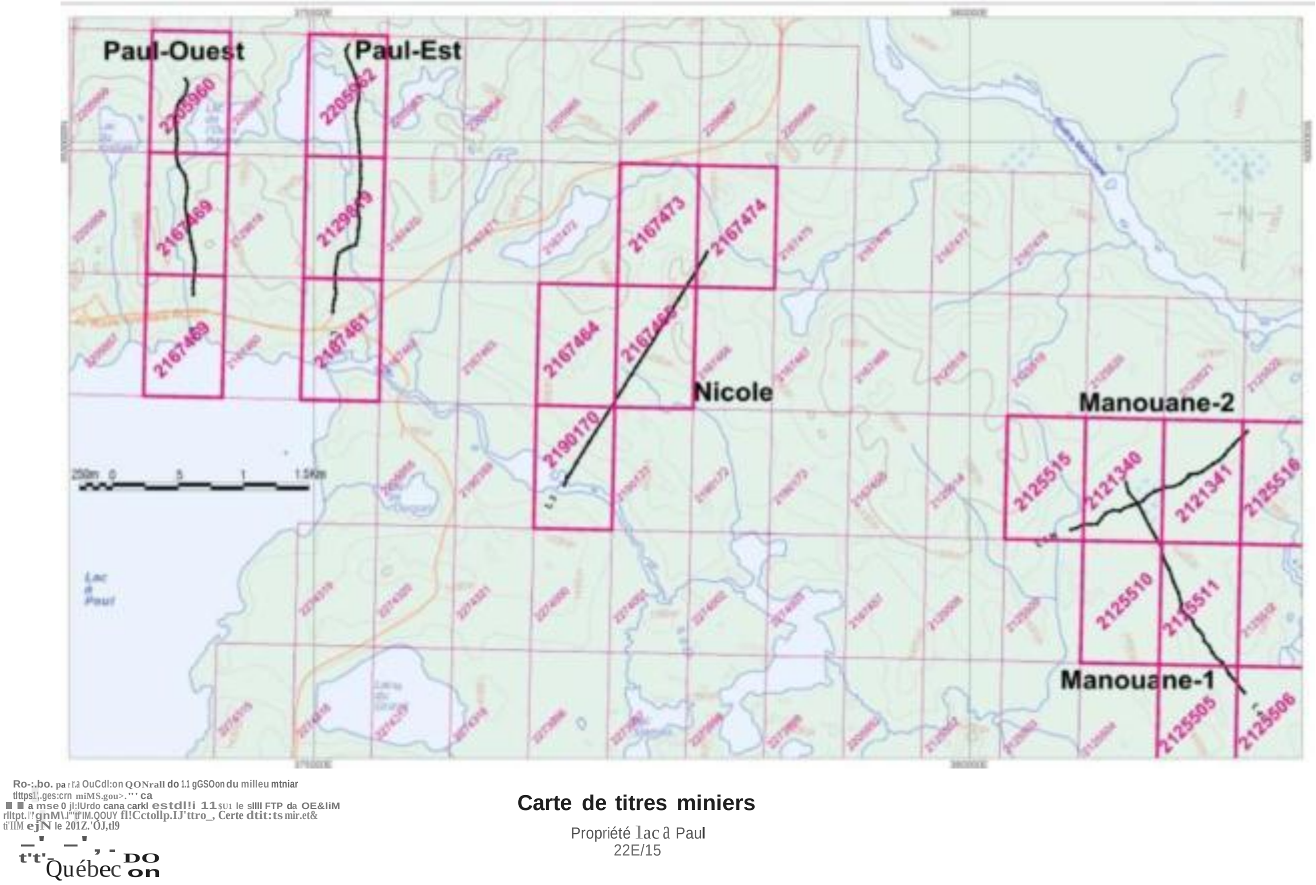


Figure 9.6.6 Claims with Gravity Ground Survey

In spring 2012, an airborne laser survey (LIDAR) covering part of the Lac a Paul Property was completed (undertaken in 2011). Figure 9.6.7 presents the areas of the survey.

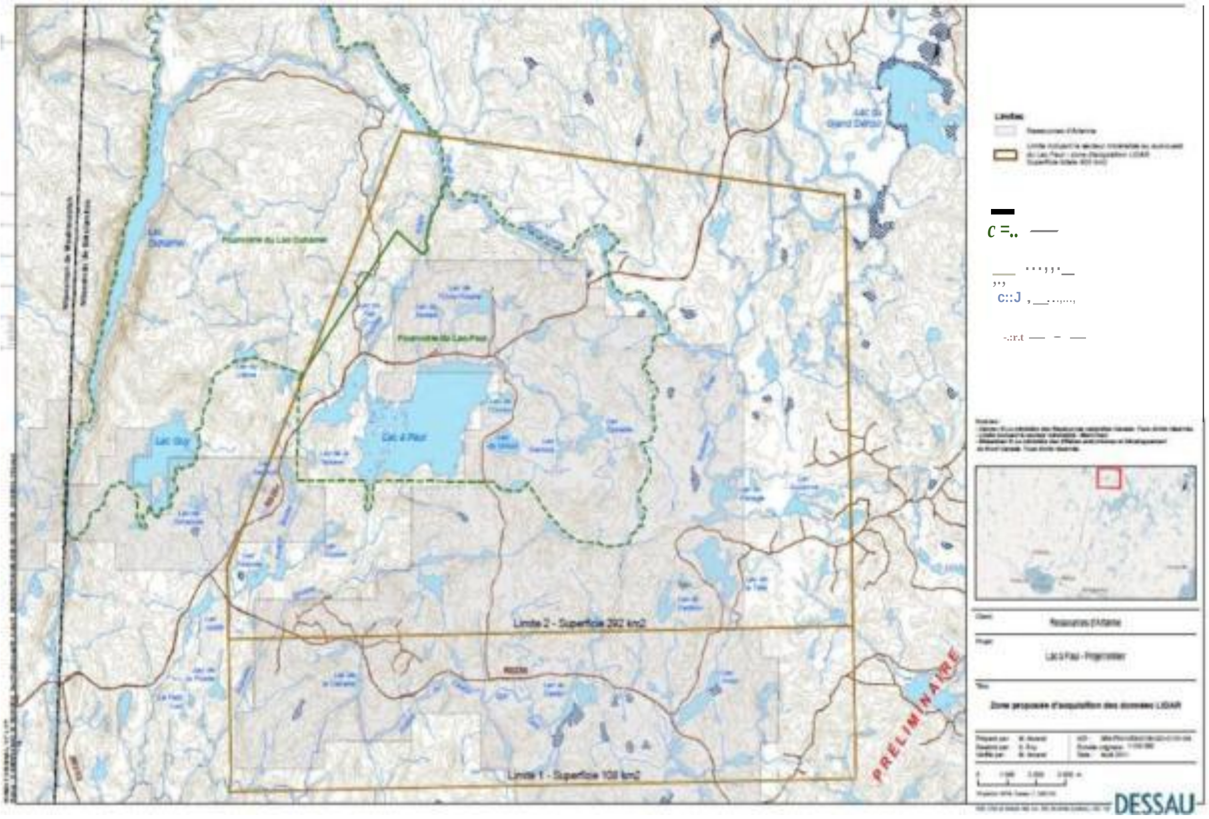


Figure 9.6.7 Proposed Area for LIDAR Survey

In late Fall 2012, other geochemical descriptions (EDX analysis) of drill core from the Manouane Zone were performed by Photonic Knowledge. The goal was to determine the correlation between the Paul and Manouane Zones.

10. DRILLING

10.1 Previous & Historical Drilling

Historical drilling on the Property consisted of diamond drill hole coring.

- 1970

  NQN Mines Ltd. carried out exploration work using geophysical methods, geological mapping and drilling, in west of Chute-des-Passes. No detailed data is available.

- 1997

  Mapping projects in some properties were conducted by Quebec Geology. It was performed for a series of geological surface sections of recognition. Virginia Gold Mines and SOQUEM did various exploration activities and eighteen (18) holes were drilled in 1998 (Isabelle, R., 2000). Two (2) of these holes are located in the Manouane Zone and two (2) holes are in the Paul Zone.

- 1999

  On December 1999, Arianne took an option on the Property. A drilling campaign by diamond drill BQ core size was performed and the total length drilled was 51.56 m. It consisted in two (2) holes that were located in Zone No.1 and the campaign was completed in March 2000 (IOS, rapport 00-197-2, Girard, R., 2000).

- 2001

  Ten (10) holes were drilled in the first campaign (Internal report, 2000-2001). The total length drilled was 270 m in order to better define the mineralized horizon. Seven (7) holes were drilled in Zone No. 1 and three (3) holes in Zone No. 2. At the end of 2001, Arianne had drilled eight (8) additional holes in Zone No. 2.

- 2008-2009 by Arianne

  Following the positive results of the surface sampling and the increasing phosphate rock market value, Arianne decided to explore this Property in order to prepare the first mineral resource NI 43-101 compliant estimate with the SGS-Geostat Ltd. group for three (3) main areas of the Property (Paul Zone, Zone No. 2 and Manouane Zone).

  A diamond drilling campaign was planned in order to better define three of the most promising zones and perform a calculation of the mineral resources. This campaign was conducted in two distinct periods by the drilling company Dami-Or from Sullivan, Quebec, Canada.

  The first campaign took place from October 27 to November 22, 2008. More than 1,860 meters were drilled with thirteen (13) drill holes in the Paul Zone and nine (9) drill holes in Zone No. 2 for about 924 meters.

  The Paul Zone drilling was performed in five (5) sections oriented north/south and separated by 200 to 300 meters. Two (2) to three (3) drill holes located approximately 100 meters apart were made by section. It was then possible to assess the mineral potential for a 140,000 m^2 surface area, being about 1 km in length.

  The Zone No. 2 drilling consisted of three (3) sections oriented west/northwest, east/southeast and separated by 200 meters. Each section consisted of three (3) holes spaced approximately at 100 meters. All three sections were completed but the overall tested area did not meet the 120,000 m^2 objective.

  The second drilling campaign occurred from January 19 to February 7, 2009. Thirteen (13) holes representing 1,947 m were drilled on the Manouane Zone. It consisted of four (4) sections oriented northwest/southeast. The drill hole lines were laterally spaced at about 200 meters and each drill hole line included two (2) to four (4) holes with approximately 100 meters between holes. Such a configuration allowed testing an area of more than 120,000 m^2.

In the summer of 2009, a drilling campaign totaling 1,002 meters in 11 holes (LAP-09-01 to LAP-09-11), was carried out on different targets within the Lac a Paul Property. Targets were located in the Lucie Zone (LAP-09-01 to LAP-09-04), Lise Zone (LAP-09-05, LAP-09-06 & LAP-09-10), Intersection Zone (LAP-09-07 to LAP-09-09) and Castor Zone (LAP-09-11).

10.2 2010-2011 Drilling

The following section is a summary of Arianne exploration reports filed with the Quebec's Department of Natural Resources (work assessment) that was translated to English.

10.2.1 Paul

The drilling program in the Paul Zone was undertaken to upgrade the inferred mineral resources in the western part of the deposit into indicated mineral resources and to also verify the lateral extension of the deposit to the west. The drilling campaign was executed between November 2 and December 8, 2010.

Seventeen (17) holes consisting of 4,125 m of diamond drilling were performed by the Nordic Drilling Company. 1,418 samples were sent to ALS Chemex Laboratory in Val d'Or. These were analyzed for major elements by X-ray fluorescence (ME-XRF06) method.

The main geological units observed in this area consisted of anorthosites, gabbros and nelsonite. Seventeen (17) of the eighteen (18) holes intersected the mineralized zone. Several holes showed interesting results, such as the following holes: PAU-10-32, 33, 37, 38, 40, 41 and 46. These holes indicated intersections exceeding 200 meters totaling more than 6.00% P_2O_5 and 6.00% TiO_2.

This drilling program allowed extension of the mineralized zone further to the west. In addition, it remained open laterally and at depth.

The positions of the drill holes are shown in Figure 10.2.1 (coordinates UTM NAD 83) including the depth, the orientation and the dip of each of them. The list is given in Table 10.2.1.

Hole Name	UTME	UTMN	Direction (°)	Dip (°)	Depth (m)
PAU-10-32	375,138	5,529,247	360	-59	462
PAU-10-33	374,926	5,529,453	360	-60	309
PAU-10-34	374,943	5,529,587	360	-45	54
PAU-10-35	374,934	5,529,352	360	-75	432
PAU-10-36	374,923	5,529,455	180	-45	63
PAU-10-37	374,854	5,529,431	360	-55	360.5
PAU-10-38	374,779	5,529,409	360	-65	351

Hole Name	UTME	UTMN	Direction (°)	Dip (°)	Depth (m)
PAU-10-39	374,785	5,529,562	360	-45	189
PAU-10-40	374,785	5,529,562	360	-70	303.5
PAU-10-41	374,717	5,529,496	360	-65	423
PAU-10-42	374,648	5,529,529	360	-45	72
PAU-10-43	374,648	5,529,529	360	-70	324.5
PAU-10-44	374,628	5,529,651	360	-45	90
PAU-10-45	374,541	5,529,582	360	-60	274.4
PAU-10-46	374,445	5,529,607	360	-70	282.5
PAU-10-47	374,445	5,529,607	360	-45	114
PAU-10-48	374,625	5,529,653	180	-45	21

Table 10.2.1 Position (UTM NAD 83), Direction, Dip and Depth of the Drill Holes 2010

Almost all drill holes were analyzed and 1,418 samples were collected. These were first sent to the laboratory of IOS Geosciences in Saguenay City. This company is responsible for the pre-treatment of samples (drying, grinding and splitting). Subsequently, a predetermined amount (about 250 g) of each sample was shipped to ALS Chemex for analysis of the major elements (including P_2O_5 and TiO_2) by X-ray fluorescence (ME-XRF06).

The rocks intersected by the drill holes are mainly nelsonite, anorthositic gabbros and gabbroic anorthosites. Some diorites, granites, amphibolites and pegmatites are also present. Enrichment in Fe-Ti oxides and apatite was observed in nelsonite, gabbros, anorthosite and sometimes in diorites. Out of the seventeen (17) holes drilled, sixteen (16) holes intercepted mineralization; in addition, five (5) of these remained open in the mineralization at depth.

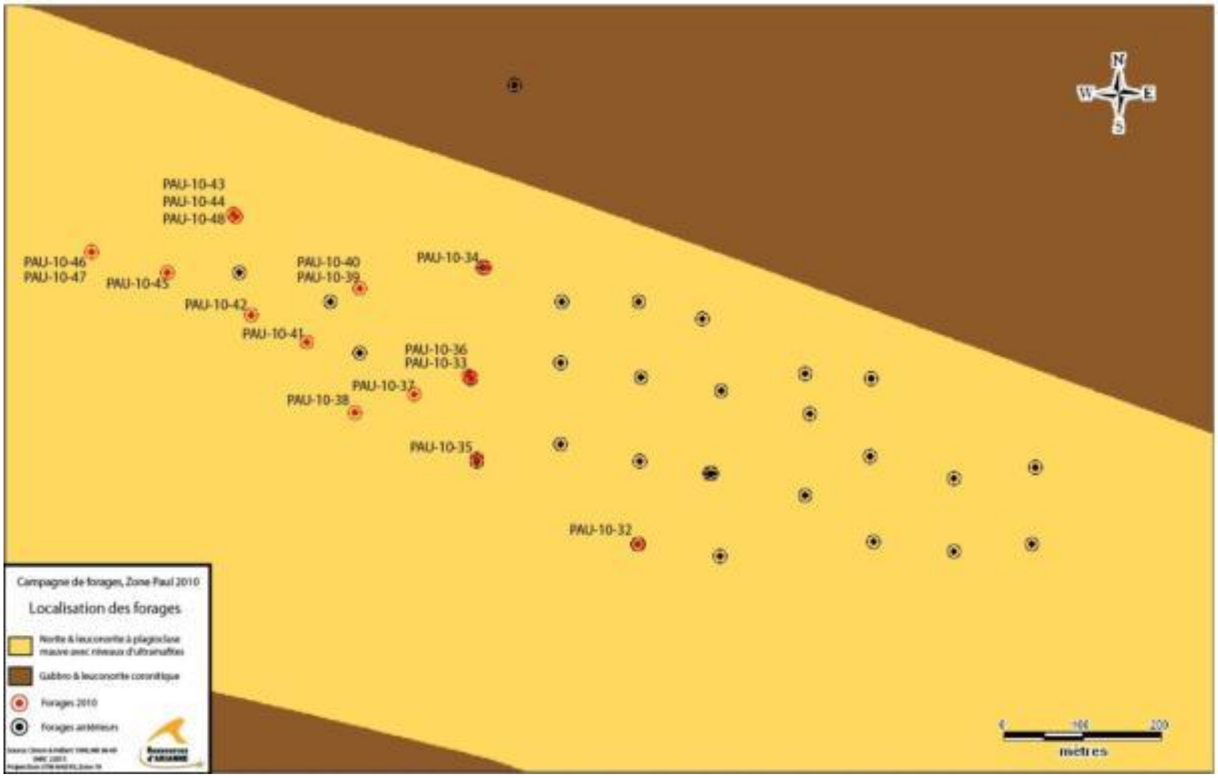


Figure 10.2.1 Location of Diamond Drill Holes Fall 2010 - Paul

Several drill holes have interesting intersections that show a marked enrichment in TiO_2 and P_2O_5.

Indeed, seven (7) holes had an intersection exceeding 200 m with more than 6.00% of P_2O_5 and 6.00% of TiO_2. The hole PAU-10-32, already analyzed from 174 to 462 m in 2009, was re-analyzed from 0 m to 174 m and interesting results were obtained from 140.75 to 174 m. These were incorporated with the intersection made in 2009. Table 10.2.2 shows the significant intersections within the different drilling holes.

All drilling reports and geochemistry analysis database were submitted to SGS Canada Inc. in Blainville.

Hole Name	From (m)	To (m)	Length	P_2O_5 (%)	TiO_2 (%)
PAU-10-32	140.75	462	321.25	6.64	6.41
PAU-10-33	3.5	293.6	290.1	7.21	8.76
including	148	182	34	7.21	10.88
	158.7	176.7	18	7.53	9.99
PAU-10-34	0	54	54	0.39	7.98
including	7.1	54	46.9	0.45	9.18
	10.06	35.7	25.64	0.48	10.27

Hole Name	From (m)	To (m)	Length	P_2O_5 (%)	TiO_2 (%)
	41.7	54	12.3	0.44	9.59
PAU-10-35	6.3	427	420.7	4.40	4.90
including	18.3	44.3	26	3.44	3.40
	87.4	432	344.6	4.80	5.37
	87.4	208.2	120.8	4.73	3.75
	306	432	126	6.48	9.04
PAU-10-36	4.3	47	42.7	7.95	6.96
PAU-10-37	6.6	330.8	324.2	7.46	8.56
including	39.8	330.8	291	8.10	9.31
	330.8	360.5	29.7	0.66	4.99
PAU-10-38	84	125.2	41.2	4.77	5.11
	135.7	351	215.3	6.69	8.68
including	135.7	211.6	75.9	7.13	9.61
	218	230	12	7.56	9.92
	233.9	351	117.1	6.91	8.72
PAU-10-39	6.6	54.6	48	5.54	11.86
	54.6	189	134.4	0.57	8.00
PAU-10-40	4.9	288.6	283.7	6.82	11.77
PAU-10-41	11.1	395.5	384.4	7.18	8.50
including	78.7	395.5	316.8	8.00	9.50
PAU-10-42	4.4	72	67.6	5.08	5.46
including	40.4	72	31.6	6.27	6.64
PAU-10-43	159.2	324.5	165.3	6.62	9.38
PAU-10-44	0	90	90	0.31	5.81
PAU-10-45	2.8	189	186.2	6.35	6.63
including	27	183	156	6.83	6.61
	44.6	183	138.4	7.01	6.67
	44.6	83.9	39.3	8.34	6.29
	106.8	183	76.2	8.19	8.44
PAU-10-46	3.8	243	239.2	6.96	8.65
including	12.8	243	230.2	7.06	8.78
	15.8	60	44.2	3.87	4.17
	90.5	223.4	132.9	9.70	10.75
	90.5	243	152.5	8.95	11.41
	120.5	157.4	36.9	10.41	9.61
PAU-10-47	4.3	81.9	77.6	6.20	6.44
including	54.2	81.9	27.7	9.62	9.03
PAU-10-48	4.5	14.9	10.4	5.84	14.37

Table 10.2.2 Best Mineralized Intersections

10.2.2 Manouane

This section presents the definition drilling campaign that was carried out during Q1 2011 in the Manouane Zone located on the Lac a Paul Property.

The drilling campaign allowed delimitation of the mineralized zone. This zone covers an area of 1,000 m (length) by 250 m (width). In addition, this mineralized zone still laterally opens to the East. It seems to close at about 150 m in depth.

The drilling campaign carried out in the winter of 2011 was conducted between February 7 and March 30, 2011. It was designed to convert inferred resources estimated at 137.7 Mt grading 5.71% P_2O_5 and 8.92% TiO_2 in indicated resources. It was also necessary to verify the lateral extension and depth of the deposit. A total of thirty-five (35) diamond drill holes were drilled by the Nordic Drilling Company. The locations of the drill holes are shown in Figure 10.2.2. Table 10.2.3 gives the coordinates (UTM NAD 83), depth, and orientation and dip of each of them.

Hole Name	UTME	UTMN	Direction	Dip	Depth (m)
MAN-11-14	381 101	5 527 320	360	-90	249
MAN-11-15	381 101	5 527 320	335	-65	228
MAN-11-16	381 067	5 527 391	335	-65	177
MAN-11-17	381 222	5 527 355	360	-90	246
MAN-11-18	381 194	5 527 417	360	-90	159
MAN-11-19	381 194	5 527 417	335	-50	117
MAN-11-20	381 238	5 527 037	335	-70	351
MAN-11-21	381 269	5 527 265	360	-90	300
MAN-11-22	381 320	5 527 189	360	-90	366
MAN-11-23	381 296	5 527 457	335	-75	144
MAN-11-24	381 296	5 527 457	335	-47	171
MAN-11-25	381 418	5 527 448	335	-60	93
MAN-11-26	381 458	5 527 359	335	-60	222
MAN-11-27	381 498	5 527 269	335	-60	225
MAN-11-28	381 370	5 527 517	335	-90	141
MAN-11-29	381 369	5 527 518	335	-50	105
MAN-11-30	381 467	5 527 579	335	-50	96
MAN-11-31	381 608	5 527 539	335	-90	138
MAN-11-32	381 608	5 527 540	335	-50	114
MAN-11-33	381 549	5 527 179	335	-60	186
MAN-11-34	381 657	5 527 450	335	-90	195.6
MAN-11-35	381 707	5 527 359	360	-90	222
MAN-11-36	381 707	5 527 358	155	-60	222
MAN-11-37	381 779	5 527 448	360	-90	185
MAN-11-38	381 780	5 527 447	155	-50	177
MAN-11-39	381 694	5 527 606	360	-90	207

Hole Name	UTME	UTMN	Direction	Dip	Depth (m)
MAN-11-40	381 011	5 527 281	335	-70	168
MAN-11-41	380 987	5 527 152	335	-70	207
MAN-11-42	381 096	5 527 098	335	-70	180
MAN-11-43	381 029	5 527 056	335	-70	225
MAN-11-44	380 959	5 527 024	335	-70	120
MAN-11-45	380 908	5 527 119	335	-70	126
MAN-11-46	381 047	5 527 191	335	-70	219
MAN-11-47	380 931	5 527 240	335	-70	135
MAN-11-48	380 990	5 527 343	335	-70	132

Table 10.2.3 Coordinates (UTM NAD 83) Direction/Dip and Drilled Hole Depth (2011)

A total of 6,548 m were drilled in the 35 drill holes. Almost all the holes were analyzed and 2,072 samples were collected. They were first sent to the IOS Geosciences Laboratory in Saguenay. This company was in charge of the pre-treatment of samples (drying, grinding and splitting). Subsequently, a predetermined amount (about 250 g) of each sample was shipped to ALS Chemex for analysis of major elements (including P_2O_5 and TiO_2) by X-ray fluorescence (ME-XRF06).

The rocks intersected by the holes were mainly anorthositic, gabbros and nelsonites. Some tonalites, anorthosites, diorites, amphibolites and pegmatites were also present. Enrichment in Fe-Ti oxides and apatite was observed in the nelsonite, gabbros, anorthosites and sometimes in the diorites. All drill holes intersected mineralization over lengths ranging from 11 to over 250 meters. The hole named Man-11-25 was stopped in mineralization because the drill could not cross a zone interpreted as a fault.

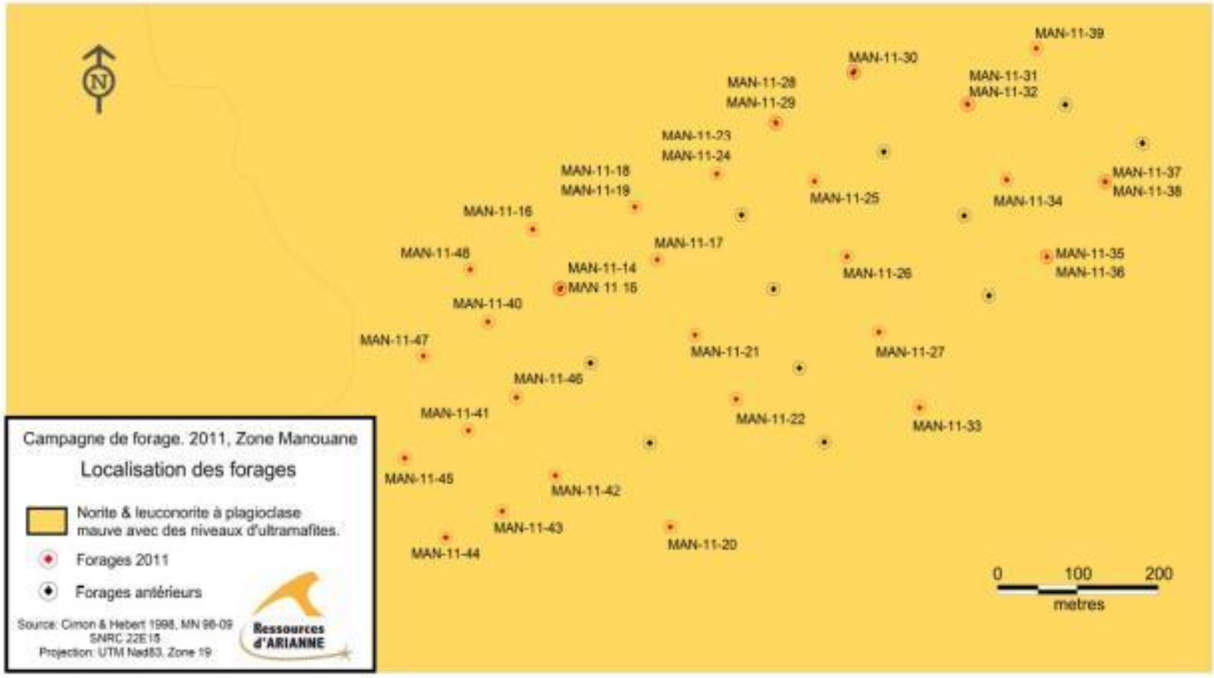


Figure 10.2.2 Location of Diamond Drill Holes Winter 2011 - Manouane

Several drill holes had intervals showing a marked enrichment in TiO_2 and P_2O_5. Indeed, five drill holes (MAN-11-26, 34, 35, 36 and 39) intersected the mineralized zone over a hundred and fifty (150) meters long with at least 6.00% P_2O_5 and 8.50% TiO_2. The drill hole MAN 11-39 had an intersection of 151.85 meters grading 7.16% P_2O_5 and 9.94% TiO_2. Two holes intersected the mineralized zone over more than 200 meters long, with grades of more than 5.00% of P_2O_5 and 7.50% of TiO_2. Table 10.2.4 shows the significant intersections connected to each of the drilling holes.

All the drilling reports and geochemistry analysis database were submitted to SGS Canada Inc. in Blainville.

Hole Name	From (m)	To (m)	Length	P_2O_5 (%)	TiO_2 (%)
MAN-11-14	150	191.1	41.1	6.96	9.75
MAN-11-15	38.5	144.25	105.75	5.46	8.26
including	70.5	144.25	73.75	6.65	10.03
MAN-11-16	16	69	53	5.86	8.87
MAN-11-17	9.7	195	185.3	5.71	9.27
including	131.5	183	51.5	6.34	9.21
MAN-11-18	16.9	150	133.1	6.79	10.06
MAN-11-19	19.6	104.9	85.3	6.50	9.80
MAN-11-20	141	338.4	197.4	5.46	7.59
MAN-11-21	15	265.8	250.8	5.29	8.51
MAN-11-22	124.9	350	225.1	4.60	7.61

Hole Name	From (m)	To (m)	Length	P_2O_5 (%)	TiO_2 (%)
MAN-11-23	12	100.9	88.9	6.58	9.45
MAN-11-24	15	97.2	82.2	6.97	9.95
MAN-11-25	17.9	93	75.1	6.87	10.13
MAN-11-26	29	185.2	156.2	6.53	9.51
MAN-11-27	35	209.9	174.9	5.73	8.43
MAN-11-28	15	107	92	6.80	9.29
MAN-11-29	22	53.2	31.2	7.28	8.87
MAN-11-30	15	70.1	55.1	7.03	10.20
MAN-11-31	21	105	84	6.14	8.68
MAN-11-32	28.2	97.6	69.4	6.55	9.87
MAN-11-33	120.3	131.2	10.9	6.11	10.82
MAN-11-34	17.8	173.7	155.9	6.70	9.28
MAN-11-35	15.9	198	182.1	6.12	8.62
MAN-11-36	18.6	213.7	195.1	6.23	8.57
MAN-11-37	12.3	62	49.7	5.92	7.79
	73	105	32	5.32	7.43
MAN-11-38	13	116	103	5.72	7.99
MAN-11-39	12.4	164.25	151.85	7.16	9.94
MAN-11-40	38.1	138	99.9	5.29	8.19
MAN-11-41	3.5	80	76.5	5.62	7.91
	104.7	191.3	86.6	5.55	8.43
MAN-11-42	59.25	150	90.75	5.64	8.03
MAN-11-43	29	40.2	11.2	5.36	6.21
	94.4	180.55	86.15	4.73	6.48
including	159.1	180.55	21.45	5.89	8.00
MAN-11-44	54	105.8	51.8	5.88	8.88
MAN-11-45	44.5	82.5	38	5.91	7.39
MAN-11-46	31.5	207.5	176	5.38	7.50
MAN-11-47	7.3	103.8	96.5	5.27	7.39
MAN-11-48	19	71.5	52.5	5.44	8.71

Table 10.2.4 Best Mineralized Intersections – Manouane

10.3 2011-2012 Drilling

The following section is a summary of the Arianne exploration reports filed with Quebec's Ministry of Natural Resources (work assessment) which were translated into English.

During 2011-2012, Arianne performed a lot of work on their Lac a Paul Property. Initially, this work intended to convert the indicated resources of the Paul Zone to Measured resources. The second scope of the work was to explore the depth extents of zones exhibiting similar geological and geophysical characteristics such as the Paul and Manouane Zones. Furthermore, some areas had presented interesting values in the previous exploration campaign. The zones delineated by this campaign are named Nicole, Traverse, Lise and Lucie (see Figure 10.3.1).

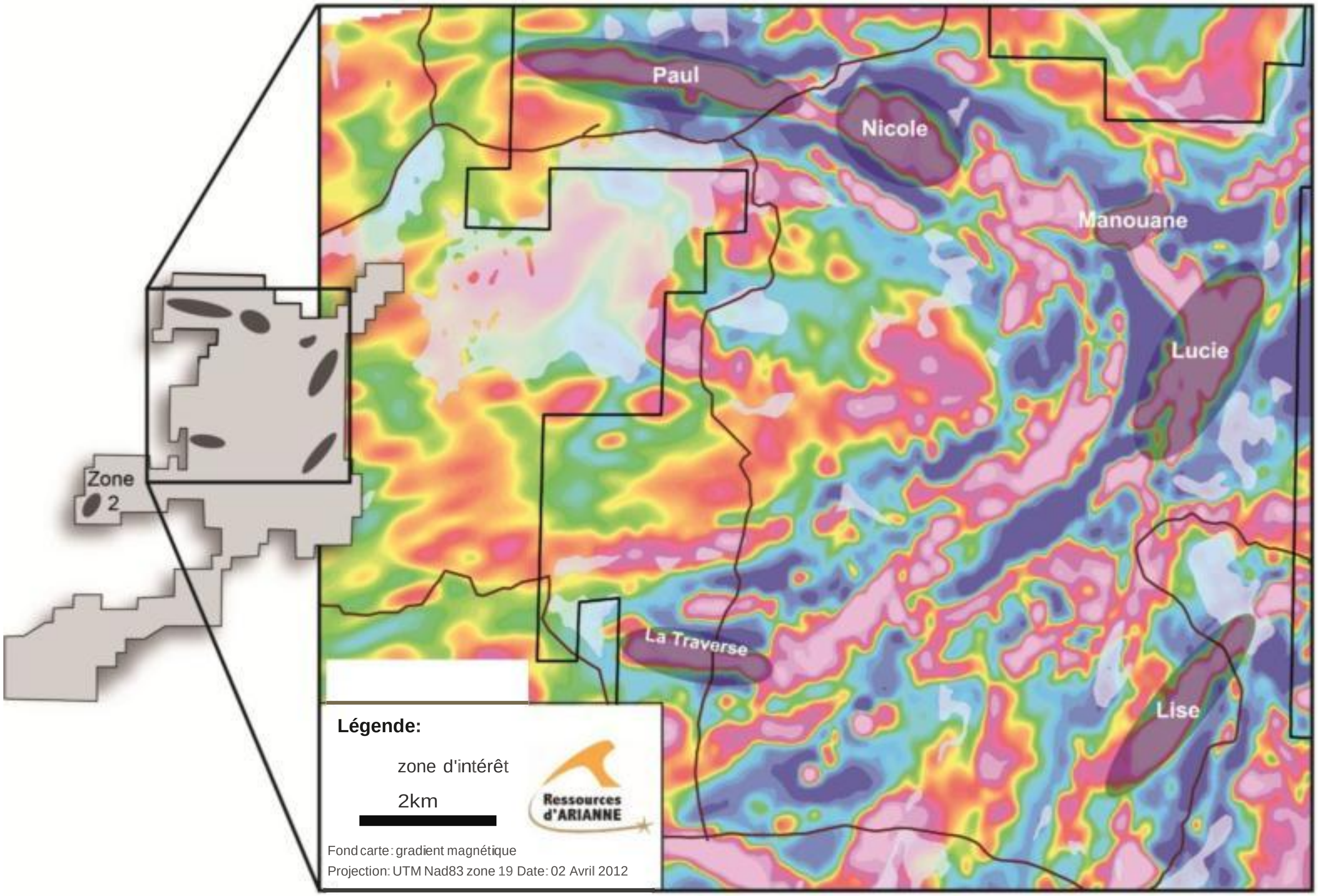


Figure 10.3.1 Location of Areas of Interest

10.3.1 Paul Zone

Drilling to convert the resources of Paul Zone was performed between September 13, 2011, and April 15, 2012. There were forty-nine (49) diamond drill holes (PAU-11-49 to PAU-12-97) totaling 13,326 meters. This campaign represented the first phase of the resources conversion since drilling had permitted to extend the depth and expand East and West extents of the zone (see Tables 10.3.1 and 10.3.2 for the locations of the drill holes).

Phase 2 started in summer 2012 with twenty-five (25) drillholes (PAU-12-98 to PAU-12-123), totaling 9,468 meters of diamond drilling completed by the Nordic Drilling Company. A total of 8,598 samples (including phase 1) were sent to the ALS Chemex Laboratory in Val d'Or. These were analyzed for major elements by X-ray fluorescence (ME-XRF06).

The main lithologies encountered consisted of anorthosites, gabbros and nelsonites. Sixty-nine (69) of the seventy-five (75) drillholes intercepted the mineralized zone. In addition, twenty-seven (27) of these ended in mineralization which remains open at depth.

Several drill holes were of particular interests. PAU-12-110 and 111 contained intersections greater than 130 and 280 meters (respectively) returning 9.00% P_2O_5 and 11.00% TiO_2. In addition, drill holes PAU-12-67, 68, 71, 72, 73, 115 and 123 contained intersections grading between 8.00 and 9.00% P_2O_5, and between 7.00% and 9.50% TiO_2. Four (4) holes with intersections showed more than three hundred fifteen (315) meters of mineralization.

This drilling campaign extended the mineralized zone further to the West. In addition, it remains open laterally and at depth.

Recommended work included further drilling to increase the indicated resources, categorizing Measured resources and better defining the deposit geometry.

PAUL Project - 2011					
Hole Number	**UTM (E)**	**UTM (N)**	**Direction [°]**	**Plunge [°]**	**Depth [m]**
PAU-11-49	375741	5529256	180	-70	278
PAU-11-50	375741	5529256	180	-45	183
PAU-11-51	375862	5529244	180	-70	288
PAU-11-52	375862	5529243	180	-45	237
PAU-11-53	374543	5529465	360	-80	360
PAU-11-54	374442	5529497	360	-70	429
PAU-11-55	374348	5529510	360	-65	354
PAU-11-56	374343	5529595	360	-70	237
PAU-11-57	374343	5529596	360	-45	147
PAU-11-58	374252	5529504	360	-65	312
PAU-11-59	374252	5529505	360	-45	282
PAU-11-60	374114	5529550	360	-70	309
PAU-11-61	374114	5529550	360	-45	207
PAU-11-62	373990	5529486	360	-65	345
PAU-11-63	373991	5529589	360	-65	273
PAU-11-64	374252	5529505	360	-90	423
PAU-11-65	375242	5529229	360	-60	408
PAU-11-66	375143	5529353	360	-60	417
2119 samples				**Total: 5489 meters**	

Table 10.3.1 Drill Holes Information – Paul Zone – 2011

PAUL Project - 2012					
Hole Number	UTM (E)	UTM (N)	Direction [°]	Plunge [°]	Depth [m]
PAU-12-67	375349	5529447	180	-65	426
PAU-12-68	375350	5529447	205	-70	405
PAU-12-69	375350	5529447	205	-50	264
PAU-12-70	375433	5529450	180	-60	384
PAU-12-71	375441	5529370	180	-60	417
PAU-12-72	375536	5529344	180	-80	348
PAU-12-73	375639	5529249	180	-80	339
PAU-12-74	375617	5529196	180	-45	150
PAU-12-75	375732	5529174	180	-45	129
PAU-12-76	375827	5529135	180	-45	83
PAU-12-77	375933	5529071	360	-65	249
PAU-12-78	375933	5529070	360	-45	168
PAU-12-79	375536	5529182	180	-55	153
PAU-12-80	375186	5529152	360	-60	380

PAUL Project - 2012					
Hole Number	UTM (E)	UTM (N)	Direction [°]	Plunge [°]	Depth [m]
PAU-12-81	375244	5529231	25	-65	300
PAU-12-82	375338	5529237	180	-60	149
PAU-12-83	374046	5529379	360	-65	478
PAU-12-84	373879	5529539	360	-65	294
PAU-12-85	373879	5529540	360	-45	201
PAU-12-86	373803	5529589	360	-70	204
PAU-12-87	373803	5529590	360	-45	147
PAU-12-88	373692	5529623	360	-70	201
PAU-12-89	373692	5529624	360	-45	174
PAU-12-90	373546	5529628	360	-70	204
PAU-12-91	373546	5529629	360	-45	219
PAU-12-92	373415	5529633	360	-70	234
PAU-12-93	373415	5529633	360	-45	183
PAU-12-94	373316	5529625	360	-70	242
PAU-12-95	373316	5529625	360	-45	240
PAU-12-96	374046	5529378	360	-45	364
PAU-12-97	374373	5529425	360	-65	471
PAU-12-98	374542	5529466	360	-55	402
PAU-12-99	374441	5529382	360	-65	416
PAU-12-100	374539	5529305	360	-65	498
PAU-12-101	374439	5529497	360	-70	75 (429 to 504)
PAU-12-102	374246	5529399	360	-70	312
PAU-12-103	374255	5529623	360	-50	129
PAU-12-104	374146	5529447	360	-70	390
PAU-12-105	373994	5529385	360	-65	462
PAU-12-106	374248	5529337	360	-70	402
PAU-12-107	374858	5529571	360	-57	282
PAU-12-108	374853	5529656	360	-55	141
PAU-12-109	374638	5529453	360	-72	450
PAU-12-110	374648	5529582	360	-45	237
PAU-12-111	374708	5529570	360	-65	327
PAU-12-112	374717	5529397	360	-65	420
PAU-12-113	374829	5529344	360	-55	444
PAU-12-114	374781	5529320	360	-60	490
PAU-12-115	374941	5529491	360	-45	285
PAU-12-116	375043	5529366	360	-60	417
PAU-12-117	375045	5529289	360	-65	403
PAU-12-118	375143	5529452	360	-60	372

PAUL Project - 2012					
Hole Number	UTM (E)	UTM (N)	Direction [°]	Plunge [°]	Depth [m]
PAU-12-119	375086	5529537	360	-60	201
PAU-12-120	375229	5529328	360	-60	405
PAU-12-121	375341	5529550	180	-65	423
PAU-12-122	375347	5529148	360	-65	339
PAU-12-123	375645	5529348	180	-70	382
6479 samples				**Total: 17305 meters**	

Table 10.3.2 Drill Holes Information - Paul Zone - 2012

Out of the seventy-five (75) drill holes (22,794 m), almost all of the drill core samples were analyzed. 8,598 samples were collected. These samples were first sent to the IOS Geosciences Laboratory at Saguenay. This company is responsible for the pre-treatment of samples (drying, grinding and splitting). Subsequently, a predefined quantity (about 250 g) of each sample was shipped to ALS Chemex for analysis of the major elements (including P_2O_5 and TiO_2) by X-ray fluorescence (ME-XRF06).

10.3.2 Paul Drilling campaign results

Lithologies intersected by the drill holes consisted mainly of nelsonites, anorthositic gabbro and gabbroic anorthosite. A few diorites, granites, amphibolite and pegmatites were also present. Enrichment in Fe-Ti oxides and apatite was observed in nelsonites, anorthosites, gabbros and occasionally in the diorites. Sixty-nine (69) of the seventy-five (75) drill holes intersected the mineralized zones. Furthermore, twenty-seven (27) of the holes remain open in mineralization at depth. Figure 10.3.2 shows the location of recent (2011-2012) and previous (2010, 2009 and 2008) drilling performed in the Paul Zone.

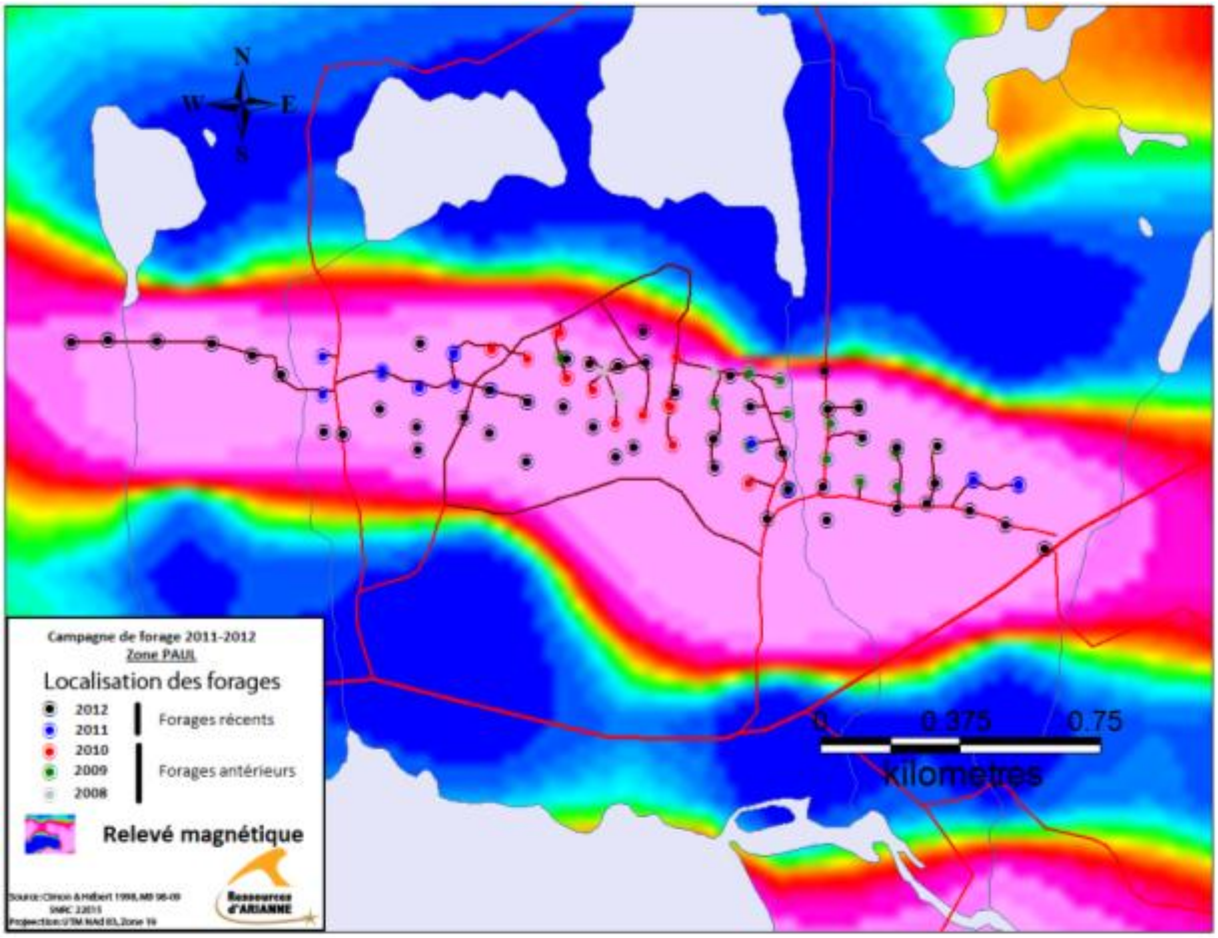


Figure 10.3.2 Location of Recent Drilling (2011-2012) and Previous (2010, 2009, 2008) in the Paul Zone

Several drill holes showed very interesting intersections and had a marked enrichment in TiO_2 and P_2O_5. Indeed, two (2) drill holes had an upper intercept grading more than 9.00% P_2O_5 and 11.00% TiO_2 with respective lengths of 280 meters and 130 meters.

In addition, six (6) drill holes had an intersection grading between 8.00 and 9.00% P_2O_5 with values in TiO_2 grading from 7.00% to 9.50%. Four (4) holes with intersections showed more than 315 meters of mineralization.

Then, eleven (11) drill holes had an intersection grading between 7.00 and 8.00% P_2O_5 with values in TiO_2 grading between 6.50% and 11.00%. Seven (7) holes with intersections showed more than 220 meters of mineralization.

Finally, twenty-one (21) drill holes had an intersection grading between 6.00 and 7.00% P_2O_5 with values in TiO_2 grading between 6.00% and 11.00%. Ten (10) holes with intersections showed more than 200 meters of mineralization.

Tables 10.3.3 and 10.3.4 show the most significant intersections within the different drillings.

All drill holes logs and analysis results were transmitted to GoldMinds Geoservices Inc. in Blainville. This model was used for the feasibility study carried out by Cegertec WorleyParsons.

PAUL Project - 2011					
Drill Hole No.	From [m]	To [m]	Length [m]	P_2O_5 [%]	TiO_2 [%]
PAU-11-49	139.8	278	138.2	6.92	8.14
including	139.8	168	28.2	6.44	10.75
PAU-11-50	105	140.3	35.3	6.53	6.23
PAU-11-51	108	288	180	7.43	8.67
including	137.9	156	18.1	8.75	11.79
PAU-11-52	127	237	110	5.80	5.50
including	166.8	197	30.2	9.33	7.31
PAU-11-53	18	360	342	5.36	5.78
including	180.6	198	17.4	10.19	8.19
and	271.8	314.1	42.3	7.32	9.43
PAU-11-54	3	429	426	7.41	7.55
including	210.7	240	29.3	10.19	10.43
and	282.3	429	146.7	10.64	10.35
PAU-11-55	12.35	336.4	324.05	6.81	6.99
including	186.2	336.4	150.2	10.26	9.93
PAU-11-56	4.2	198	193.8	6.27	7.59
including	118.8	168	49.2	10.21	9.75
PAU-11-57	6	117	111	5.17	6.98
PAU-11-58	5.5	298.9	293.4	6.49	6.70
including	163.7	298.9	135.2	9.77	9.31
PAU-11-59	6.1	144	137.9	3.63	4.19
	169.4	212.1	42.7	10.53	11.15
PAU-11-60	0.7	286.2	285.5	5.48	8.03
including	197.7	234	36.3	10.16	22.23
and	171.3	265.6	94.3	6.5	13.52
PAU-11-61	1.2	132.3	131.1	3.10	3.57
PAU-11-62	2.3	289.8	287.5	5.99	6.40
including	125.4	165.3	39.9	11.64	8.15
PAU-11-63	5.8	124.45	118.65	4.85	4.87

PAUL Project - 2011					
Drill Hole No.	From [m]	To [m]	Length [m]	P_2O_5 [%]	TiO_2 [%]
	165	240.5	75.5	0.11	11.11
PAU-11-64	15	423	408	5.29	6.47
including	259.8	419.85	160.05	6.96	8.95
PAU-11-65	5.2	408.25	403.05	6.81	6.16
including	223.5	271.5	48	9.9	8.41
PAU-11-66	5.2	394	388.8	7.67	7.84

Table 10.3.3 Best Mineralized Intersections of Paul Zone – 2011

PAUL Project - 2012					
Drill Hole No.	From [m]	To [m]	Length [m]	P_2O_5 [%]	TiO_2 [%]
PAU-12-67	30.1	426	395.9	8.65	8.20
including	359.3	411	51.7	10.4	9.37
PAU-12-68	34.5	405	370.5	8.18	7.58
including	51	110.3	59.3	9.71	8.29
PAU-12-69	21	257.6	236.6	7.34	6.91
including	10	60	50	7.00	11.02
PAU-12-70	250	384	134	7.85	7.29
PAU-12-71	67.5	417	349.5	8.16	7.33
including	255.3	330	74.7	10.57	7.33
PAU-12-72	93	348	255	7.99	7.58
including	96	189	93	9.57	9.49
PAU-12-73	24.2	339	314.8	8.70	7.37
including	198	315	117	10.20	6.12
PAU-12-74	3	150	147	3.58	3.72
PAU-12-75	10	129	119	3.89	4.40
PAU-12-76	9	83.4	74.4	6.55	6.11
PAU-12-77	9	235.3	226.3	7.55	6.80
including	40	81	41	9.80	7.02
PAU-12-78	13.3	127	113.7	6.66	7.19
PAU-12-79	3	145.5	142.5	3.32	3.63
PAU-12-80	4	349.2	345.2	5.33	5.00
PAU-12-81	79.5	300	220.5	7.54	6.49
PAU-12-82	3.5	149	145.5	4.12	3.70
PAU-12-83	181.7	445	263.3	4.92	5.20
PAU-12-84	8.3	190.2	181.9	6.30	6.45
PAU-12-85	6.6	159	152.4	5.90	5.50
PAU-12-86	9	137.5	128.5	4.91	5.32

PAUL Project - 2012					
Drill Hole No.	From [m]	To [m]	Length [m]	P_2O_5 [%]	TiO_2 [%]
including	115.2	137.5	22.3	8.22	10.91
PAU-12-87	12	135.3	123.3	5.21	5.82
PAU-12-88	42.5	107.9	65.4	6.85	6.74
PAU-12-89	47.5	104.2	56.7	8.36	7.91
	69.8	143.3	73.5	4.66	8.89
PAU-12-90	9	151.8	142.8	6.35	6.23
	113.7	151.8	38.1	10.26	8.51
PAU-12-91	12	153.9	141.9	6.44	7.09
PAU-12-92	3	123.6	120.6	5.05	4.96
	123.6	190.8	67.2	0.36	9.32
PAU-12-93	3	160.4	157.4	5.75	5.78
including	142.1	158	15.9	11.07	9.00
PAU-12-94	8.2	202.5	194.3	6.57	6.83
including	155.5	202.5	47	8.16	9.29
PAU-12-95	9	210.1	201.1	6.52	6.89
including	112.8	146.8	34	9.89	8.06
PAU-12-96	102	331.8	229.8	5.73	6.14
including	274.1	331.8	57.7	8.81	9.86
PAU-12-97	66.6	454.2	387.6	6.81	6.78
including	356	454.2	98.2	10.19	9.57
PAU-12-98	9	402	393	7.85	7.67
including	216	402	186	10.6	9.74
PAU-12-99	135.8	416	280.2	5.24	5.55
including	383.5	416	32.5	9.43	9.26
PAU-12-100	238.9	498	259.1	4.38	5.06
PAU-12-101	429	504	75	1.48	3.05
PAU-12-102	114	312	198	3.92	4.29
PAU-12-103	3.5	129	125.5	2.91	5.34
PAU-12-104	54	339	285	5.89	5.77
including	240	330	90	8.81	7.95
PAU-12-105	168	390.1	222.1	5.21	5.34
	410.3	462	51.7	0.31	11.16
PAU-12-106	222	402	180	3.85	4.29
PAU-12-107	3	42	39	7.84	12.03
	57.1	244.5	187.4	1.07	9.93
PAU-12-108	3	141	138	0.99	3.99
PAU-12-109	3	450	447	5.70	6.85
including	240.5	442.1	201.6	7.14	9.89

PAUL Project - 2012					
Drill Hole No.	From [m]	To [m]	Length [m]	P_2O_5 [%]	TiO_2 [%]
PAU-12-110	9.5	141	131.5	9.87	10.98
PAU-12-111	4.9	287.75	282.85	9.22	20.08
PAU-12-112	4.3	420	415.7	4.54	5.31
including	267	369.9	102.9	6.58	8.76
PAU-12-113	14.35	444	429.65	6.77	7.04
including	209.5	444	234.5	8.22	8.74
PAU-12-114	3	490	487	4.95	5.53
including	361.2	490	128.8	6.92	8.99
PAU-12-115	7	142.8	135.8	8.49	9.72
	189	253.5	64.5	0.13	12.34
PAU-12-116	279	417	138	6.15	9.34
including	369	396	27	10.61	11.49
PAU-12-117	3	402.5	399.5	6.90	6.31
including	236.7	302.8	66.1	10.75	8.72
PAU-12-118	6.1	366	359.9	4.25	9.71
including	6.1	247.4	241.3	6.19	8.55
PAU-12-119	2.5	82.8	80.3	7.28	11.26
PAU-12-120	278.6	360	81.4	7.19	8.23
PAU-12-121	168	423	255	6.70	11.42
PAU-12-122	2.4	339	336.6	5.37	4.89
PAU-12-123	153	382	229	8.16	7.55

Table 10.3.4 Best Mineralized Intersections of Paul Zone – 2012

10.3.3 2011-2012 Conclusions and Recommendations

This major drilling campaign achieved its objectives for the western extension where drilling intersected the nelsonites as predicted. Also, the contacts that define the envelope of the deposit were identified and inferred resources were transferred to Indicated or Measured resources.

This drilling campaign demonstrated that the Paul Zone remains open at depth. Drilling at the ends of the deposit still contains mineralization suggesting that the limits have not been reached. This hypothesis is consistent with the magnetometer survey that shows a significant magnetic anomaly that extends far to the east and west of the drilled area.

In response to the work of 2011-2012, another drilling campaign was recommended to verify the west extension of the deposit with contact definition holes.

10.3.4 Fall 2012 Drilling Campaign

The drilling program in the fall of 2012 took place between October 10, 2012 and December 4, 2012. The goals of this drill program were: 1) to check and confirm contact depth of the mineralized zone for the north and south ends and 2) define the western part of the deposit as Indicated or Measured resources in this sector. The new data was used to better define the geometry of the deposit and to generate a new resource estimate completed by Goldminds Geoservices Inc.

Thirty (30) new drill holes were completed during this campaign (PAU-12-124 to PAU-12-153) totaling 7,558 meters of diamond drilling. The drilling was done by the Nordic Drilling Company. The locations of the holes are shown in Figure 10.3.3. Table 10.3.5 displays information regarding the position and orientation of the drill holes.

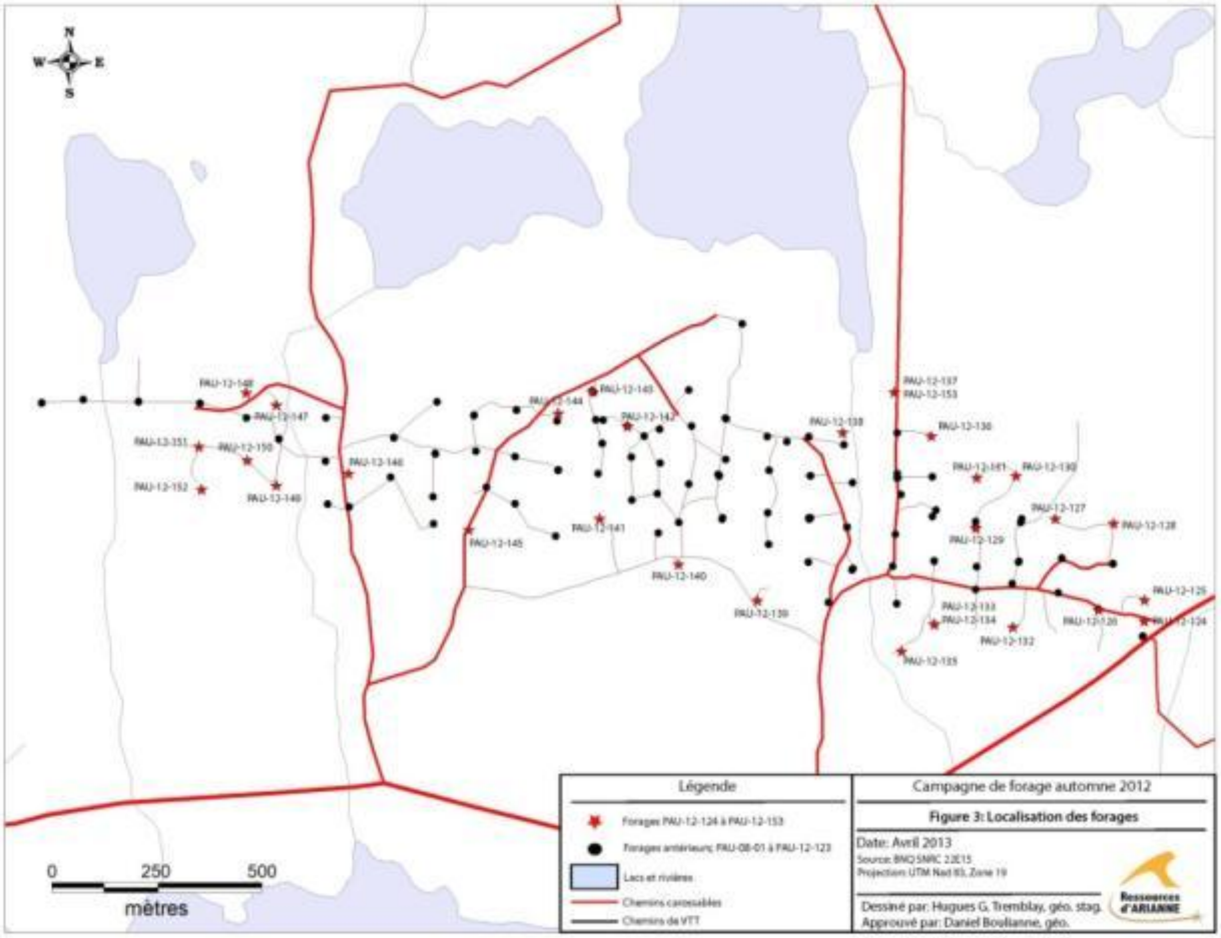


Figure 10.3.3 Location of Drill Holes PAU-12-124 to PAU-12-153

Name	UTME	UTMN	Altitude	Azimuth	Inclination	Start (m)	End (m)
PAU-12-124	375936	5529107	435	180	-45	0	168
PAU-12-125	375937	5529158	438	180	-65	0	197
PAU-12-126	375827	5529135	441	180	-45	83.4	150
PAU-12-127	375724	5529350	458	180	-65	0	312
PAU-12-128	375863	5529340	457	180	-65	0	338
PAU-12-129	375535	5529329	449	180	-60	201	345
PAU-12-130	375631	5529453	457	180	-65	0	351
PAU-12-131	375538	5529449	454	180	-68	0	327.4
PAU-12-132	375624	5529094	436	360	-70	0	291
PAU-12-133	375437	5529101	436	360	-70	0	279
PAU-12-134	375437	5529102	436	360	-45	0	265
PAU-12-135	375359	5529036	422	360	-63	0	351
PAU-12-136	375430	5529547	448	180	-65	0	360
PAU-12-137	375341	5529651	443	180	-65	0	360
PAU-12-138	375219	5529555	439	360	-45	0	102
PAU-12-139	375017	5529157	447	360	-60	0	402
PAU-12-140	374829	5529242	459	360	-55	0	408
PAU-12-141	374641	5529351	466	360	-65	0	382
PAU-12-142	374708	5529571	453	360	-45	0	150
PAU-12-143	374625	5529653	454	180	-45	21	172
PAU-12-144	374543	5529601	461	360	-45	0	143
PAU-12-145	374331	5529324	452	360	-65	0	300
PAU-12-146	374044	5529458	445	360	-45	0	273
PAU-12-147	373874	5529620	439	360	-45	0	120
PAU-12-148	373802	5529650	448	360	-45	0	132
PAU-12-149	373873	5529430	446	360	-65	0	357
PAU-12-150	373804	5529489	453	360	-70	0	258
PAU-12-151	373689	5529522	450	360	-60	0	213
PAU-12-152	373695	5529420	452	360	-60	0	261
PAU-12-153	375341	5529651	443	180	-65	360	456

Table 10.3.5 Paul Zone – 2012 Drill Holes Information

A total of 2,031 samples were collected in this drilling campaign. They were all shipped to ALS Chemex in Val-d'Or to be analyzed for major elements by X-ray fluorescence using the ME-XRF06 method.

Given the nature of this drilling, the most frequently intercepted lithologies in the drill holes were mineralized gabbroic anorthosite, apatite, and other non-mineralized units. The latter are usually the direct surrounding rocks of the mineralized lens of nelsonitic composition. Most holes were drilled to the north or south of this lens. The results of this drilling program increased the geological knowledge of the deposit, in particular the dimensions, limits and orientation.

The apatite deposit of Paul Zone consists of a nelsonite lens to the north, a mineralized anorthosite gabbro to the south, and a transitional zone consisting of a mixture of gabbro and nelsonite between these two lithologies. The mineralized anorthosite gabbro must have a value of P_2O_5 greater than 4% to be included in the deposit for visualisation purposes. Figures 10.3.4 and 10.3.5 are 3D models of the mineralized envelope generated using the LeapFrog software.

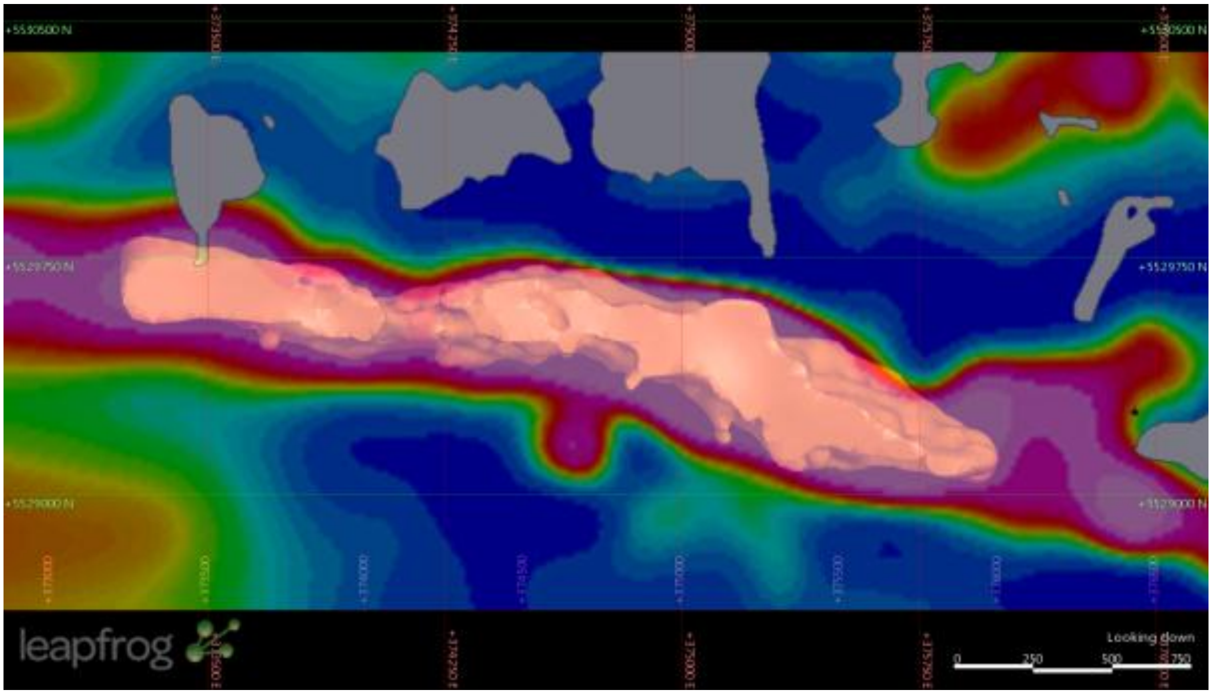


Figure 10.3.4 Plan View of the Mineralized Envelope with the Mag Overlay

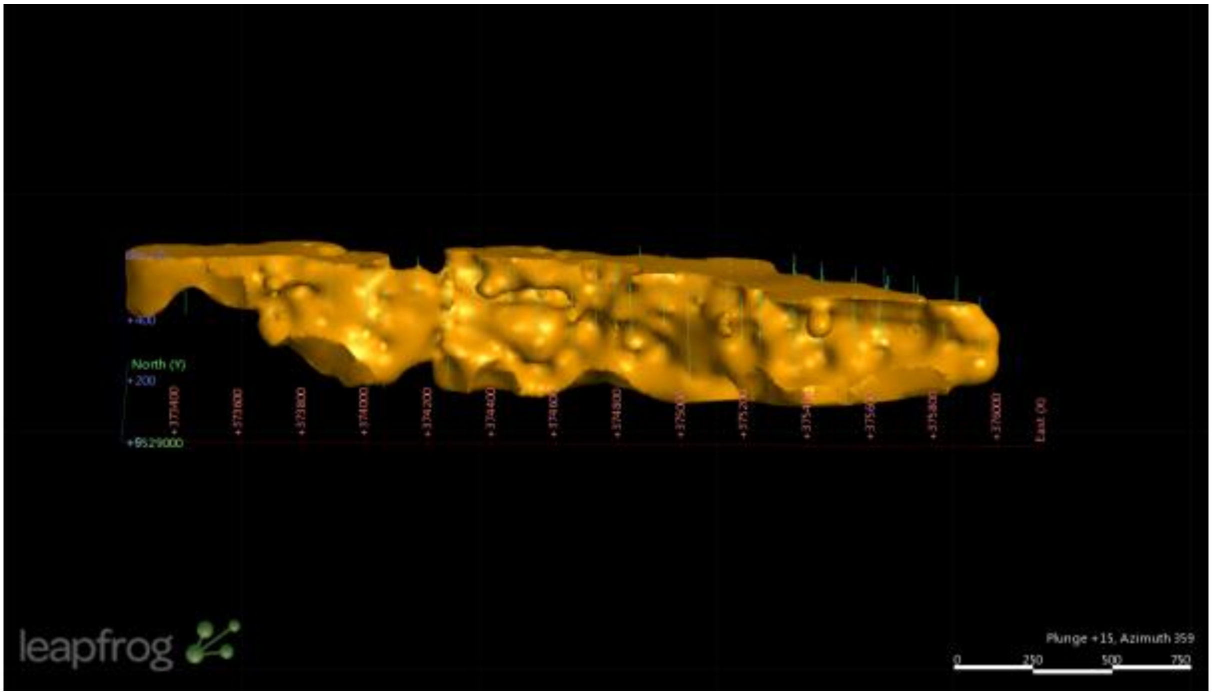


Figure 10.3.5 Mineralized Envelope Looking North

The nelsonite lens is the richest part of the deposit. It is present throughout the whole length of the deposit, which is now 2,700 meters. Moreover, it remains open at depth. Boreholes intercepted it at more than four hundred (400) meters vertical depth. It has a true width of 150 meters on average. In the eastern central area, it has a thickness of more than 300 meters. In one sector, the lens becomes pinched and has a thickness of ten (10) to thirty (30) meters. Drill holes show that it is present near the surface of almost the entire deposit. This nelsonite lens has an EW orientation and generally has a very steep dip (between 70˚ to 85˚) to the south. Figure 10.3.6 is a geological interpretation of the nelsonite lens in space. It was carried out with the Discover 3D software. Note that the view is facing to the north.

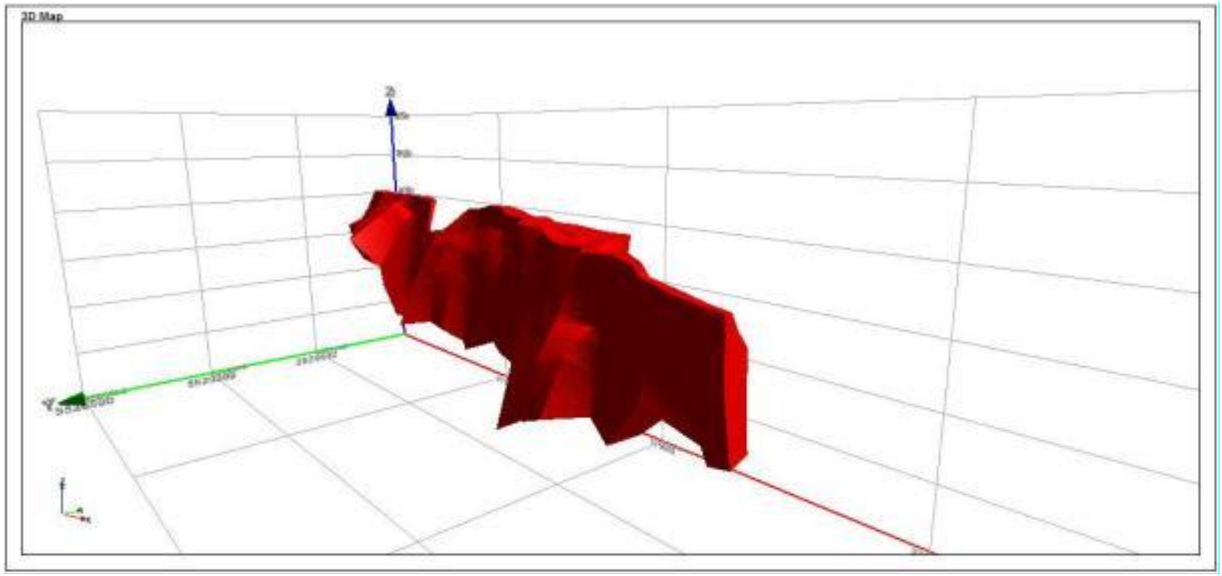


Figure 10.3.6 Geological Interpretation of the Nelsonite Lens, Looking to the NW

As one objective of the campaign was to intercept the nelsonite lens at depth, it is quite normal that lithologies most commonly encountered were mineralized apatite anorthosite gabbro (to the south) and the non-mineralized anorthosite gabbro to the north. Besides these lithologies, nelsonite was encountered in most drill holes. Other rocks that were intercepted are anorthosite, diorite gneiss, pyroxenite and late dykes of tonalitic to granitic composition.

A total of six (6) new drill holes were carried out on three (3) sections in the west part of the deposit. Previously, these sections hosted only one (1) drill hole. The additional drill holes per section were used to increase the tonnage of ore in this area while converting the present tonnes into Measured or Indicated resources. In addition, each of the holes intercepted the nelsonite lens.

Finally, all the drill holes of this campaign achieved the goal that was assigned to them during planning with the exception of drill hole PAU-12-137 (and its extension PAU-12-153), which did not intersect the nelsonite lens to the north. The drill hole remained in the contact zone for most of its length and provided important information on the mineralogical composition of the host rock in this area.

The drill logs and drill sections can be found at the Arianne office including the analytical certificates.

The fall 2012 drilling campaign put an end to the drilling work which started in September 2011 with the objective to increase the resources of the Paul Zone.

The deposit remains open at depth on its entire length. The west side drilling intersected significant intersections of nelsonite. It is hypothesized that this mineralization continues in this direction, which is why an exploratory drilling campaign is recommended to investigate this possible extension.

The new resource calculation conducted by GoldMinds Geoservices Inc., taking into account all the drilling (153 holes: PAU-08-01 to PAU-12-153)), is included in this report and is used in the current feasibility study carried out by Cegertec WorleyParsons Inc.

10.3.5 Other Drilling Lise, Nicole, Traverse & Lucie

This section covers the exploration drilling campaign conducted during 2011 and winter 2012 in the areas of Nicole, Lise, Traverse and Lucie of the Lac a Paul Property.

The drilling on Nicole, La Traverse, Lise and Lucie campaign aimed to find new deposits with similarities to those of the Paul and Manouane Zones.

10.3.5.1 Areas of Exploration

The four (4) exploration areas previously mentioned contained forty-one (41) diamond drill holes totaling seven thousand six hundred and seven (7,607) meters (see Figure 10.3.7).

They are divided as follows:

- Lise Zone: 7 drill holes totaling 1,401 meters.
- Nicole Zone: 20 drill holes totaling 4,005 meters.
- Traverse Zone: 6 drill holes totaling 954 meters.
- Lucie Zone: 6 drill holes totaling 1,246 meters.

These areas of exploration have proven the presence of P_2O_5 and TiO_2 mineralization.

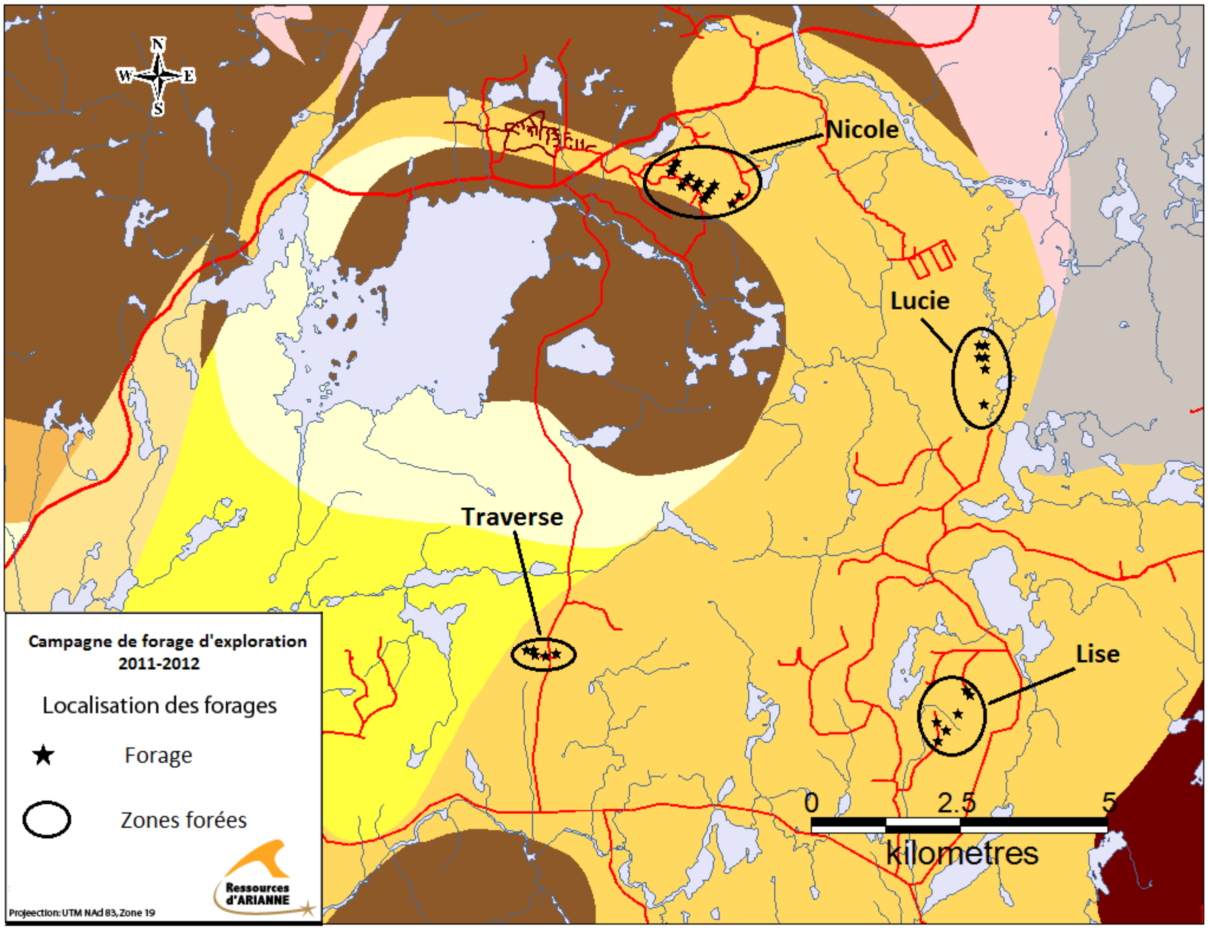


Figure 10.3.7 Location of Zones with Property Geology and Drill Hole Location

10.3.5.2 Nicole Zone

Twenty (20) holes were drilled and fourteen (14) of these intersected mineralization. In addition, six (6) holes remain open in the mineralization. There were four (4) holes with an intersection greater than 120 meters, three (3) of them containing more than 7.00% P_2O_5 and 6.00% TiO_2 and one showing more than 5.50% P_2O_5 and 6.50% TiO_2. In addition, there were two (2) holes with an upper intersection of 200 meters containing more than 5.50% P_2O_5 and 6.50% TiO_2.

10.3.5.3 Lucie Zone

Six (6) holes intersected mineralization. There was one (1) drill hole having an upper intersection of 80 meters long, containing more than 7.00% P_2O_5 and 7.50% TiO_2.

10.3.5.4 Lise Zone

All holes intersected mineralization. Four (4) holes had an intersection of more than fifty (50) meters, two (2) of them containing more than 5.50% P_2O_5 and 6.50% TiO_2. The other two (2) holes showed more than 5.00% P_2O_5 and 5.50% TiO_2. In addition, there were two (2) holes with intersections greater than ninety (90) meters, the first one containing more than 5.00% P_2O_5 and 5.50% TiO_2 and the second hole showing more than 4.00% P_2O_5 and 4.50% TiO_2.

10.3.5.5 Traverse Zone

All holes intersected mineralization. In addition, one (1) of them ended in mineralization at depth. One (1) hole had an intersection of 170 meters with grades of more than 6.00% P_2O_5 and 7.00% TiO_2. A second drill hole had an intersection of 130 meters with more than 5.00% P_2O_5 and 6.50% TiO_2. There are two (2) additional holes with an intersection greater than 65 and 90 meters in length, measuring over 6.50% P_2O_5 and 6.50% TiO_2 and more than 6.50% P_2O_5 and 8.00% TiO_2 respectively.

The recent drilling clearly showed extension of apatite rich mineralization outside the known zones.

Tables 10.3.6 through to 10.3.9 list the significant intersections of every drill hole in each zone. Accordingly, Figures 10.3.8 through to 10.3.11 show the location of every borehole.

Drill hole	From (m)	To (m)	Length (m)	P_2O_5 (%)	TiO_2 (%)
LIZ-11-01	3.40	69.00	65.60	4.94	5.82
and	95.00	107.60	12.60	7.42	6.36
LIZ-11-02	87.00	163.40	76.40	4.13	4.62
including	96.00	114.10	18.10	4.84	5.34
LIZ-11-03	4.90	26.05	21.15	5.50	6.08
and	41.40	102.00	60.60	3.93	4.39
including	67.40	80.75	13.35	4.90	6.52
	86.40	102.00	15.60	6.60	6.37
LIZ-11-04	3.20	17.30	14.10	5.34	7.11
and	83.85	208.00	124.15	4.92	6.29
including	83.85	132.00	48.15	5.42	6.41
	145.40	208.00	62.60	5.37	7.21
LIZ-11-05	1.80	23.10	21.30	4.55	6.06
and	68.50	165.00	96.50	5.05	5.84
including	68.50	95.85	27.35	6.45	8.32
	110.35	141.00	30.65	6.64	7.34
LIZ-11-06	123.90	216.40	92.50	5.14	5.77
including	123.90	184.50	60.60	5.40	6.37
	194.80	216.40	21.60	5.84	6.11
LIZ-11-07	130.00	144.00	14.00	4.86	5.93

Drill hole	From (m)	To (m)	Length (m)	P_2O_5 (%)	TiO_2 (%)
and	183.15	276.00	92.85	3,7	4.21
including	183.15	234.15	51.00	5.05	5.88
LAP-09-05	40.20	78.80	38.60	3,81	4.46
including	40.20	49.40	9.20	5.58	7.33
	58.50	78.80	20.30	4.60	4.75
LAP-09-10	3.00	102.00	99.00	5.31	6.84
including	3.00	33.00	30.00	5.91	7.45
	66.00	102.00	36.00	6.42	8.89

Table 10.3.6 Best Mineralized Intersections – Lise Zone

Note that exploration drill holes LAP-09-05 and LAP-09-10 were added to the table since they are part of the area and are included in the area with the same geophysical anomaly.

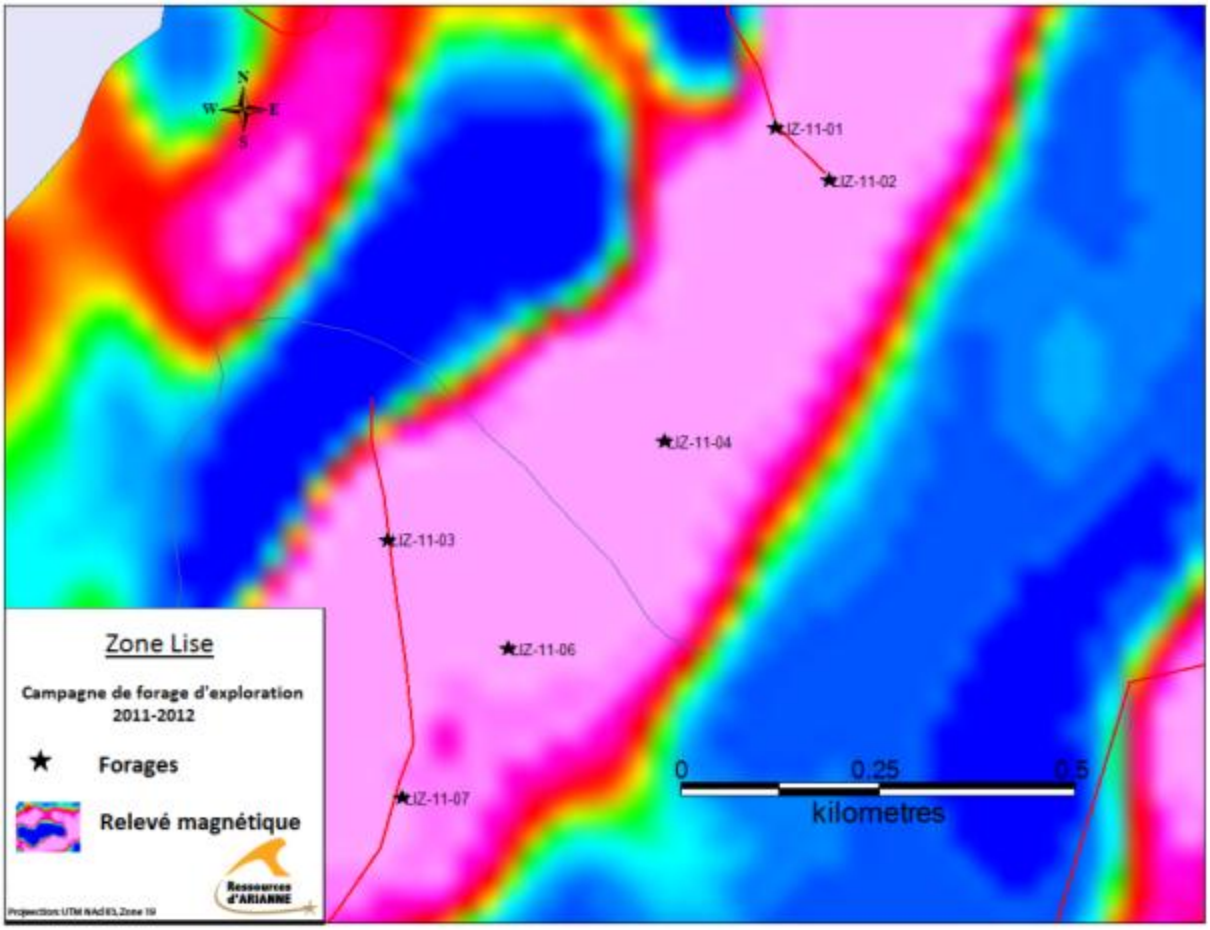


Figure 10.3.8 Location of Drill Holes in Lise Zone

Drill hole	From (m)	To (m)	Length (m)	P_2O_5 (%)	TiO_2 (%)
NIC-11-01	3.20	128.10	124.90	5.58	7.23
NIC-11-02	3.70	189.00	185.30	3.19	3.38
including	3.70	30.00	26.30	6.38	9.41
	98.00	126.00	28.00	5.10	5.00
	173.80	189.00	15.20	7.54	5.70
NIC-11-03	3.00	123.00	120.00	6.35	6.53
NIC-11-04	3.00	143.70	140.70	6.24	6.18
including	3.00	124.90	121.90	6.75	6.76
NIC-11-05	1.80	60.20	58.40	3.34	3.80
NIC-11-06	5.00	159.00	154.00	3.07	3.44
including	27.00	50.25	23.25	4.24	4.86
	76.00	119.40	43.40	4.99	4.96
NIC-11-07	41.10	213.20	172.10	4.15	5.32
including	41.10	160.20	119.10	4.55	6.00
	174.40	213.20	38.80	4.30	5.00
NIC-11-08	63.00	134.50	71.50	3.18	3.89
and	158.20	302.70	144.50	5.52	5.65
NIC-11-09	75.70	97.20	21.50	1.13	1.86
NIC-11-10	11.00	98.90	87.90	3.29	3.85
including	11.00	34.20	23.20	5.48	5.91
	47.20	74.30	27.10	4.37	5.42
NIC-11-11	35.90	336.00	300.10	4.98	5.95
including	35.90	73.40	37.50	5.66	7.82
	97.50	336.00	238.50	5.23	6.08
NIC-11-12	3.00	134.90	131.90	5.08	6.00
including	23.50	60.00	36.50	6.05	6.83
	72.60	134.90	62.30	5.77	7.02
NIC-11-13	6.00	81.00	75.00	4.39	5.39
NIC-11-14	7.10	251.40	244.30	3.36	4.05
including	7.10	28.10	21.00	6.26	8.07
NIC-11-15	8.60	237.00	228.40	3.56	4.56
including	164.60	237.00	72.40	5.03	5.20
NIC-11-16	2.90	103.90	101.00	4.14	4.54
including	2.90	24.50	21.60	4.89	5.34
	34.00	54.40	20.40	5.21	5.19
	66.10	103.90	37.80	4.82	5.34
NIC-11-17	10.90	88.20	77.30	3.35	4.13
including	57.50	70.00	12.50	4.80	4.42
	76.40	88.20	11.80	6.19	5.54

Drill hole	From (m)	To (m)	Length (m)	P_2O_5 (%)	TiO_2 (%)
NIC-11-18	21.00	180.50	159.50	1.94	4.24
NIC-11-19	1.80	222.00	220.20	3.99	4.83
NIC-11-20	5.30	207.00	201.70	3.75	4.53
including	5.30	57.30	52.00	4.51	5.83
	132.70	159.80	27.10	4.47	4.75
	168.40	207.00	38.60	4.01	4.80

Table 10.3.7 Best Mineralized Intersections – Nicole Zone

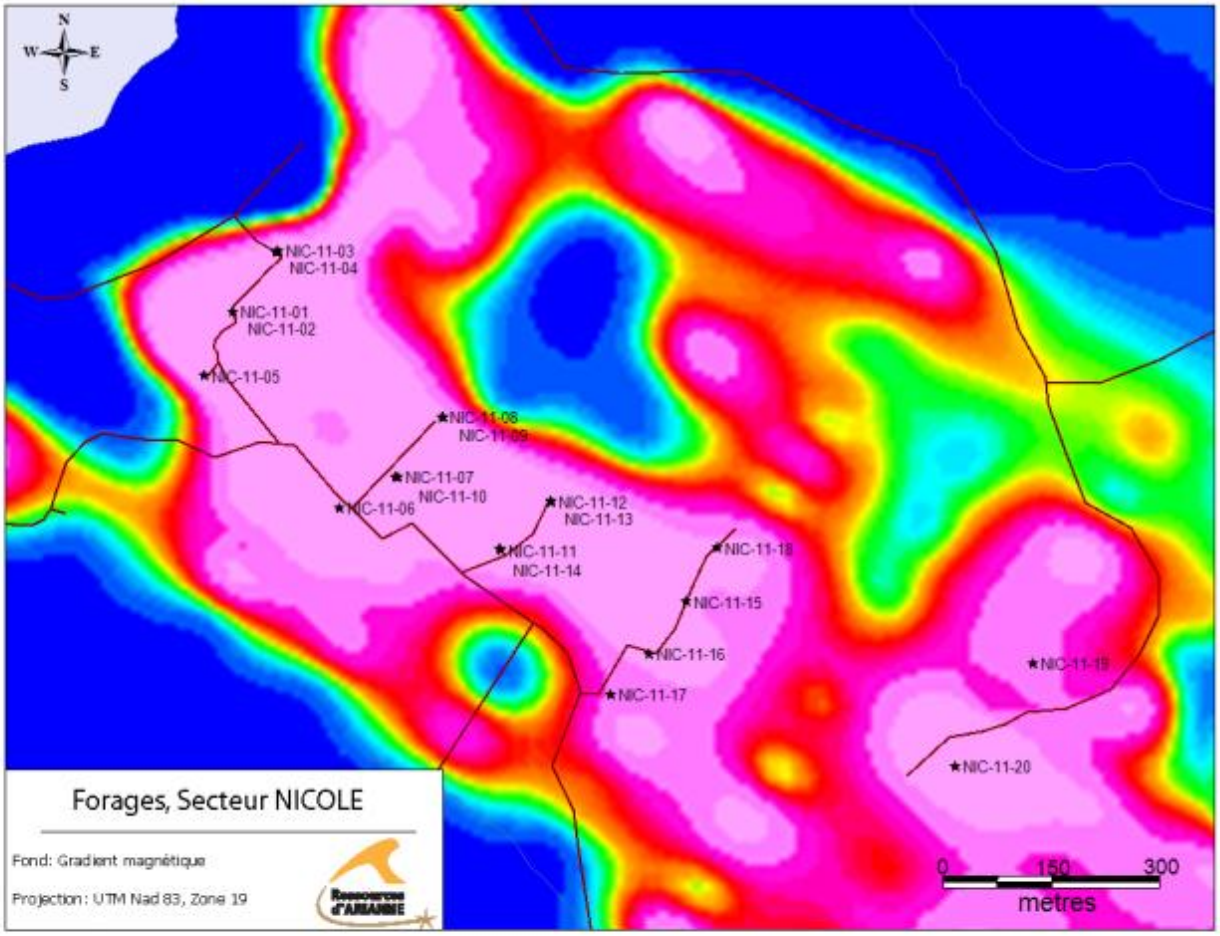


Figure 10.3.9 Location of Drill Holes in Nicole Zone

Drill hole	From (m)	To (m)	Length (m)	P_2O_5 (%)	TiO_2 (%)
TRA-11-01	3.10	94.90	91.80	6.61	8.12
and	108.20	135.00	26.80	3.71	4.45
TRA-11-02	66.90	144.00	77.10	4.73	6.62
including	66.90	107.70	40.80	6.72	9.64
TRA-11-03	3.40	135.00	131.60	4.90	6.38
including	3.40	45.00	41.60	5.03	7.36
	49.85	72.80	22.95	5.51	6.45
	87.00	131.00	44.00	5.57	7.13
TRA-11-04	2.50	46.40	43.90	5.49	7.67
and	84.20	138.00	53.80	4.08	4.26
including	100.10	132.00	31.90	4.87	4.86
TRA-11-05	3.20	131.30	128.10	5.12	5.86
including	3.20	67.10	63.90	6.66	6.87
	90.30	131.30	41.00	5.46	7.21
TRA-11-06	3.80	177.00	173.20	6.39	7.10

Table 10.3.8 Best Mineralized Intersections – Traverse Zone

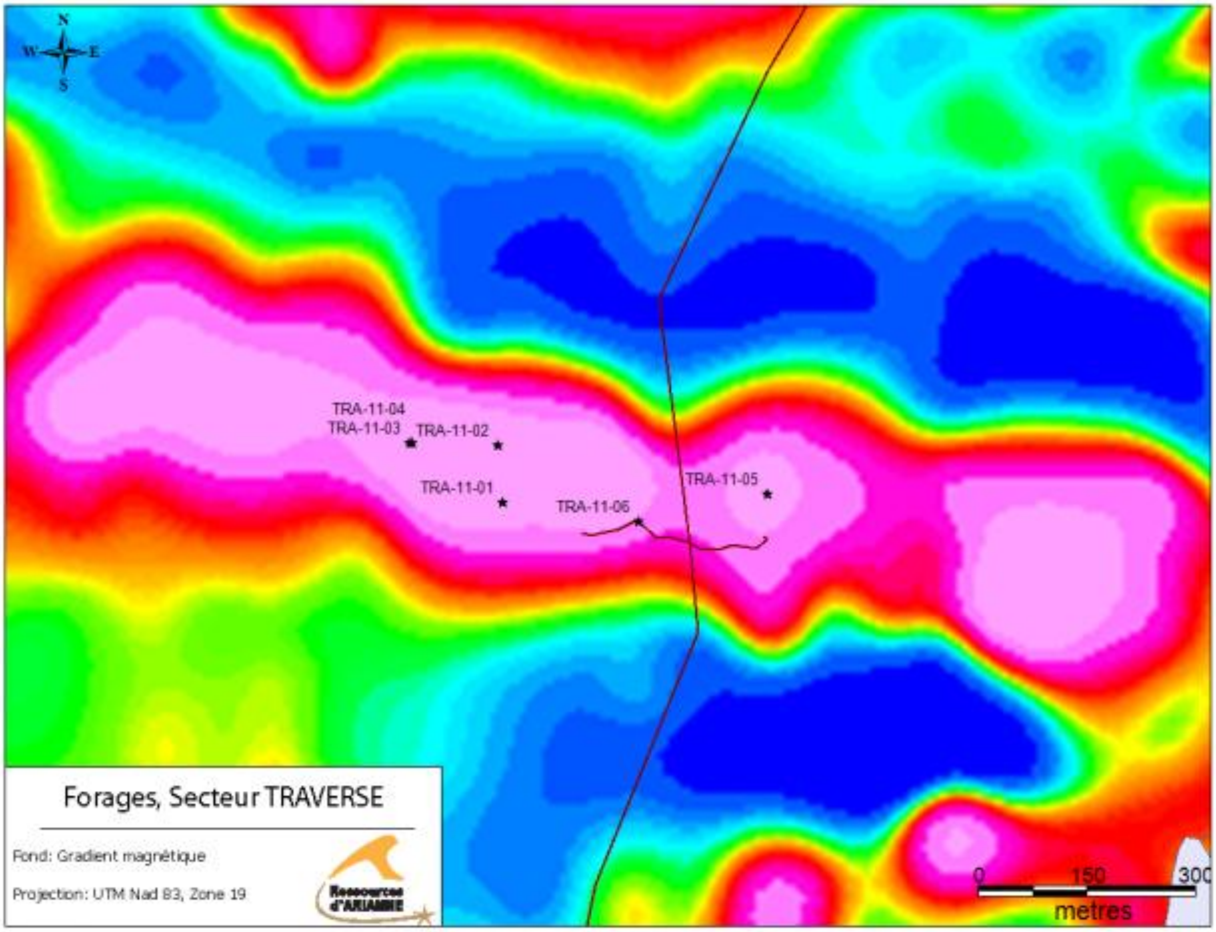


Figure 10.3.10 Location of Drill Holes in Traverse Zone

Drill hole	From (m)	To (m)	Length (m)	P_2O_5 (%)	TiO_2 (%)
LUC-12-01	21.30	256.50	235.20	4.72	5.39
including	21.30	71.70	50.40	6.23	7.44
	161.00	232.00	71.00	6.36	6.90
LUC-12-02	40.50	162.60	122.10	5.10	5.64
including	40.50	87.30	46.80	6.47	7.20
	135.50	162.60	27.10	6.46	7.23
LUC-12-03	29.00	279.00	250.00	5.10	6.17
including	115.00	256.80	141.80	6.13	7.20
LUC-12-04	42.00	87.30	45.30	5.41	6.17
LUC-12-05	57.70	150.00	92.30	4.07	5.33
including	57.70	72.60	14.90	5.90	7.11
	110.50	150.00	39.50	5.41	7.29
LUC-12-06	8.40	181.90	173.50	4.16	3.88
including	14.60	48.80	34.20	6.19	5.68
	76.80	124.90	48.10	5.41	4.76

Intersections Lucie Area

Drill hole	From (m)	To (m)	Length (m)	P_2O_5 (%)	TiO_2 (%)
LAP-09-01			Off-zone		
LAP-09-02	5	21.0	16.0	4.86	5.35
LAP-09-03	17.0	38.0	21.2	5.27	5.03
LAP-09-04			Off-zone		

Table 10.3.9 Best Mineralized Intersections – Lucie Zone

Note that exploration drill holes LAP-09-01, LAP-09-02, LAP-09-03 and LAP-09-04 were added to the table since they are part of the area and are included in the area with the same geophysical anomaly.

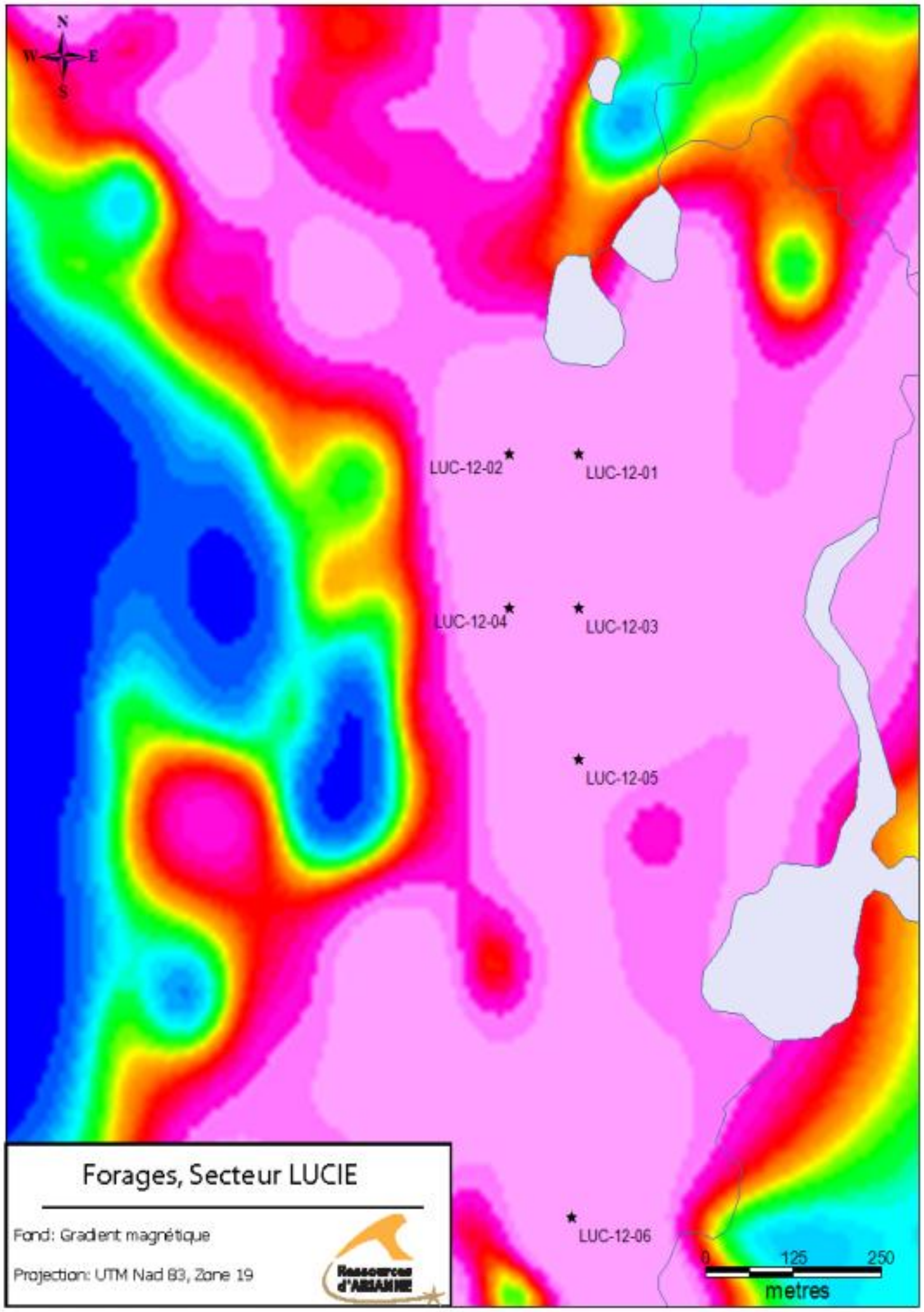


Figure 10.3.11 Location of Drill Holes in Lucie Zone

11. SAMPLE PREPARATION, ANALYSIS AND SECURITY

This section describes the method and approach used by Arianne over the drilling campaigns at Paul’s Property.

This section includes the same information as what was presented in yearend 2011, i.e. QA/QC up to Pau10-48; new information was added pertaining to the drilling activities beyond Pau-10-48 that were not included in previous technical reports.

The Lac a Paul deposit was sampled by BQ (Virginia) and NQ diamond drill holes, core samples taken from 2008 to 2012 being NQ drilling. The drill hole spacing varied from 60 to 125 meters. The cross section spacing varied from 60 meters to 150 meters but generally 90 meters.

Deposits are recognized over lengths of more than 1 km each and are massive structure with an average thickness of about 150 to 300 meters depending of the deposit.

The rock is competent and core recovery is extremely good. Samples are of good quality and are representative of the intersected rock. The mineralized rock being generally of massive fine grain, drilling holes smaller than the BQ diameter is not recommended.

The mineralization with grade of interest is within the nelsonite and anorthositic gabbro units of the anorthositic complex. These units have some inclusions and are intersected from time to time by quartz and dykes which are barren; these sections were not sampled and are considered zero grades. The decision to sample was based on the aspect of the rock and its visual composition. The core is usually sampled and analyzed over its full length.

The mineralization is associated with significant magnetic expression on the surface. It was found that a layer of relatively high grade TiO_2 with magnetite is at contact of the nelsonite; this layer of low grade apatite was difficult to differentiate from the normal mineralization. It was therefore sampled and the analytical results assisted in determining contacts during the interpretation phase at the Paul Zone.

The surface sampling by Arianne is made by hammering the surface rock in order to get about 2 to 5 Kg of rocks which are put into a bag with a tag and label. The rock is described and the position recorded with a hand held GPS.

For the core recovered by diamond drilling, the core boxes were identified, length of core were marked with wood blocks and boxes were closed and wrapped from drill site to portable core logging and splitting facilities of Arianne.

At the core shack, the core was reviewed and logged by a geologist; sections to sample were identified by the geologist (Mr. Christian Tremblay, a registered P. Geo. in the Province of Quebec).

Technicians then prepared the core and split it in half to keep a witness core. This was done under supervision of the Arianne contract geologist Christian Tremblay, acting geologist for every drilling campaigns from 2008 to 2012. Each drilling campaign was under supervision of the Arianne vice-president exploration, Daniel Boulianne, registered P. Geo. in the Province of Quebec. Sample bags with label and tags were sealed and put into rice bags and identified for shipping to laboratory facilities.

There is no reason to believe that work performed by Arianne staff and contractors was not made in a professional manner, hence in the Author's opinion, the work performed by Arianne meets or exceeds standards of best practice for sampling and logging diamond drilling core.

Initially in the Lac a Paul exploration phase by Arianne, sample lengths were at 1.5 meter long. After reception of the first drilling campaign results, showing some relatively low variation of grade within 2 samples of 1.5 m, a decision was made to increase the sample length to three (3) meters; the Author participated in this decision. The standard sample length for the 2010, 2011 and 2012 drilling in this report was therefore three (3) meters.

The NQ core was separated in two parts with a hydraulic core splitter and the witness core was preserved. The half core sample was put into plastic bags, tagged and sealed. The sample bags were afterwards listed and included into a rice bag for shipment to IOS laboratory in Chicoutimi, Quebec, where the sample was entirely crushed 0 to minus ¼ inch. An approximate split of 1 kg was taken using a riffle splitter after crushing and material afterwards ground with rotary disc pulverizer to approximately 95% passing 2 mm. Samples of 200 to 250 grams from this riffle split material were then bagged for shipping. Sample bags were afterwards listed and included into a rice bag for shipment to the ALS Laboratory.

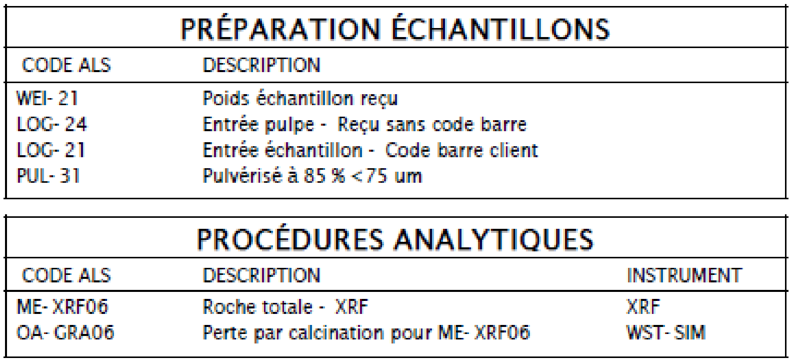
The Author visited the IOS facility on February 14, 2011, and found the equipment and procedures to be adequate in the Lac a Paul context. Due to time and cost, samples from PAU-12-98 and above (on April 16, 2012) were directly shipped to ALS Laboratory for complete reduction and preparation.

During the exploration program, emphasis was put on P_2O_5 and TiO_2. This work was mainly aimed at defining mineral resources of P_2O_5 and TiO_2. All major oxides were analyzed.

11.1 Sample Preparation at the Laboratory

IOS Geoscientific Services for Arianne shipped the samples to ALS Chemex Laboratory in Val d'Or, Quebec. The following procedures were used separately or combined in a package in order to meet specific sample preparation requirements.

Samples were weighed and pulverized (PUL 31 was used) prior to analysis. An excerpt from a typical certificate is given in Table 11.1.1.



PRÉPARATION ÉCHANTILLONS

CODE ALS	DESCRIPTION
WEI- 21	Poids échantillon reçu
LOG- 24	Entrée pulpe - Reçu sans code barre
LOG- 21	Entrée échantillon - Code barre client
PUL- 31	Pulvérisé à 85 % <75 um

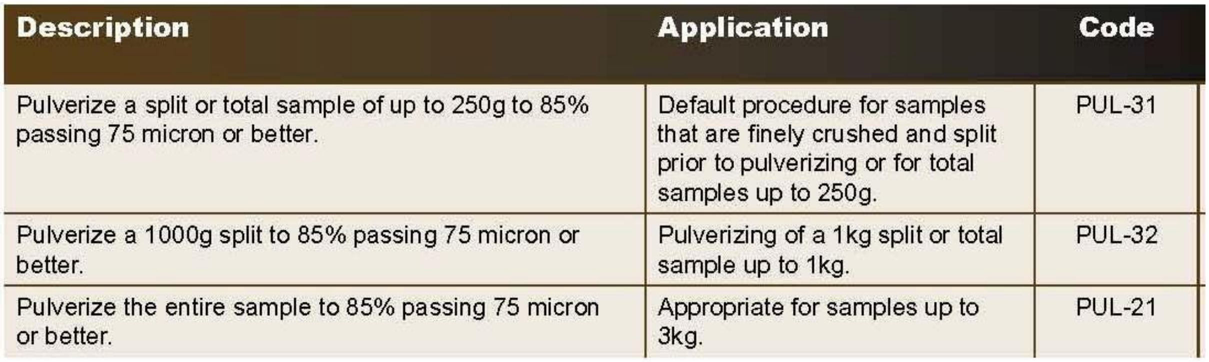
PROCÉDURES ANALYTIQUES

CODE ALS	DESCRIPTION	INSTRUMENT
ME- XRF06	Roche totale - XRF	XRF
OA- GRA06	Perte par calcination pour ME- XRF06	WST- SIM

Table 11.1.1 Example of Certificate

11.1.1 Pulverizing

All pulverizing procedures used “flying disk” or “ring and puck” style grinding mills (see Table 11.1.2). Unless otherwise indicated, all pulverizing procedures guarantee that for most sample types, at least 85% of the material was pulverized to 75 micron (200 mesh) or better.



Description	Application	Code
Pulverize a split or total sample of up to 250g to 85% passing 75 micron or better.	Default procedure for samples that are finely crushed and split prior to pulverizing or for total samples up to 250g.	PUL-31
Pulverize a 1000g split to 85% passing 75 micron or better.	Pulverizing of a 1kg split or total sample up to 1kg.	PUL-32
Pulverize the entire sample to 85% passing 75 micron or better.	Appropriate for samples up to 3kg.	PUL-21

Table 11.1.2 Pulverizing Procedure by ALS Chemex Laboratory in Val d’Or

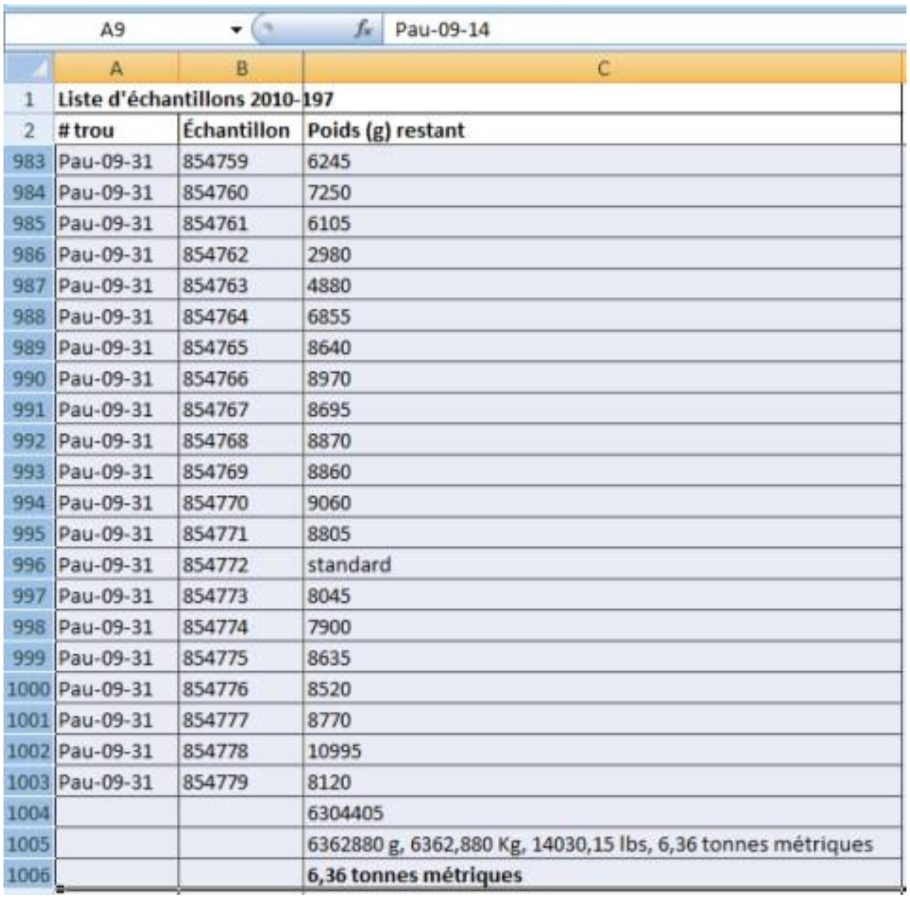
Arianne relied on ALS Chemex as its main laboratory. According to the certificates provided by Arianne, the Author concludes that the analytical results were from the same laboratory batch. Some analytical results were presented in oxides while some were expressed by element, in percent or ppm. The Author’s independent samples with SGS Laboratory were considered third party. Quality Assurance/Quality Control (QA/QC) procedures are presented and discussed in Section 11.3.

11.2 Bulk Sample Material Used for Metallurgical Testing

In the course of the study, Arianne was requested by COREM to provide about eight (8) tonnes of representative sample from the Paul Zone. The Vice-President of exploration from Arianne, Mr. Daniel Boulianne, Senior Geologist, elected to use the coarse rejects material from the core. The independent IOS Laboratory, which had the rejects in storage, sent these rejects directly to COREM for a total of 6.36 tonnes. The remaining additional 1.5 to 1.7 tonnes was taken from the blasted outcrop near hole PAU-09-18 under Arianne's staff supervision.

With this approach, Arianne took adequate steps to prepare a representative composite sample.

Table 11.2.1 is an extract of the rejects sample list from holes PAU-09-14 to 22 and PAU-09-24 to 31 which composed the 6.36 tonnes sent to COREM. The remaining 1.7 tonnes was taken by Arianne staff in the field and sent with the rejects to COREM in plastic barrels on wooden crates. Drill holes locations are presented in Figure 11.2.1.



A9 Pau-09-14

	A	B	C
1	Liste d'échantillons 2010-197		
2	# trou	Échantillon	Poids (g) restant
983	Pau-09-31	854759	6245
984	Pau-09-31	854760	7250
985	Pau-09-31	854761	6105
986	Pau-09-31	854762	2980
987	Pau-09-31	854763	4880
988	Pau-09-31	854764	6855
989	Pau-09-31	854765	8640
990	Pau-09-31	854766	8970
991	Pau-09-31	854767	8695
992	Pau-09-31	854768	8870
993	Pau-09-31	854769	8860
994	Pau-09-31	854770	9060
995	Pau-09-31	854771	8805
996	Pau-09-31	854772	standard
997	Pau-09-31	854773	8045
998	Pau-09-31	854774	7900
999	Pau-09-31	854775	8635
1000	Pau-09-31	854776	8520
1001	Pau-09-31	854777	8770
1002	Pau-09-31	854778	10995
1003	Pau-09-31	854779	8120
1004			6304405
1005			6362880 g, 6362,880 Kg, 14030,15 lbs, 6,36 tonnes métriques
1006			**6,36 tonnes métriques**

Table 11.2.1 Partial List of Core Reject Samples Used for the COREM Metallurgical Testing

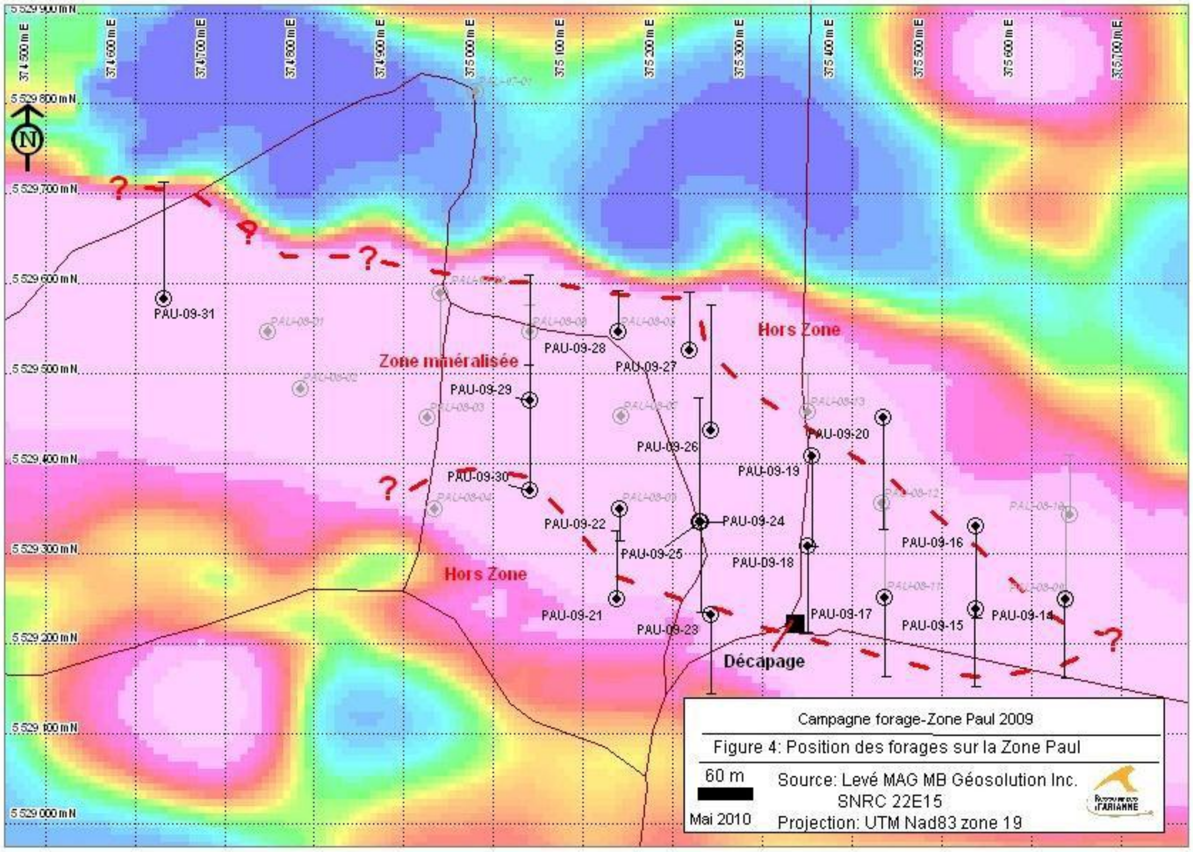


Figure 11.2.1 Position of Diamond Drill Holes Used for Metallurgical Testing Bulk Sample - Paul

Figure 11.2.1 confirms that material for the metallurgical testing bulk sample (6.36 tonnes) is well distributed throughout part of the deposit. The stripping zone (the black square in Figure 11.2.1) indicates the first location where rock was stripped. The origin of the remaining source of the bulk (around 1.5 to 1.7 tonnes) is located just to the north of the first stripped area, besides hole PAU-09-18. The total shipment weight was 8,165 kg. The grade of the in-house standard gives the average grade of this material. The colour code reflects the magnetic signature.

As a next step, the Author recommends that tests on recovery (geometallurgical approach) should take place to assess the variability of recovery across each deposit in 3D.

11.3 Quality Control Program

The QC program that was put in place by Arianne was used in the 2010-2011-2012 drilling program. Arianne relied on its own program and independent samples taken by SGS Geostat as an external quality control step to complete the QC program.

11.3.1 Paul QA/QC-Reliability of Results

The reliability of analytical results in TiO_2 and P_2O_5 from ALS Chemex Laboratory was verified. Indeed, numerous standards (samples for which the grade is known) and blanks (samples that do not contain the elements of interest) were inserted in the sample stream for each drill hole.

The procedure consisted in inserting two reference materials and one blank at the start of the sample sequence shipped to the laboratory. Subsequently, certified and in-house reference materials were alternately inserted, along with blanks throughout the sample sequence. One of these was alternately introduced after every 11 to 13 samples. Finally, one blank was inserted at the end of each sampling sequence. Quality control was performed by Arianne personnel and QA/QC monitoring was performed while the drilling campaign was in progress.

The blanks used in this drill program were blocks of quartz from the SITEQ quarry at St-François-de-Sales. They were brushed and cleaned with oxalic acid before being sent for analysis. These rocks showed no known enrichment in TiO_2 and P_2O_5. Values in P_2O_5 and TiO_2 during the 2010 campaign are shown in Table 11.3.1. They vary from 0.01 to 0.21% TiO_2 and from 0.009 to 0.336% P_2O_5.

Hole Name	Depth (m)	Sample Number	ALS values P_2O_5 (%)	ALS values TiO_2 (%)
PAU-10-32	0	H853153	0.014	-0.01
	270	H853188	0.026	-0.01
	365	H853223	0.044	-0.01
	462	H853256	0.052	0.01
PAU-10-33	0	H853259	0.013	0.03
	99.6	H853296	0.054	0.02
	209.7	H853332	0.053	0.02
	309	H853364	0.03	0.02
PAU-10-34	0	H853367	0.014	0.02
	54	H853387	0.014	0.02
PAU-10-35	0	H853390	0.011	-0.01
	120.9	H853427	0.03	-0.01
	239.3	H853462	0.027	-0.01
	354	H853498	0.04	0.06
	432	H854828	0.062	-0.01
PAU-10-36	0	H854831	0.016	-0.01
	47	H854848	0.045	0.04
PAU-10-37	0	H854851	0.023	-0.01
	119.9	H854887	0.059	0.02
	222.4	H854923	0.111	0.08
	321.4	H854959	0.069	0.04

Hole Name	Depth (m)	Sample Number	ALS values P_2O_5 (%)	ALS values TiO_2 (%)
	360.5	H854977	0.016	-0.01
PAU-10-38	0	H854980	0.018	0.01
	144.7	H855016	0.042	0.02
	245.9	H855050	0.052	0.03
	344.9	H855086	0.052	0.03
	351	H855090	0.044	0.01
PAU-10-39	0	H855093	0.022	-0.01
	111	H855130	0.009	0.01
	189	H855159	0.009	0.05
PAU-10-40	0	H855163	0.013	0.01
	105.5	H855200	0.102	0.1
	203.8	H855234	0.052	0.03
	303.5	H855268	0.021	-0.01
PAU-10-41	0	H855272	0.015	-0.01
	114.7	H855311	0.336	0.21
	219	H855350	0.056	0.05
	323	H855389	0.063	0.02
	423	H855423	0.019	-0.01
PAU-10-42	0	H855426	0.015	-0.01
PAU-10-43	0	H855441	0.024	-0.01
	183.2	H855480	0.051	0.03
	295.3	H855519	0.114	0.12
PAU-10-44	0	H855546	0.018	-0.01
PAU-10-45	0	H855572	0.031	0.03
	121.8	H855611	0.132	0.08
	237	H855650	0.013	-0.01
PAU-10-46	0	H855657	0.016	-0.01
	123.5	H855696	0.024	-0.01
	232.4	H855735	0.031	0.03
PAU-10-47	0	H855749	0.013	-0.01
	114	H855790	0.014	0.03
PAU-10-48	0	H855793	0.012	-0.01

Table 11.3.1 Arianne Blank Check Samples Sent to ALS Chemex Laboratory in Val d'Or

In addition, four standards were used to validate the analytical results. There were two certified standards (DC79003 and SY-4), one approved standard (FER-1), and one home-made standard (PMRI10).

The SY-4 standard was certified by CANMET Mining and Mineral CANMET services in Ontario. It was used to check the values for P_2O_5 and TiO_2. The certified values were 0.131% of P_2O_5 and 0.287% of TiO_2.

The values obtained with the laboratory analysis for this drilling campaign gave relative errors ranging from 1.527% to 11.450% for P_2O_5 and absolute relative errors ranging between 1.045% and 5.923% for TiO_2.

The other certified standard, DC 79003, was only valid for P_2O_5. It was certified by the China National Analysis Center for Iron and Steel. The standard value was 6.06% for P_2O_5. The values obtained during laboratory tests showed an absolute error that varied from 4.274% to 5.099%.

The FER-1 standard was prepared by CANMET and was used as material reference by the Geological Survey of Canada. Standard values were: 2.39% P_2O_5 and 75.86% Fe_2O_3. Results obtained in laboratory tests showed absolute errors ranging from 0.01% to 4.79% for Fe_2O_3 and 1.674% to 16.276% for P_2O_5.

Finally, the PMRI 10 in-house standard was taken from the Paul Zone stripping rock. It was used to check the P_2O_5 and TiO_2 values. With the numbers that are available today, the average is 10.286% P_2O_5 (min: 9.175, max: 10.435) with a standard deviation of 0.134, and an average of 5.476% TiO_2 (min: 5.13%, max: 5.54%) with a standard deviation of 0.044%. Using the previous averages, the lab tests showed errors ranging from 0% to 10.801% P_2O_5 and 0.073% to 6.318% in TiO_2.

All results for samples analysis and standards checks, along with the percentage of error in the calibration values are presented in Table 11.3.2 to Table 11.3.6. Samples of drill hole PAU-10-35 and PAU-10-40 were reversed by the laboratory. Analysis of recovery was made. The laboratory confirmed that the samples had been reversed and that the good results to be considered were those of the analysis times. The certificates of the first analysis and the reanalysis were provided for validation.

Drill hole Name	Depth (m)	Sample Number	Standard values P_2O_5 (%)	Obtained value P_2O_5 (%)	Relative Error (%)	Standard value TiO_2 (%)	Obtained value TiO_2 (%)	Relative Error (%)
PAU-10-32	0	H853151	0.131	0.126	-3.817	0.287	0.28	-2.439
PAU-10-33	0	H853257	0.131	0.127	-3.053	0.287	0.28	-2.439
PAU-10-34	0	H853365	0.131	0.126	-3.817	0.287	0.29	1.045
PAU-10-35	0	H853388	0.131	0.126	-3.817	0.287	0.28	-2.439
PAU-10-36	0	H854829	0.131	0.127	-3.053	0.287	0.27	-5.923
PAU-10-37	0	H854849	0.131	0.126	-3.817	0.287	0.28	-2.439
PAU-10-38	0	H854978	0.131	0.126	-3.817	0.287	0.29	1.045

PAU-10-39	0	H855091	0.131	0.126	-3.817	0.287	0.28	-2.439
PAU-10-40	0	H855161	0.131	0.129	-1.527	0.287	0.29	1.045
PAU-10-41	0	H855270	0.131	0.116	-11.450	0.287	0.27	-5.923
PAU-10-42	0	H855424	0.131	0.126	-3.817	0.287	0.30	4.530
PAU-10-43	0	H855439	0.131	0.126	-3.817	0.287	0.28	-2.439
PAU-10-44	0	H855544	0.131	0.127	-3.053	0.287	0.29	1.045
PAU-10-45	0	H855570	0.131	0.129	-1.527	0.287	0.28	-2.439
PAU-10-46	0	H855655	0.131	0.126	-3.817	0.287	0.29	1.045
PAU-10-47	0	H855747	0.131	0.126	-3.817	0.287	0.29	1.045
PAU-10-48	0	H855791	0.131	0.126	-3.817	0.287	0.28	-2.439

Table 11.3.2 Arianne SY-4 Standard Check

Drill hole Name	Depth (m)	Sample Number	Standard value P_2O_5 (%)	Obtained value P_2O_5 (%)	Relative Error (%)
PAU-10-32	0	H853152	6.06	5.789	-4.472
PAU-10-33	0	H853258	6.06	5.772	-4.752
PAU-10-34	0	H853366	6.06	5.768	-4.818
PAU-10-35	0	H853389	6.06	5.775	-4.703
PAU-10-36	0	H854830	6.06	5.79	-4.455
PAU-10-37	0	H854850	6.06	5.765	-4.868
PAU-10-38	0	H854979	6.06	5.782	-4.587
PAU-10-39	0	H855092	6.06	5.785	-4.538
PAU-10-40	0	H855162	6.06	5.766	-4.851
PAU-10-41	0	H855162	6.06	5.786	-4.521
PAU-10-42	0	H855425	6.06	5.76	-4.950
PAU-10-43	0	H855440	6.06	5.758	-4.983
PAU-10-44	0	H855545	6.06	5.751	-5.099
PAU-10-45	0	H855571	6.06	5.76	-4.950
PAU-10-46	0	H855656	6.06	5.801	-4.274
PAU-10-47	0	H855748	6.06	5.782	-4.587
PAU-10-48	0	H855792	6.06	5.795	-4.373

Table 11.3.3 Arianne DC79003 Standard Check

rillhole Name	Depth (m)	Sample Number	Standard value Fe_2O_3 (%)	Obtained value Fe_2O_3 (%)	Relative Error (%)	Standard value P_2O_5 (%)	Obtained value P_2O_5 (%)	Relative Error (%)
PAU-10-32	246	H853178	75.86	75.55	-0.41	2.39	2.251	-5.816
	332	H853211	75.86	76.00	0.18	2.39	2.231	-6.653
	441	H853247	75.86	75.85	-0.01	2.39	2.241	-6.234
PAU-10-33	66.6	H853283	75.86	75.55	-0.41	2.39	2.251	-5.816
	173.7	H853319	75.86	75.50	-0.47	2.39	2.242	-6.192
	279	H853355	75.86	75.65	-0.28	2.39	2.24	-6.276
PAU-10-35	87.4	H853414	75.86	75.77	-0.12	2.39	2.257	-5.565
	208.2	H853451	75.86	76.04	0.24	2.39	2.319	-2.971
	324	H853487	75.86	75.70	-0.21	2.39	2.252	-5.774
	421	H854823	76.86	75.80	-1.38	2.39	2.24	-6.276

Table 11.3.4 Arianne FER-1 Standard Check Part 1

Drill hole Name	Depth (m)	Sample Number	Standard value Fe_2O_3 (%)	Obtained value Fe_2O_3 (%)	Relative Error (%)	Standard value P_2O_5 (%)	Obtained value P_2O_5 (%)	Relative Error (%)
PAU-10-37	83.9	H854874	75.86	75.75	-0.15	2.39	2.241	-6.234
	186.1	H854910	75.86	75.67	-0.25	2.39	2.241	-6.234
	285.4	H854946	75.86	75.95	0.12	2.39	2.245	-6.067
PAU-10-38	99	H855003	75.86	75.85	-0.01	2.39	2.232	-6.611
	207.7	H855039	75.86	75.76	-0.13	2.39	2.251	-5.816
	314.9	H855075	75.86	75.75	-0.15	2.39	2.241	-6.234
PAU-10-39	74.2	H855117	75.86	75.79	-0.09	2.39	2.251	-5.816
	174	H855153	75.86	75.30	-0.74	2.39	2.221	-7.071
PAU-10-40	69.5	H855187	75.86	76.02	0.21	2.39	2.261	-5.397
PAU-10-41	81.7	H855299	75.86	79.49	4.79	2.39	2.001	-16.276
	186.6	H855338	75.86	77.59	2.28	2.39	2.338	-2.176
	290	H855377	75.86	76.15	0.38	2.39	2.541	6.318
	406.1	H855417	75.86	73.00	-3.77	2.39	2.350	-1.674
PAU-10-42	72	H855543	75.86	75.76	-0.13	2.39	2.261	-5.397
PAU-10-43	150.2	H855468	75.86	75.97	0.15	2.39	2.251	-5.816
	262.3	H855507	75.86	76.00	0.18	2.39	2.261	-5.397
PAU-10-44	64.2	H855569	75.86	75.71	-0.20	2.39	2.263	-5.314
PAU-10-45	75.2	H855599	75.86	75.59	-0.36	2.39	2.261	-5.397
	204.5	H855638	75.86	75.78	-0.11	2.39	2.006	-16.067
PAU-10-46	85.7	H855684	75.86	75.72	-0.18	2.39	2.262	-5.356
	199.4	H855723	75.86	75.41	-0.59	2.39	2.251	-5.816
PAU-10-47	78.1	H855776	75.86	75.78	-0.11	2.39	2.251	-5.816

Table 11.3.5 Arianne FER-1 Standard Check Part 2

Drill hole Name	Depth (m)	Sample Number	Standard value P_2O_5 (%)	Obtained value P_2O_5 (%)	Relative Error (%)	Standard value TiO_2 (%)	Obtained valueTiO_2 (%)	Relative Error (%)
PAU-10-32	202	H853165	10.286	10.301	0.146	5.476	5.47	-0.110
	303	H853200	10.286	10.312	0.253	5.476	5.5	0.438
	411	H853236	10.286	10.291	0.049	5.476	5.48	0.073
PAU-10-33	37	H853273	10.286	10.290	0.039	5.476	5.48	0.073
	140.7	H853307	10.286	10.301	0.146	5.476	5.46	-0.292
	246	H853343	10.286	10.309	0.224	5.476	5.51	0.621
PAU-10-34	32.7	H853378	10.286	10.260	-0.253	5.476	5.46	-0.292
PAU-10-35	36.3	H853402	10.286	10.261	-0.243	5.476	5.47	-0.110
	173.2	H853438	10.286	10.261	-0.243	5.476	5.41	-1.205
	275.6	H853474	10.286	10.304	0.175	5.476	5.43	-0.292
	387	H854810	10.286	10.275	-0.146	5.476	5.45	-0.475
PAU-10-37	47.5	H854862	10.286	10.287	0.010	5.476	5.47	-0.110
	153.1	H854898	10.286	10.288	0.019	5.476	5.47	-0.110
	252.4	H854934	10.286	10.302	0.156	5.476	5.49	0.256
	348.1	H854971	10.286	10.301	0.146	5.476	5.48	0.073
PAU-10-38	65	H854991	10.286	10.282	-0.039	5.476	5.46	-0.292
	174.7	H855027	10.286	10.301	0.146	5.476	5.48	0.073
	278.9	H855062	10.286	10.310	0.233	5.476	5.47	-0.110
PAU-10-39	39.6	H855105	10.286	10.312	0.253	5.476	5.50	0.438
	141	H855141	10.286	10.310	0.233	5.476	5.49	0.256
PAU-10-40	34.9	H855174	10.286	10.310	0.233	5.476	5.46	-0.292
	140.8	H855211	10.286	10.310	0.233	5.476	5.42	-1.023
PAU-10-41	46.6	H855286	10.286	10.312	0.253	5.476	5.50	0.438
	153.7	H855325	10.286	9.175	-10.801	5.476	5.13	-6.318
	254	H855364	10.286	10.261	-0.243	5.476	5.45	-0.475
	365	H855403	10.286	10.272	-0.136	5.476	5.45	-0.475
PAU-10-42	43.4	H855532	10.286	10.282	-0.039	5.476	5.47	-0.110
PAU-10-43	42.6	H855455	10.286	10.310	0.233	5.476	5.47	-0.110
	225.1	H855494	10.286	10.281	-0.049	5.476	5.46	-0.292
	324.5	H855530	10.286	10.321	0.340	5.476	5.5	0.438
PAU-10-44	41.8	H855560	10.286	10.152	-1.303	5.476	5.47	-0.110
PAU-10-45	41.8	H855586	10.286	10.435	1.449	5.476	5.51	0.621
	160.8	H855625	10.286	10.281	-0.049	5.476	5.46	-0.292
PAU-10-46	42.8	H855671	10.286	10.300	0.136	5.476	5.46	-0.292
	163.4	H855710	10.286	10.310	0.233	5.476	5.50	0.438
	282.5	H855746	10.286	10.295	0.087	5.476	5.48	0.073
PAU-10-47	42.2	H855763	10.286	10.310	0.233	5.476	5.51	0.621
PAU-10-48	21	H855800	10.286	10.301	0.146	5.476	5.50	0.438

Table 11.3.6 Arianne PMRI10 Standard Check

11.3.2 Paul QA/QC-Reliability of Results After Drilling PAU-10-48

TiO_2 and P_2O_5 analytical results from ALS Chemex Laboratory were verified for reliability. 326 blanks and 584 standards were sent to this laboratory.

Certification of blanks

Blanks used during this drilling campaign were decorative stones made of calcite purchased in a supermarket retailer (Rona Inc., etc.). They were brushed and cleaned with oxalic acid before being sent for analysis. These rocks had no known enrichment in TiO_2 and P_2O_5. The TiO_2 and P_2O_5 values for all blanks of the four (4) zones are shown in Tables 11.3.7 and 11.3.8. They range from 0.002% to 0.462% P_2O_5 (excluding four extreme values of 1.3%, 1.47%, 4.429% and 6.79%) and from 0.01% to 0.94% TiO_2 (excluding five extreme values of 2.3%, 4.2%, 5.47%, 5.97%, and 6.01%).

PAUL Project - 2011				
Hole Number	**Depth [m]**	**Sample Number**	**Lab Value P_2O_5 [%]**	**Lab Value TiO_2 [%]**
PAU-11-49	0	K338334	0.009	-0.01
	102	K338373	0.018	0.05
	207.75	K338413	0.037	0.01
	278	K338442	0.202	0.19
PAU-11-50	0	K338445	0.011	-0.01
	105	K338484	0.013	-0.01
	183	K338519	0.014	-0.01
PAU-11-51	3	k338522	0.017	-0.01
	99	k338562	0.012	-0.01
	201	k338600	0.059	0.01
	288	k338633	0.030	0.01
PAU-11-52	0	K338636	0.002	-0.01
	106	K338675	0.007	0.01
	195	K338713	0.120	0.01
	237	K338728	0.015	0.01
PAU-11-53	0	K338731	0.007	0.01
	108	K338769	0.011	0.03
	201	K338806	0.031	0.03
	291	K338845	0.068	0.06
	360	K338871	0.022	0.02
PAU-11-54	0	K338874	0.012	-0.01
	111	K338913	0.066	0.05
	216	K338950	0.083	0.05
	318	H900738	0.177	0.05
	423	H900777	0.161	0.08
	429	H900780	0.130	0.06
PAU-11-55	0	H900783	0.019	0.03
	123	H900823	0.267	0.22
	222	H900862	1.300	0.93

PAUL Project - 2011				
Hole Number	Depth [m]	Sample Number	Lab Value P_2O_5 [%]	Lab Value TiO_2 [%]
	327	H900900	0.166	0.11
	354	H900910	0.021	0.05
PAU-11-56	0	H900913	0.018	0.02
	108.8	H900952	0.027	0.02
	216.6	H900991	0.013	0.03
	234	H900997	0.014	0.02
PAU-11-57	0	H901004	0.010	-0.01
	106.5	H901044	0.041	0.01
	147	H901059	0.016	-0.01
PAU-11-58	0	H901062	0.014	-0.01
	102	H901100	0.053	0.01
	201	H901139	0.079	0.04
	301.6	H901177	0.050	0.01
	312	H901182	0.027	0.13
PAU-11-59	0	H901185	0.009	0.01
	102	H901223	0.061	0.02
	210	H901263	0.179	0.14
	282	H901295	0.033	0.02
PAU-11-60	0	M072003	0.005	0.01
	108	M072042	0.027	0.02
	219	M072083	0.107	0.09
	309	M072119	0.004	0.03
PAU-11-61	0	M072122	0.004	0.01
	101.1	M072165	0.027	0.03
	207	M072199	0.004	0.03
PAU-11-62	0	M072202	0.021	-0.01
	102	M072242	0.064	0.04
	202.9	M072282	0.071	0.06
	301.1	M072321	0.031	0.02
	345	M072340	0.025	0.1
PAU-11-63	0	M072343	0.013	-0.01
	108	M072384	0.094	0.08
	210	M072423	0.015	0.08
	273	M072444	0.012	0.01
PAU-11-64	0	M072447	0.021	-0.01
	111	M072486	0.036	-0.01
	210	M072526	0.033	-0.01

PAUL Project - 2011				
Hole Number	Depth [m]	Sample Number	Lab Value P_2O_5 [%]	Lab Value TiO_2 [%]
	321.3	M072566	0.072	0.04
	423	M072606	0.109	0.06
PAU-11-65	0	M073630	0.016	0.01
	123	M073674	0.087	0.07
	240	M073718	0.290	0.22
	360	M073758	0.041	0.02
	408.25	M073778	0.087	0.10
PAU-11-66	0	M073781	0.014	0.01
	117	M073820	0.051	0.03
	231	M073863	0.087	0.07
	345	M073902	0.277	0.26
	417	M073930	0.026	0.05

Table 11.3.7 Blank Values in the Paul Zone - 2011

PAUL Project - 2012				
Hole Number	Depth [m]	Sample Number	Lab Value P_2O_5 [%]	Lab Value TiO_2 [%]
PAU-12-67	0	M073933	0.018	0.01
	93	M073969	0.150	0.13
	198	M074006	0.127	0.09
	288	M074042	0.100	0.07
	372	M074076	0.148	0.10
	426	M074099	0.081	0.05
PAU-12-68	0	M074102	0.014	-0.01
	91.5	M074137	0.123	0.09
	182.7	M074174	0.058	0.04
	279	M074210	0.062	0.05
	362.8	M074244	0.079	0.05
	405	M074261	0.048	0.03
PAU-12-69	0	M074264	0.057	0.13
	94.5	M074300	0.124	0.11
	174	M074337	0.089	0.14
	257.6	M074370	0.062	0.03
PAU-12-70	250	M074373	0.024	-0.01
	342	M074409	0.283	0.20
	384	M074427	0.288	0.23

PAUL Project - 2012

Hole Number	Depth [m]	Sample Number	Lab Value P_2O_5 [%]	Lab Value TiO_2 [%]
PAU-12-71	0	M074430	0.014	0.02
	96	M074466	0.128	0.10
	186	M074503	0.123	0.09
	294	M074537	0.062	0.03
	393	M074573	0.088	0.05
	417	M074583	0.079	0.04
PAU-12-72	0	M074586	0.023	-0.01
	102	M074622	0.268	0.20
	201	M074658	0.220	0.11
	278	M074692	0.124	0.08
	348	M074719	0.231	0.12
PAU-12-73	0	M074722	0.028	-0.01
	93	M074756	0.335	0.19
	174	M074792	0.239	0.13
	259	M074828	0.390	0.16
	318	M074851	0.267	0.34
	339	M074859	0.276	0.20
PAU-12-74	0	M074862	0.026	0.01
	87	M074897	0.049	0.03
	150	M074920	0.012	0.02
PAU-12-75	0	M074923	0.020	-0.01
	90.9	M074958	0.048	0.01
	129	M074974	0.054	0.01
PAU-12-76	0	M074977	0.022	0.01
	83.4	M054008	0,176	0.09
PAU-12-77	0	M054011	0.023	0.01
	102.9	M054046	0.128	0.08
	219	M054082	0.222	0.14
	235.3	M054090	0.077	0.04
PAU-12-78	0	M054093	0.020	-0.01
	108	M054130	0.075	0.02
	165.4	M054152	0.043	0.08
PAU-12-79	0	M054155	0.032	0.01
	145.5	M054192	0.080	0.05
PAU-12-80	0	M054195	0.020	0.01
	240	M054232	0.043	0.03
	315	M054267	0.082	0.06

PAUL Project - 2012				
Hole Number	Depth [m]	Sample Number	Lab Value P_2O_5 [%]	Lab Value TiO_2 [%]
	380.3	M054284	0.035	0.01
PAU-12-81	0	M054287	0.027	0.01
	80.8	M054321	0.032	0.01
	168	M054357	0.207	0.10
	243	M054392	0.109	0.06
	300	M054414	0.092	0.04
PAU-12-82	0	M054417	0.128	0.05
	93	M054453	0.037	0.02
	149	M054475	0.036	0.03
PAU-12-83	0	M055013	0.023	0.05
	99	M055048	0.019	0.02
	213	M055083	0.035	0.05
	300	M055118	0.029	0.03
	379.3	M055154	6.790	6.01
	456.2	M055188	0.019	0.03
	478	M055197	0.004	0.01
PAU-12-84	0	M055200	0.046	0.05
	99	M055239	0.038	0.04
	180	M055274	0.062	0.06
	265.8	M055311	0.034	0.10
	294	M055325	0.031	0.05
PAU-12-85	0	M055328	0.025	0.04
	93	M055361	0.034	0.04
	169	M055396	0.028	0.04
	201	M055408	0.017	0.04
PAU-12-86	0	M055411	0.020	0.04
	96	M055447	0.040	0.04
	174	M055484	0.435	5.97
	204	M055500	0.023	0.04
PAU-12-87	0	M055503	0.027	0.07
	90	M055538	0.032	0.05
	147	M055567	0.022	0.03
PAU-12-88	0	M055570	0.049	0.05
	81	M055606	0.109	0.08
	162	M055643	0.022	0.04
PAU-12-89	0	M055661	0.022	0.04
	96	M055698	0.354	0.30

PAUL Project - 2012				
Hole Number	**Depth [m]**	**Sample Number**	**Lab Value P_2O_5 [%]**	**Lab Value TiO_2 [%]**
	174	M055733	0.005	0.03
PAU-12-90	0	M055736	0.010	0.06
	111	M055777	0.015	0.05
	198	M055812	0.012	0.04
	204	M055815	0.014	0.04
PAU-12-91	0	M055818	0.007	0.04
	96	M055853	0.026	0.07
	175.1	M055887	0.008	0.04
	219	M055907	0.005	0.04
PAU-12-92	0	M055910	0.007	0.04
	91.6	M055945	0.016	0.04
	180	M055981	0.015	0.05
	234	M056003	0.014	0.05
PAU-12-93	0	M056006	0.010	0.05
	99	M056044	0.058	0.10
	183	M056081	0.025	0.07
PAU-12-94	0	M056084	0.011	0.04
	84	M056119	0.053	0.07
	174	M056155	4.429	5.47
	242	M056184	0.009	0.06
PAU-12-95	0	M056187	0.011	0.06
	91	M056223	0.027	0.07
	167.2	M056259	0.065	0.10
	240	M056285	0.011	0.05
PAU-12-96	0	M056288	0.005	0.02
	114.5	M056326	0.008	0.03
	204.6	M056362	0.017	0.03
	280	M056398	0.048	0.07
	364	M056435	0.008	0.02
PAU-12-97	0	M056438	0.011	0.05
	90	M056475	0.012	0.04
	189	M056513	0.013	0.04
	268	M056549	0.021	0.02
	342	M056584	0.141	0.09
	432	M056619	0.142	0.08
	471	M056635	0.419	4.20
PAU-12-98	3	m056653	0.008	0.03

PAUL Project - 2012				
Hole Number	Depth [m]	Sample Number	Lab Value P_2O_5 [%]	Lab Value TiO_2 [%]
	96	m056692	0.018	0.02
	222	m056732	0.111	0.09
	327	m056770	0.161	0.13
	402	m056800	0.301	0.22
PAU-12-99	6	M056803	0.005	0.03
	103	M056839	0.007	0.03
	180	M056874	0.027	0.04
	276	N138014	0.015	0.02
	372	N138053	0.025	0.03
	416	N138072	0.066	0.04
PAU-12-100	4	N138075	0.002	0.01
	142.1	N138112	0.011	0.03
	234	N138150	0.010	0.06
	333	N138189	0.050	0.04
	426	N138226	0.017	-0.01
	498	N138255	0.018	0.01
PAU-12-101	429	N138258	0.017	-0.01
	504	N138295	0.011	-0.01
PAU-12-102	6	N138303	0.020	0.07
	129	N138341	0.023	0.05
	240	N138379	0.018	0.04
	312	N138411	0.014	0.04
PAU-12-103	129	N138414	0.046	0.06
	88	N138450	0.016	0.04
	129	N138466	0.011	0.10
PAU-12-104	5.5	N138469	0.005	0.02
	90	N138505	0.057	0.11
	186	N138542	0.036	0.06
	276	N138579	0.120	0.16
	390	N138619	0.019	0.06
PAU-12-105	0	N138622	0.020	0.01
	99	N138658	0.013	0.03
	219	N138695	0.023	0.01
	312	N138733	0.038	0.02
	407.6	N138770	0.013	0.03
	462	N138791	0.008	0.02
PAU-12-106	0	N138794	0.015	-0.01

PAUL Project - 2012				
Hole Number	Depth [m]	Sample Number	Lab Value P_2O_5 [%]	Lab Value TiO_2 [%]
	114.7	N138831	0.006	0.01
	208.1	N138866	0.011	0.02
	303	N138903	0.020	0.01
	393	N138941	0.028	0.02
	402	N138945	0.028	0.01
PAU-12-107	3	N138948	0.007	0.01
	95.4	N138984	0.020	0.05
	195	N139023	0.008	0.15
	282	N139059	0.009	0.01
PAU-12-108	0	N139062	0.017	-0.01
	141	N139115	0.008	-0.01
PAU-12-109	3	N139118	0.006	-0.01
	105	N139157	0.021	-0.01
	216	N139196	0.054	0.04
	320	N139234	0.117	0.11
	420	N139273	0.093	0.10
	450	N139285	0.027	0.04
PAU-12-110	9	N139288	0.006	-0.01
	111	N139326	0.066	0.08
	219	N139366	0.009	0.01
PAU-12-111	4.9	N139375	0.015	0.01
	105	N139413	0.462	0.35
	207	N139452	0.200	0.22
	312	N139491	0.015	0.01
	327	N139497	0.012	0.01
PAU-12-112	4.3	N139500	0.009	-0.01
	111	N139539	0.024	0.02
	213	N139578	0.035	0.01
	324	N139617	0.117	0.10
	420	N139654	0.138	0.13
PAU-12-113	3.8	N139657	0.005	-0.01
	115.7	N139697	0.025	0.01
	209.5	N139737	0.014	-0.01
	309	N139776	0.042	0.01
	408	N139815	0.050	0.03
	444	N139829	0.063	0.03
PAU-12-114	0	N139832	0.007	-0.01

PAUL Project - 2012				
Hole Number	Depth [m]	Sample Number	Lab Value P_2O_5 [%]	Lab Value TiO_2 [%]
	95.35	N139868	0.014	0.02
	200.5	N139905	0.020	0.01
	328	N140507	0.082	0.05
	411.4	N140546	0.038	0.02
	490	N140077	0.050	0.04
PAU-12-115	0	N140080	0.007	-0.01
	87	N140115	0.105	0.08
	192	N140151	0.017	0.11
	285	N140187	0.010	0.04
PAU-12-116	0	N140190	0.059	0.04
	360.7	N140225	0.009	0.01
	417	N140248	0.041	0.09
PAU-12-117	0	N140251	0.008	-0.01
	100.7	N140287	0.012	-0.01
	187.3	N140323	0.087	0.04
	261	N140354	0.079	0.03
	348.4	N140391	0.064	0.05
	402.5	N140411	0.064	0.05
PAU-12-118	6.1	N140414	0.006	-0.01
	108	N140454	0.206	0.19
	201	N140492	0.013	0.03
	306	N140583	0.008	0.07
	372.3	N140607	0.007	0.06
PAU-12-119	2.5	N140610	0.028	0.03
	109	N140649	0.017	0.02
	201	N140682	0.011	0.01
PAU-12-120	278.6	N140685	0.005	-0.01
	378	N140723	0.021	0.08
	405	N140733	0.011	0.05
PAU-12-121	12	N140736	0.008	0.06
	147	N140774	0.012	0.06
	245.3	N140811	0.066	0.11
	342	N140847	0.072	0.07
	423	N140880	0.063	0.05
PAU-12-122	2.4	N140883	0.007	-0.01
	99	N140922	0.046	0.03
	204	N140961	0.080	0.05

PAUL Project - 2012				
Hole Number	Depth [m]	Sample Number	Lab Value P_2O_5 [%]	Lab Value TiO_2 [%]
PAU-12-123	309	N141000	0.145	0.10
	339	N141013	0.054	0.04
	3.2	N141016	0.024	0.02
	102	N141055	0.007	0.02
	207	N141094	0.097	0.05
	303	N141133	0.082	0.05
	382	N141165	0.052	0.03

Table 11.3.8 Blank Values in the Paul Zone - 2012

In addition, four (4) standards were used to validate the analytical results. There were two certified standards, DC79003 and SY-4, one FER-1approved standard, and one in-house standard, PMRI10.

Certification of SY-4 Standard

SY-4 Standard was certified by CANMET in Ontario. It was used to check the values for P_2O_5 and TiO_2. The certified values are: 0.131% P_2O_5 and 0.287% TiO_2. Values obtained from the Laboratory analyses for this drilling campaign gave relative errors ranging between 0.763 and 4.58% for P_2O_5 and ranging from 1.045% to 5.923% TiO_2. See Tables 11.3.9 and 11.3.10 for details.

PAUL Project - 2011								
Hole	Depth	Sample	Theor. Value	Lab Value	Rel. Error	Theor. Value	Lab Value	Rel. Error
Number	[m]	Number	P_2O_5 [%]	P_2O_5 [%]	[%]	TiO_2 [%]	TiO_2 [%]	[%]
PAU-11-49	0	K338333	0.131	0.127	3.053	0.287	0.26	9.408
PAU-11-50	0	K338444	0.131	0.129	1.527	0.287	0.28	2.439
PAU-11-51	3	k338521	0.131	0.127	3.053	0.287	0.28	2.439
PAU-11-52	0	K338635	0.131	0.127	3.053	0.287	0.28	2.439
PAU-11-53	0	K338730	0.131	0.126	3.817	0.287	0.27	5.923
PAU-11-54	0	K338873	0.131	0.126	3.817	0.287	0.28	2.439
PAU-11-55	0	H900782	0.131	0.127	3.053	0.287	0.28	2.439
PAU-11-56	0	H900912	0.131	0.127	3.053	0.287	0.29	1.045
PAU-11-57	0	H901003	0.131	0.126	3.817	0.287	0.29	1.045
PAU-11-58	0	H901061	0.131	0.126	3.817	0.287	0.28	2.439
PAU-11-59	0	H901184	0.131	0.127	3.053	0.287	0.29	1.045
PAU-11-60	0	M072002	0.131	0.127	3.053	0.287	0.28	2.439
PAU-11-61	0	M072121	0.131	0.129	1.527	0.287	0.28	2.439
PAU-11-62	0	M072201	0.131	0.126	3.817	0.287	0.28	2.439
PAU-11-63	0	M072342	0.131	0.127	3.053	0.287	0.29	1.045
PAU-11-64	0	M072446	0.131	0.126	3.817	0.287	0.28	2.439
PAU-11-65	0	M073629	0.131	0.129	1.527	0.287	0.29	1.045
PAU-11-66	0	M073780	0.131	0.128	2.290	0.287	0.29	1.045

Table 11.3.9 Values of SY-4 Standard for Paul Zone – 2011

PAUL Project - 2012								
Hole	Depth	Sample	Theor. Value	Lab Value	Rel. Error	Theor. Value	Lab Value	Rel. Error
Number	[m]	Number	P_2O_5 [%]	P_2O_5 [%]	[%]	TiO_2 [%]	TiO_2 [%]	[%]
PAU-12-67	0	M073932	0.131	0.127	3.053	0.287	0.28	2.439
PAU-12-68	0	M074101	0.131	0.129	1.527	0.287	0.28	2.439
PAU-12-69	0	M074263	0.131	0.126	3.817	0.287	0.28	2.439
PAU-12-70	250	M074372	0.131	0.128	2.290	0.287	0.28	2.439
PAU-12-71	0	M074429	0.131	0.126	3.817	0.287	0.28	2.439
PAU-12-72	0	M074585	0.131	0.129	1.527	0.287	0.28	2.439

PAUL Project - 2012								
Hole Number	Depth [m]	Sample Number	Theor. Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Theor. Value TiO_2 [%]	Lab Value TiO_2 [%]	Rel. Error [%]
PAU-12-73	0	M074721	0.131	0.127	3.053	0.287	0.25	12.892
PAU-12-74	0	M074861	0.131	0.127	3.053	0.287	0.28	2.439
PAU-12-75	0	M074922	0.131	0.127	3.053	0.287	0.28	2.439
PAU-12-76	0	M074976	0.131	0.126	3.817	0.287	0.29	1.045
PAU-12-77	0	M054010	0.131	0.127	3.053	0.287	0.29	1.045
PAU-12-78	0	M054092	0.131	0.127	3.053	0.287	0.28	2.439
PAU-12-79	0	M054154	0.131	0.126	3.817	0.287	0.29	1.045
PAU-12-80	0	M054194	0.131	0.127	3.053	0.287	0.29	1.045
PAU-12-81	0	M054286	0.131	0.129	1.527	0.287	0.28	2.439
PAU-12-82	0	M054416	0.131	0.126	3.817	0.287	0.29	1.045
PAU-12-83	0	M055012	0.131	0.132	0.763	0.287	0.27	5.923
PAU-12-84	0	M055199	0.131	0.127	3.053	0.287	0.28	2.439
PAU-12-85	0	M055327	0.131	0.126	3.817	0.287	0.30	4.530
PAU-12-86	0	M055410	0.131	0.132	0.763	0.287	0.30	4.530
PAU-12-87	0	M055502	0.131	0.135	3.053	0.287	0.28	2.439
PAU-12-88	0	M055569	0.131	0.131	0.000	0.287	0.30	4.530
PAU-12-89	0	M055660	0.131	0.132	0.763	0.287	0.30	4.530
PAU-12-90	0	M055735	0.131	0.127	3.053	0.287	0.30	4.530
PAU-12-91	0	M055817	0.131	0.13	0.763	0.287	0.29	1.045
PAU-12-92	0	M055909	0.131	0.127	3.053	0.287	0.29	1.045
PAU-12-94	0	M056083	0.131	0.132	0.763	0.287	0.30	4.530
PAU-12-95	0	M056186	0.131	0.133	1.527	0.287	0.30	4.530
PAU-12-96	0	M056287	0.131	0.126	3.817	0.287	0.28	2.439
PAU-12-97	0	M056437	0.131	0.127	3.053	0.287	0.29	1.045
PAU-12-98	3	m056652	0.131	0.128	2.290	0.287	0.28	2.439
PAU-12-99	6	M056802	0.131	0.126	3.817	0.287	0.29	1.045
PAU-12-100	4	N138074	0.131	0.126	3.817	0.287	0.29	1.045
PAU-12-77	0	M054010	0.131	0.127	3.053	0.287	0.29	1.045
PAU-12-78	0	M054092	0.131	0.127	3.053	0.287	0.28	2.439
PAU-12-79	0	M054154	0.131	0.126	3.817	0.287	0.29	1.045

PAUL Project - 2012								
Hole Number	Depth [m]	Sample Number	Theor. Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Theor. Value TiO_2 [%]	Lab Value TiO_2 [%]	Rel. Error [%]
PAU-12-80	0	M054194	0.131	0.127	3.053	0.287	0.29	1.045
PAU-12-81	0	M054286	0.131	0.129	1.527	0.287	0.28	2.439
PAU-12-82	0	M054416	0.131	0.126	3.817	0.287	0.29	1.045
PAU-12-83	0	M055012	0.131	0.132	0.763	0.287	0.27	5.923
PAU-12-84	0	M055199	0.131	0.127	3.053	0.287	0.28	2.439
PAU-12-85	0	M055327	0.131	0.126	3.817	0.287	0.30	4.530
PAU-12-86	0	M055410	0.131	0.132	0.763	0.287	0.30	4.530
PAU-12-87	0	M055502	0.131	0.135	3.053	0.287	0.28	2.439
PAU-12-88	0	M055569	0.131	0.131	0.000	0.287	0.3	4.530
PAU-12-89	0	M055660	0.131	0.132	0.763	0.287	0.3	4.530
PAU-12-90	0	M055735	0.131	0.127	3.053	0.287	0.3	4.530
PAU-12-91	0	M055817	0.131	0.13	0.763	0.287	0.29	1.045
PAU-12-92	0	M055909	0.131	0.127	3.053	0.287	0.29	1.045
PAU-12-94	0	M056083	0.131	0.132	0.763	0.287	0.3	4.530
PAU-12-95	0	M056186	0.131	0.133	1.527	0.287	0.3	4.530
PAU-12-96	0	M056287	0.131	0.126	3.817	0.287	0.28	2.439
PAU-12-97	0	M056437	0.131	0.127	3.053	0.287	0.29	1.045
PAU-12-98	3	M056652	0.131	0.128	2.290	0.287	0.28	2.439
PAU-12-99	6	M056802	0.131	0.126	3.817	0.287	0.29	1.045
PAU-12-100	4	N138074	0.131	0.126	3.817	0.287	0.29	1.045
PAU-12-101	429	N138257	0.131	0.126	3.817	0.287	0.28	2.439
PAU-12-102	6	N138302	0.131	0.129	1.527	0.287	0.29	1.045
PAU-12-103	3.5	N138413	0.131	0.128	2.290	0.287	0.29	1.045
PAU-12-104	5.5	N138468	0.131	0.129	1.527	0.287	0.29	1.045
PAU-12-105	0	N138621	0.131	0.127	3.053	0.287	0.28	2.439
PAU-12-106	0	N138793	0.131	0.126	3.817	0.287	0.28	2.439
PAU-12-107	3	N138947	0.131	0.126	3.817	0.287	0.28	2.439
PAU-12-108	3	N139061	0.131	0.126	3.817	0.287	0.28	2.439
PAU-12-109	3	N139117	0.131	0.127	3.053	0.287	0.28	2.439
PAU-12-110	9	N139287	0.131	0.129	1.527	0.287	0.29	1.045

PAUL Project - 2012								
Hole Number	Depth [m]	Sample Number	Theor. Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Theor. Value TiO_2 [%]	Lab Value TiO_2 [%]	Rel. Error [%]
PAU-12-111	4.9	N139374	0.131	0.125	4.580	0.287	0.3	4.530
PAU-12-112	4.3	N139499	0.131	0.127	3.053	0.287	0.29	1.045
PAU-12-113	3.8	N139656	0.131	0.128	2.290	0.287	0.29	1.045
PAU-12-114	0	N139831	0.131	0.128	2.290	0.287	0.28	2.439
PAU-12-115	0	N140079	0.131	0.128	2.290	0.287	0.29	1.045
PAU-12-116	0	N140189	0.131	0.126	3.817	0.287	0.28	2.439
PAU-12-117	0	N140250	0.131	0.128	2.290	0.287	0.28	2.439
PAU-12-118	6.1	N140413	0.131	0.129	1.527	0.287	0.28	2.439
PAU-12-119	2.5	N140609	0.131	0.129	1.527	0.287	0.28	2.439
PAU-12-120	278.6	N140684	0.131	0.128	2.290	0.287	0.28	2.439
PAU-12-121	12	N140735	0.131	0.127	3.053	0.287	0.29	1.045
PAU-12-122	2.4	N140882	0.131	0.126	3.817	0.287	0.28	2.439
PAU-12-123	3.2	N141015	0.131	0.126	3.817	0.287	0.28	2.439

Table 11.3.10 Values of SY-4 Standard for Paul Zone – 2012

Certification of the DC79003 Standard

The other certified standard, DC79003, was only valid for P_2O_5 analysis. It was certified by the China National Analysis Center for Iron and Steel. The standard value was 6.06% P_2O_5. Values obtained from laboratory tests showed an absolute relative error ranging between 0.132% and 6.815% P_2O_5. TiO_2 values obtained in the laboratory ranged from 0.440% to 0.510% as shown in Tables 11.3.11 and 11.3.12.

PAUL Project - 2011						
Hole Number	Depth [m]	Sample Number	Theor. Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Lab Value TiO_2 [%]
PAU-11-49	0	K338332	6.06	5.781	4.604	0.44
PAU-11-50	0	K338443	6.06	5.778	4.653	0.48
PAU-11-51	3	k338520	6.06	5.794	4.389	0.48
PAU-11-52	0	K338634	6.06	5.680	6.271	0.48
PAU-11-53	0	K338729	6.06	5.775	4.703	0.47
PAU-11-54	0	K338872	6.06	5.798	4.323	0.48
PAU-11-55	0	H900781	6.06	5.786	4.521	0.48
PAU-11-56	0	H900911	6.06	5.780	4.620	0.49
PAU-11-57	0	H901002	6.06	5.754	5.050	0.48
PAU-11-58	0	H901060	6.06	5.783	4.571	0.48
PAU-11-59	0	H901183	6.06	5.785	4.538	0.49
PAU-11-60	0	M072001	6.06	5.789	4.472	0.48
PAU-11-61	0	M072120	6.06	5.788	4.488	0.48
PAU-11-62	0	M072200	6.06	5.761	4.934	0.48
PAU-11-63	0	M072341	6.06	5.784	4.554	0.48
PAU-11-64	0	M072445	6.06	5.800	4.290	0.48
PAU-11-65	0	M073628	6.06	5.806	4.191	0.48
PAU-11-66	0	M073779	6.06	5.786	4.521	0.48

Table 11.3.11 Values of DC79003 Standard for Paul Zone – 2011

PAUL Project - 2012						
Hole Number	Depth [m]	Sample Number	Theor.Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel Error [%]	Lab Value TiO_2 [%]
PAU-12-67	0	M073931	6.06	5.785	4.538	0.48
PAU-12-68	0	M074100	6.06	5.763	4.901	0.48
PAU-12-69	0	M074262	6.06	5.747	5.165	0.48
PAU-12-70	250	M074371	6.06	5.742	5.248	0.48
PAU-12-71	0	M074428	6.06	5.760	4.950	0.48
PAU-12-72	0	M074584	6.06	5.713	5.726	0.49
PAU-12-73	0	M074720	6.06	5.903	2.591	0.47
PAU-12-74	0	M074860	6.06	5.781	4.604	0.48

PAUL Project - 2012						
Hole Number	**Depth [m]**	**Sample Number**	**Theor.Value P_2O_5 [%]**	**Lab Value P_2O_5 [%]**	**Rel Error [%]**	**Lab Value TiO_2 [%]**
PAU-12-75	0	M074921	6.06	5.784	4.554	0.48
PAU-12-76	0	M074975	6.06	5.788	4.488	0.49
PAU-12-77	0	M054009	6.06	5.781	4.604	0.49
PAU-12-78	0	M054091	6.06	5.780	4.620	0.48
PAU-12-79	0	M054153	6.06	5.676	6.337	0.48
PAU-12-80	0	M054193	6.06	5.780	4.620	0.49
PAU-12-81	0	M054285	6.06	5.647	6.815	0.48
PAU-12-82	0	M054415	6.06	5.680	6.271	0.48
PAU-12-83	0	M055011	6.06	6.195	2.228	0.47
PAU-12-84	0	M055198	6.06	5.939	1.997	0.47
PAU-12-87	0	M055501	6.06	6.142	1.353	0.46
PAU-12-88	0	M055568	6.06	6.194	2.211	0.48
PAU-12-89	0	M055659	6.06	6.153	1.535	0.49
PAU-12-90	0	M055734	6.06	6.068	0.132	0.51
PAU-12-91	0	M055816	6.06	6.140	1.320	0.49
PAU-12-92	0	M055908	6.06	6.101	0.677	0.47
PAU-12-92	36	M055922	6.06	6.060	0.000	0.47
PAU-12-93	0	M056004	6.06	5.923	2.261	0.47
PAU-12-94	0	M056082	6.06	6.092	0.528	0.48
PAU-12-95	0	M056185	6.06	6.121	1.007	0.49
PAU-12-96	0	M056286	6.06	5.742	5.248	0.48
PAU-12-97	0	M056436	6.06	5.779	4.637	0.48
PAU-12-98	0	m056651	6.06	5.733	5.396	0.48
PAU-12-99	0	M056801	6.06	5.700	5.941	0.48
PAU-12-100	0	N138073	6.06	5.818	3.993	0.48
PAU-12-101	429	N138256	6.06	5.685	6.188	0.48
PAU-12-102	0	N138301	6.06	5.688	6.139	0.49
PAU-12-103	0	N138412	6.06	5.697	5.990	0.48
PAU-12-104	0	N138467	6.06	5.679	6.287	0.48
PAU-12-105	0	N138620	6.06	5.695	6.023	0.48
PAU-12-106	0	N138792	6.06	5.683	6.221	0.48

PAUL Project - 2012						
Hole Number	Depth [m]	Sample Number	Theor.Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel Error [%]	Lab Value TiO_2 [%]
PAU-12-107	0	N138946	6.06	5.801	4.274	0.49
PAU-12-108	0	N139060	6.06	5.679	6.287	0.48
PAU-12-109	0	N139116	6.06	5.790	4.455	0.48
PAU-12-110	0	N139286	6.06	5.802	4.257	0.48
PAU-12-111	0	N139373	6.06	5.910	2.475	0.50
PAU-12-112	0	N139498	6.06	5.749	5.132	0.48
PAU-12-113	0	N139655	6.06	5.675	6.353	0.49
PAU-12-114	0	N139830	6.06	5.688	6.139	0.49
PAU-12-115	0	N140078	6.06	5.688	6.139	0.49
PAU-12-116	0	N140188	6.06	5.687	6.155	0.48
PAU-12-117	0	N140249	6.06	5.695	6.023	0.48
PAU-12-118	0	N140412	6.06	5.746	5.182	0.48
PAU-12-119	0	N140608	6.06	5.678	6.304	0.49
PAU-12-120	278.6	N140683	6.06	5.693	6.056	0.48
PAU-12-121	0	N140734	6.06	5.743	5.231	0.49
PAU-12-122	0	N140881	6.06	5.797	4.340	0.48
PAU-12-123	0	N141014	6.06	5.864	3.234	0.48

Table 11.3.12 Values of DC79003 Standard for Paul Zone – 2012

Certification of SARM-39 Standard

SARM-39 Standard was prepared by MINTEK and is used was reference material by the Geological Survey of Canada. The standard values were: 1.46% P_2O_5 and 1.58% TiO_2. Results of laboratory tests showed absolute errors ranging from 0.068% to 5.08% in P_2O_5 and 0.000% to 5.063% TiO_2 as shown in Tables 11.3.13 and 11.3.14.

PAUL Project - 2011								
Hole Number	Depth [m]	Sample Number	Theor.Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Theor.Value TiO_2 [%]	Lab Value TiO_2 [%]	Rel. Error [%]
PAU-11-49	69	K338361	1.46	1.433	1.8493	1.58	1.61	1.899
	170.95	K338400	1.46	1.433	1.8493	1.58	1.60	1.266
	270	K338438	1.46	1.432	1.9178	1.58	1.59	0.633
PAU-11-50	72	K338471	1.46	1.429	2.1233	1.58	1.61	1.899
	163.5	K338510	1.46	1.429	2.1233	1.58	1.60	1.266
PAU-11-51	69	k338549	1.46	1.430	2.0548	1.58	1.60	1.266
	168	k338588	1.46	1.430	2.0548	1.58	1.60	1.266
	267	k338625	1.46	1.433	1.8493	1.58	1.60	1.266
PAU-11-52	72	K338661	1.46	1.430	2.0548	1.58	1.59	0.633
	166.8	K338701	1.46	1.436	1.6438	1.58	1.59	0.633
PAU-11-53	75	K338757	1.46	1.421	2.6712	1.58	1.61	1.899
	171.25	K338794	1.46	1.434	1.7808	1.58	1.60	1.266
	263.3	K338833	1.46	1.429	2.1233	1.58	1.6	1.266
PAU-11-54	72	K338899	1.46	1.430	2.0548	1.58	1.61	1.899
	186.3	K338938	1.46	1.436	1.6438	1.58	1.61	1.899
	282.3	H900725	1.46	1.429	2.1233	1.58	1.61	1.899
	384	H900763	1.46	1.436	1.6438	1.58	1.61	1.899
PAU-11-55	87	H900810	1.46	1.386	5.0685	1.58	1.61	1.899
	186.2	H900849	1.46	1.429	2.1233	1.58	1.60	1.266
	294	H900888	1.46	1.426	2.3288	1.58	1.60	1.266
PAU-11-56	75	H900939	1.46	1.429	2.1233	1.58	1.59	0.633
	183	H900977	1.46	1.430	2.0548	1.58	1.61	1.899
PAU-11-57	80.7	H901031	1.46	1.429	2.1233	1.58	1.61	1.899
PAU-11-58	69	H901088	1.46	1.426	2.3288	1.58	1.59	0.633
	163.7	H901125	1.46	1.429	2.1233	1.58	1.61	1.899

PAUL Project - 2011								
Hole Number	Depth [m]	Sample Number	Theor.Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Theor.Value TiO_2 [%]	Lab Value TiO_2 [%]	Rel. Error [%]
	266.8	H901164	1.46	1.429	2.1233	1.58	1.60	1.266
PAU-11-59	69	H901211	1.46	1.430	2.0548	1.58	1.61	1.899
	174	H901250	1.46	1.729	1.4247	1.58	1.61	1.899
	271.3	H901290	1.46	1.430	2.0548	1.58	1.59	0.633
PAU-11-60	72	M072029	1.46	1.435	1.7123	1.58	1.61	1.899
	180	M072069	1.46	1.432	1.9178	1.58	1.59	0.633
	293.9	M072112	1.46	1.425	2.3973	1.58	1.60	1.266
PAU-11-61	63	M072151	1.46	1.429	2.1233	1.58	1.61	1.899
PAU-11-62	67	M072229	1.46	1.430	2.0548	1.58	1.59	0.633
	168	M072268	1.46	1.435	1.7123	1.58	1.59	0.633
	270	M072308	1.46	1.429	2.1233	1.58	1.60	1.266
PAU-11-63	72	M072371	1.46	1.436	1.6438	1.58	1.60	1.266
PAU-11-63	177	M072410	1.46	1.434	1.7808	1.58	1.61	1.899
PAU-11-64	78	M072474	1.46	1.429	2.1233	1.58	1.59	0.633
	177	M072513	1.46	1.432	1.9178	1.58	1.59	0.633
	282	M072552	1.46	1.436	1.6438	1.58	1.61	1.899
	390	M072592	1.46	1.429	2.1233	1.58	1.60	1.266
PAU-11-65	87	M073660	1.46	1.432	1.9178	1.58	1.61	1.899
	207	M073705	1.46	1.429	2.1233	1.58	1.6	1.266
	327	M073745	1.46	1.434	1.7808	1.58	1.61	1.899
PAU-11-66	81	M073807	1.46	1.437	1.5753	1.58	1.61	1.899
	189	M073846	1.46	1.434	1.7808	1.58	1.61	1.899
	300	M073889	1.46	1.434	1.7808	1.58	1.61	1.899
	411	M073927	1.46	1.437	1.5753	1.58	1.60	1.266

Table 11.3.13 Values of SARM-39 Standard for Paul Zone – 2011

PAUL Project - 2012								
Hole Number	Depth [m]	Sample Number	Theo. Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Theor. Value TiO_2 [%]	Lab Value TiO_2 [%]	Rel. Error [%]
PAU-12-67	68.7	M073958	1.46	1.436	1.644	1.58	1.61	1.899
	152.5	M073995	1.46	1.436	1.644	1.58	1.61	1.899
	261	M074030	1.46	1.431	1.986	1.58	1.60	1.266
	347	M074065	1.46	1.444	1.096	1.58	1.61	1.899
PAU-12-68	68.2	M074126	1.46	1.434	1.781	1.58	1.61	1.899
	153	M074161	1.46	1.436	1.644	1.58	1.59	0.633
	246	M074198	1.46	1.435	1.712	1.58	1.61	1.899
	336	M074233	1.46	1.430	2.055	1.58	1.61	1.899
PAU-12-69	68.4	M074288	1.46	1.435	1.712	1.58	1.60	1.266
	150	M074326	1.46	1.433	1.849	1.58	1.61	1.899
	240	M074363	1.46	1.436	1.644	1.58	1.60	1.266
PAU-12-70	306	M074396	1.46	1.430	2.055	1.58	1.59	0.633
PAU-12-71	66	M074454	1.46	1.433	1.849	1.58	1.61	1.899
	158	M074491	1.46	1.435	1.712	1.58	1.60	1.266
	267	M074526	1.46	1.436	1.644	1.58	1.61	1.899
	360	M074561	1.46	1.430	2.055	1.58	1.60	1.266
PAU-12-72	69	M074610	1.46	1.429	2.123	1.58	1.59	0.633
	165	M074645	1.46	1.435	1.712	1.58	1.61	1.899
	262	M074682	1.46	1.433	1.885	1.58	1.61	1.899
	342	M074716	1.46	1.435	1.712	1.58	1.61	1.899
PAU-12-73	60	M074744	1.46	1.430	2.055	1.58	1.59	0.633
	147	M074781	1.46	1.430	2.055	1.58	1.61	1.899
PAU-12-73	234	M074817	1.46	1.428	2.192	1.58	1.61	1.899
PAU-12-74	63.8	M074887	1.46	1.434	1.781	1.58	1.60	1.266
PAU-12-75	62	M074945	1.46	1.429	2.123	1.58	1.61	1.899
PAU-12-76	68	M075000	1.46	1.431	1.986	1.58	1.60	1.266
PAU-12-77	73	M054034	1.46	1.429	2.123	1.58	1.60	1.266
	183	M054069	1.46	1.433	1.849	1.58	1.60	1.266
PAU-12-78	81	M054118	1.46	1.424	2.466	1.58	1.61	1.899
PAU-12-79	54	M054178	1.46	1.435	1.712	1.58	1.61	1.899

PAUL Project - 2012								
Hole Number	Depth [m]	Sample Number	Theo. Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Theor. Value TiO_2 [%]	Lab Value TiO_2 [%]	Rel. Error [%]
PAU-12-80	159	M054219	1.46	1.434	1.781	1.58	1.60	1.266
	291.3	M054256	1.46	1.432	1.918	1.58	1.60	1.266
PAU-12-81	60	M054310	1.46	1.430	2.055	1.58	1.60	1.266
	141	M054344	1.46	1.430	2.055	1.58	1.61	1.899
	217	M054381	1.46	1.433	1.849	1.58	1.61	1.899
PAU-12-82	60	M054441	1.46	1.434	1.781	1.58	1.61	1.899
PAU-12-83	66	M055036	1.46	1.476	1.096	1.58	1.62	2.532
	181.7	M055071	1.46	1.464	0.274	1.58	1.58	0.000
	272.5	M055106	1.46	1.455	0.342	1.58	1.61	1.899
	354.4	M055142	1.46	1.419	2.808	1.58	1.57	0.633
	436	M055179	1.46	1.439	1.438	1.58	1.57	0.633
PAU-12-84	70.6	M055226	1.46	1.451	0.616	1.58	1.56	1.266
	150	M055262	1.46	1.439	1.438	1.58	1.58	0.000
	235.2	M055298	1.46	1.454	0.411	1.58	1.59	0.633
PAU-12-85	66	M055350	1.46	1.445	1.027	1.58	1.57	0.633
	144	M055384	1.46	1.453	0.479	1.58	1.62	2.532
PAU-12-86	70.2	M055435	1.46	1.428	2.192	1.58	1.57	0.633
	145	M055472	1.46	1.487	1.849	1.58	1.62	2.532
PAU-12-87	60	M055526	1.46	1.475	1.027	1.58	1.61	1.899
	135.3	M055561	1.46	1.481	1.438	1.58	1.58	0.000
PAU-12-88	58.6	M055594	1.46	1.479	1.301	1.58	1.61	1.899
	130.7	M055630	1.46	1.435	1.712	1.58	1.61	1.899
PAU-12-89	69.8	M055686	1.46	1.473	0.890	1.58	1.66	5.063
	148	M055721	1.46	1.446	0.959	1.58	1.58	0.000
PAU-12-90	84	M055765	1.46	1.459	0.068	1.58	1.62	2.532
	165	M055800	1.46	1.455	0.342	1.58	1.59	0.633
PAU-12-91	66	M055841	1.46	1.445	1.027	1.58	1.55	1.899
	152	M055876	1.46	1.477	1.164	1.58	1.63	3.165
PAU-12-92	63	M055934	1.46	1.455	0.342	1.58	1.59	0.633
	147	M055969	1.46	1.461	0.068	1.58	1.60	1.266

PAUL Project - 2012								
Hole Number	Depth [m]	Sample Number	Theo. Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Theor. Value TiO_2 [%]	Lab Value TiO_2 [%]	Rel. Error [%]
PAU-12-94	55.7	M056106	1.46	1.490	2.055	1.58	1.63	3.165
	147	M056143	1.46	1.453	0.479	1.58	1.61	1.899
	231	M056179	1.46	1.446	0.959	1.58	1.64	3.797
PAU-12-95	63	M056211	1.46	1.462	0.137	1.58	1.62	2.532
	141	M056247	1.46	1.455	0.342	1.58	1.62	2.532
PAU-12-96	82.6	M056313	1.46	1.430	2.055	1.58	1.60	1.266
	177	M056350	1.46	1.433	1.849	1.58	1.59	0.633
	253.6	M056386	1.46	1.430	2.055	1.58	1.61	1.899
	339	M056423	1.46	1.446	0.959	1.58	1.61	1.899
PAU-12-97	58.2	M056462	1.46	1.429	2.123	1.58	1.61	1.899
	159	M056500	1.46	1.428	2.192	1.58	1.62	2.532
	243	M056536	1.46	1.429	2.123	1.58	1.61	1.899
	315	M056572	1.46	1.427	2.260	1.58	1.60	1.266
	399	M056607	1.46	1.437	1.575	1.58	1.63	3.165
PAU-12-98	63	m056680	1.46	1.433	1.849	1.58	1.59	0.633
	174.4	m056718	1.46	1.435	1.712	1.58	1.59	0.633
	297	m056759	1.46	1.430	2.055	1.58	1.60	1.266
	384	m056793	1.46	1.435	1.712	1.58	1.61	1.899
PAU-12-99	72	M056828	1.46	1.430	2.055	1.58	1.61	1.899
	147	M056861	1.46	1.436	1.644	1.58	1.60	1.266
	237	M056897	1.46	1.429	2.123	1.58	1.61	1.899
	244.5	N138001	1.46	1.433	1.849	1.58	1.59	0.633
	342	N138040	1.46	1.432	1.918	1.58	1.60	1.266
PAU-12-100	72	N138287	1.46	1.428	2.192	1.58	1.60	1.266
	111	N138100	1.46	1.423	2.534	1.58	1.62	2.532
	201	N138138	1.46	1.434	1.781	1.58	1.61	1.899
	300	N138176	1.46	1.434	1.781	1.58	1.59	0.633
	395.5	N138213	1.46	1.423	2.534	1.58	1.61	1.899
	487.7	N138250	1.46	1.433	1.849	1.58	1.62	2.532
PAU-12-102	93	N138328	1.46	1.435	1.712	1.58	1.61	1.899

PAUL Project - 2012								
Hole Number	Depth [m]	Sample Number	Theo. Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Theor. Value TiO_2 [%]	Lab Value TiO_2 [%]	Rel. Error [%]
	192	N138366	1.46	1.436	1.644	1.58	1.60	1.266
	298	N138404	1.46	1.433	1.849	1.58	1.61	1.899
PAU-12-103	66	N138439	1.46	1.435	1.712	1.58	1.61	1.899
PAU-12-104	57.3	N138493	1.46	1.430	2.055	1.58	1.60	1.266
	151.5	N138529	1.46	1.432	1.918	1.58	1.61	1.899
	246	N138566	1.46	1.429	2.123	1.58	1.59	0.633
	351	N138605	1.46	1.433	1.849	1.58	1.61	1.899
PAU-12-105	66	N138646	1.46	1.430	2.055	1.58	1.61	1.899
	189	N138683	1.46	1.429	2.123	1.58	1.59	0.633
	283	N138720	1.46	1.436	1.644	1.58	1.61	1.899
	375	N138757	1.46	1.435	1.712	1.58	1.60	1.266
PAU-12-106	81	N138818	1.46	1.429	2.123	1.58	1.61	1.899
	177	N138854	1.46	1.431	1.986	1.58	1.59	0.633
	276.2	N138890	1.46	1.429	2.123	1.58	1.59	0.633
	361.8	N138928	1.46	1.430	2.055	1.58	1.61	1.899
PAU-12-107	66	N138972	1.46	1.427	2.260	1.58	1.59	0.633
PAU-12-107	162	N139010	1.46	1.429	2.123	1.58	1.61	1.899
	258	N139049	1.46	1.428	2.192	1.58	1.61	1.899
PAU-12-108	84	N139091	1.46	1.436	1.644	1.58	1.61	1.899
PAU-12-109	75	N139145	1.46	1.436	1.644	1.58	1.61	1.899
	183	N139183	1.46	1.433	1.849	1.58	1.61	1.899
	288	N139222	1.46	1.432	1.918	1.58	1.60	1.266
	387	N139260	1.46	1.431	1.986	1.58	1.61	1.899
PAU-12-110	78	N139313	1.46	1.438	1.507	1.58	1.65	4.430
	183	N139353	1.46	1.443	1.164	1.58	1.61	1.899
PAU-12-111	69	N139400	1.46	1.435	1.712	1.58	1.61	1.899
	177	N139439	1.46	1.441	1.301	1.58	1.63	3.165
	279	N139478	1.46	1.439	1.438	1.58	1.61	1.899
PAU-12-112	75	N139526	1.46	1.431	1.986	1.58	1.61	1.899
	183	N139565	1.46	1.429	2.123	1.58	1.61	1.899

PAUL Project - 2012								
Hole Number	Depth [m]	Sample Number	Theo. Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Theor. Value TiO_2 [%]	Lab Value TiO_2 [%]	Rel. Error [%]
	291	N139604	1.46	1.436	1.644	1.58	1.61	1.899
	390.7	N139643	1.46	1.433	1.849	1.58	1.59	0.633
PAU-12-113	84	N139684	1.46	1.431	1.986	1.58	1.59	0.633
	177	N139723	1.46	1.430	2.055	1.58	1.60	1.266
	276	N139763	1.46	1.436	1.644	1.58	1.59	0.633
	372	N139802	1.46	1.435	1.712	1.58	1.59	0.633
PAU-12-114	63	N139856	1.46	1.432	1.918	1.58	1.61	1.899
	165	N139892	1.46	1.433	1.849	1.58	1.60	1.266
	297	N139944	1.46	1.428	2.192	1.58	1.59	0.633
	385.3	N140533	1.46	1.430	2.055	1.58	1.61	1.899
	477	N140070	1.46	1.433	1.849	1.58	1.61	1.899
PAU-12-115	57	N140103	1.46	1.429	2.123	1.58	1.61	1.899
	159	N140139	1.46	1.432	1.918	1.58	1.60	1.266
	253.5	N140175	1.46	1.430	2.055	1.58	1.61	1.899
PAU-12-116	333	N140213	1.46	1.434	1.781	1.58	1.61	1.899
PAU-12-117	69	N140275	1.46	1.426	2.329	1.58	1.59	0.633
	156	N140311	1.46	1.431	1.986	1.58	1.58	0.000
	240	N140344	1.46	1.430	2.055	1.58	1.60	1.266
	312.9	N140378	1.46	1.435	1.712	1.58	1.59	0.633
PAU-12-118	77.9	N140442	1.46	1.431	1.986	1.58	1.61	1.899
	168	N140479	1.46	1.427	2.260	1.58	1.61	1.899
	270	N140569	1.46	1.431	1.986	1.58	1.60	1.266
PAU-12-119	73	N140636	1.46	1.432	1.918	1.58	1.59	0.633
	185.9	N140675	1.46	1.432	1.918	1.58	1.61	1.899
PAU-12-120	353.7	N140712	1.46	1.432	1.918	1.58	1.60	1.266
PAU-12-121	114	N140762	1.46	1.436	1.644	1.58	1.61	1.899
	213	N140798	1.46	1.430	2.055	1.58	1.60	1.266
	309	N140835	1.46	1.432	1.918	1.58	1.61	1.899
PAU-12-121	405	N140873	1.46	1.430	2.055	1.58	1.61	1.899
PAU-12-122	63	N140909	1.46	1.431	1.986	1.58	1.58	0.000

PAUL Project - 2012								
Hole Number	Depth [m]	Sample Number	Theo. Value P_2O_5 [%]	Lab Value P_2O_5 [%]	Rel. Error [%]	Theor. Value TiO_2 [%]	Lab Value TiO_2 [%]	Rel. Error [%]
PAU-12-123	168	N140948	1.46	1.432	1.918	1.58	1.60	1.266
	265.6	N140988	1.46	1.435	1.712	1.58	1.58	0.000
	69.6	N141042	1.46	1.425	2.397	1.58	1.59	0.633
	172	N141081	1.46	1.435	1.712	1.58	1.61	1.899
	272.5	N141120	1.46	1.434	1.781	1.58	1.60	1.266
	366	N141159	1.46	1.431	1.986	1.58	1.59	0.633

Table 11.3.14 Values of SARM-39 Standard for Paul Zone – 2012

In order to validate the analytical results provided by ALS Chemex Laboratory, Arianne's geologists introduced 265 standards and blanks across the sampling sequence; this validation process took place in the sampling campaign following PAU-12-123.

Certification of blanks

Blanks in this drilling campaign were made of calcite aggregates used for landscaping. The 30kg bags were purchased at hardware stores such as *Rona, Potvin & Bouchard,* etc. These rocks did not have enrichment in P_2O_5 and TiO_2 of which we are aware. The P_2O_5 and TiO_2 values are shown in Table 11.3.15. P_2O_5 varies from 0.008% to 0.375% whereas the TiO_2 varies from 0.01% to 0.29%.

Hole No.	Depth	Sample Nº	P_2O_5 (%)	TiO_2 (%)
PAU-12-124	0	N141460	0.024	0.01
PAU-12-124	117	N141500	0.023	0.01
PAU-12-124	168	N141518	0.022	0.03
PAU-12-125	0	N141521	0.012	0.01
PAU-12-125	129	N141560	0.112	0.08
PAU-12-125	196	N141582	0.060	0.06
PAU-12-126	83.4	N141585	0.008	0.01
PAU-12-126	150	N141601	0.026	0.01
PAU-12-127	0	N141605	0.027	0.01
PAU-12-127	204	N141646	0.026	0.01
PAU-12-127	312	N141686	0.132	0.08
PAU-12-128	0	N141689	0.068	0.05
PAU-12-128	159	N141729	0.020	0.03

Hole No.	Depth	Sample Nº	P_2O_5 (%)	TiO_2 (%)
PAU-12-128	267	N141768	0.025	0.06
PAU-12-128	338	N141792	0.048	0.06
PAU-12-129	201	N141795	0.009	0.01
PAU-12-129	312	N141835	0.030	0.01
PAU-12-129	345	N141848	0.030	0.01
PAU-12-130	0	N141851	0.012	0.01
PAU-12-130	280.5	N141891	0.023	0.10
PAU-12-130	351	N141912	0.175	0.10
PAU-12-131	0	N141915	0.011	0.01
PAU-12-131	216	N142004	0.057	0.05
PAU-12-131	327.4	N142044	0.065	0.03
PAU-12-132	0	N142047	0.183	0.04
PAU-12-132	114	N142087	0.034	0.01
PAU-12-132	223	N142125	0.080	0.03
PAU-12-132	291	N142152	0.067	0.03
PAU-12-133	0	N142155	0.011	0.01
PAU-12-133	108	N142195	0.032	0.01
PAU-12-133	216	N142235	0.026	0.01
PAU-12-133	279	N142259	0.053	0.01
PAU-12-134	0	N142262	0.013	0.01
PAU-12-134	111	N142300	0.025	0.01
PAU-12-134	211.3	N142340	0.018	0.01
PAU-12-134	265	N142350	0.020	0.01
PAU-12-135	0	N142353	0.01	0.01
PAU-12-135	177	N142392	0.073	0.05
PAU-12-135	306	N142430	0.078	0.05
PAU-12-135	351	N142447	0.150	0.11
PAU-12-136	0	N142450	0.009	0.01
PAU-12-136	156	N142486	0.014	0.02
PAU-12-136	195	N142500	0.157	0.16
PAU-12-136	297	N142537	0.123	0.08
PAU-12-136	360	N142560	0.105	0.10
PAU-12-137	0	N142563	0.010	0.01

Hole No.	Depth	Sample Nº	P_2O_5 (%)	TiO_2 (%)
PAU-12-137	181.9	N142602	0.012	0.09
PAU-12-137	285	N142640	0.009	0.06
PAU-12-137	360	N142668	0.010	0.03
PAU-12-138	0	N142671	0.027	0.11
PAU-12-138	102	N142704	0.012	0.05
PAU-12-139	0	N142707	0.010	0.01
PAU-12-139	117	N142746	0.045	0.02
PAU-12-139	402	N142782	0.050	0.02
PAU-12-140	0	N142785	0.039	0.01
PAU-12-140	266.6	N142824	0.024	0.01
PAU-12-140	379.5	P292112	0.079	0.07
PAU-12-140	408	P292123	0.150	0.09
PAU-12-141	0	P292147	0.021	0.01
PAU-12-141	225	P292184	0.131	0.14
PAU-12-141	330	P292222	0.035	0.01
PAU-12-141	382	P292243	0.112	0.10
PAU-12-142	0	P292246	0.027	0.01
PAU-12-142	109.3	P292285	0.021	0.04
PAU-12-142	150	P292300	0.013	0.08
PAU-12-143	21	P292303	0.009	0.01
PAU-12-143	172	P292346	0.014	0.01
PAU-12-144	0	P292349	0.026	0.01
PAU-12-144	108	P292389	0.194	0.22
PAU-12-144	143	P292403	0.038	0.06
PAU-12-145	0	P292406	0.010	0.01
PAU-12-145	243	P292444	0.027	0.01
PAU-12-145	300	P292458	0.114	0.08
PAU-12-146	0	P292461	0.013	0.01
PAU-12-146	102	P292500	0.068	0.03
PAU-12-146	210	P292538	0.101	0.10
PAU-12-146	273	P292562	0.020	0.10
PAU-12-147	0	P292565	0.017	0.02
PAU-12-147	97	P292604	0.069	0.02

Hole No.	Depth	Sample Nº	P_2O_5 (%)	TiO_2 (%)
PAU-12-147	120	P292613	0.017	0.01
PAU-12-148	0	P292616	0.051	0.05
PAU-12-148	111.2	P292655	0.021	0.12
PAU-12-148	132	P292664	0.012	0.02
PAU-12-149	0	P292667	0.011	0.01
PAU-12-149	144.1	P292707	0.038	0.03
PAU-12-149	252	P292748	0.107	0.09
PAU-12-149	357	P292787	0.375	0.29
PAU-12-150	0	P292790	0.011	0.02
PAU-12-150	110.2	P292829	0.025	0.02
PAU-12-150	216	P292869	0.027	0.01
PAU-12-150	258	P292886	0.011	0.01
PAU-12-151	0	P292889	0.009	0.01
PAU-12-151	116.6	P292928	0.018	0.01
PAU-12-151	213	P292965	0.009	0.01
PAU-12-152	0	P292968	0.009	0.01
PAU-12-152	117	P293008	0.020	0.01
PAU-12-152	261	P293049	0.020	0.01
PAU-12-153	360	P293053	0.009	0.01
PAU-12-153	456	P293076	0.012	0.04

Table 11.3.15 Blank Assay Results for the Paul Zone – 2012 After PAU-12-123

Certification of DC79003 standard

The certified DC79003 standard was only valid for P_2O_5. It was certified by the China National Analysis Center for Iron and Steel. The expected value was 6.06% P_2O_5. The obtained values showed an absolute relative error of 0.45% to 5.87% as shown in Table 11.3.16.

Most values were below the expected values; hence this batch may be slightly underestimated for P_2O_5. However, this situation was considered immaterial as it was within acceptable limits on the conservative side.

Hole No.	Depth (m)	Sample Nº	Standard Value P_2O_5 (%)	Laboratory Value P_2O_5 (%)	Relative Error (%)
PAU-12-124	0	N141458	6.06	5.84	3.63
PAU-12-125	0	N141519	6.06	5.78	4.60
PAU-12-126	83.4	N141583	6.06	5.75	5.18
PAU-12-127	0	N141603	6.06	5.72	5.63
PAU-12-128	0	N141687	6.06	5.78	4.60
PAU-12-129	201	N141793	6.06	5.76	5.02
PAU-12-130	0	N141849	6.06	5.83	3.83
PAU-12-131	0	N141913	6.06	5.74	5.23
PAU-12-132	0	N142045	6.06	5.84	3.70
PAU-12-133	0	N142153	6.06	5.70	5.87
PAU-12-134	0	N142260	6.06	5.75	5.10
PAU-12-135	0	N142351	6.06	5.81	4.14
PAU-12-136	0	N142448	6.06	5.76	4.95
PAU-12-137	0	N142561	6.06	5.79	4.41
PAU-12-138	0	N142669	6.06	5.78	4.57
PAU-12-139	0	N142705	6.06	5.77	4.83
PAU-12-140	0	N142783	6.06	5.89	2.89
PAU-12-141	0	P292145	6.06	5.90	2.71
PAU-12-142	0	P292244	6.06	5.76	5.02
PAU-12-143	21	P292301	6.06	5.74	5.21
PAU-12-144	0	P292347	6.06	5.88	2.90
PAU-12-145	0	P292404	6.06	5.80	4.29
PAU-12-146	0	P292459	6.06	6.03	0.58
PAU-12-147	0	P292563	6.06	5.98	1.37
PAU-12-148	0	P292614	6.06	6.01	0.81
PAU-12-149	0	P292665	6.06	6.01	0.78
PAU-12-150	0	P292788	6.06	6.00	0.97
PAU-12-151	0	P292887	6.06	6.03	0.45
PAU-12-152	0	P292966	6.06	6.02	0.63
PAU-12-153	360	P293051	6.06	5.98	1.30

Table 11.3.16 DC79003 Standard Assay Results Paul Zone – 2012 After PAU-12-123

Certification of the SY-4 Standard

The other certified standard is SY-4. It came from CANMET in Ontario. It was used to verify values for P_2O_5 and TiO_2. Certified values were: 0.131% P_2O_5 and 0.287% TiO_2. The obtained values from the laboratory varied from 0% to 7.634% for P_2O_5 and 1.045% to 9.408% for TiO_2 as shown in Table 11.3.17.

Hole No.	Depth (m)	Sample Nº	Standard Value P_2O_5 (%)	Laboratory Value P_2O_5 (%)	Relative Error (%)	Standard Value TiO_2 (%)	Laboratory Value TiO_2 (%)	Relative Error (%)
PAU-12-124	0	N141459	0.131	0.125	4.580	0.287	0.26	9.408
PAU-12-125	0	N141520	0.131	0.123	6.107	0.287	0.29	1.045
PAU-12-126	83.4	N141584	0.131	0.125	4.580	0.287	0.27	5.923
PAU-12-127	0	N141604	0.131	0.123	6.107	0.287	0.29	1.045
PAU-12-128	0	N141688	0.131	0.127	3.053	0.287	0.28	2.439
PAU-12-129	201	N141794	0.131	0.125	4.580	0.287	0.27	5.923
PAU-12-130	0	N141850	0.131	0.130	0.763	0.287	0.28	2.439
PAU-12-131	0	N141914	0.131	0.129	1.527	0.287	0.29	1.045
PAU-12-132	0	N142046	0.131	0.126	3.817	0.287	0.29	1.045
PAU-12-133	0	N142154	0.131	0.132	0.763	0.287	0.28	2.439
PAU-12-134	0	N142261	0.131	0.132	0.763	0.287	0.28	2.439
PAU-12-135	0	N142352	0.131	0.129	1.527	0.287	0.28	2.439
PAU-12-136	0	N142449	0.131	0.129	1.527	0.287	0.28	2.439
PAU-12-137	0	N142562	0.131	0.121	7.634	0.287	0.27	5.923
PAU-12-138	0	N142670	0.131	0.127	3.053	0.287	0.28	2.439
PAU-12-139	0	N142706	0.131	0.131	0.000	0.287	0.27	5.923
PAU-12-140	0	N142784	0.131	0.135	3.053	0.287	0.28	2.439
PAU-12-141	0	P292146	0.131	0.124	5.344	0.287	0.28	2.439
PAU-12-142	0	P292245	0.131	0.131	0.000	0.287	0.28	2.439
PAU-12-143	21	P292302	0.131	0.132	0.763	0.287	0.29	1.045
PAU-12-144	0	P292348	0.131	0.128	2.290	0.287	0.28	2.439
PAU-12-145	0	P292405	0.131	0.130	0.763	0.287	0.29	1.045
PAU-12-146	0	P292460	0.131	0.131	0.000	0.287	0.30	4.530
PAU-12-147	0	P292564	0.131	0.128	2.290	0.287	0.28	2.439
PAU-12-148	0	P292615	0.131	0.131	0.000	0.287	0.28	2.439

Hole No.	Depth (m)	Sample Nº	Standard Value P_2O_5 (%)	Laboratory Value P_2O_5 (%)	Relative Error (%)	Standard Value TiO_2 (%)	Laboratory Value TiO_2 (%)	Relative Error (%)
PAU-12-149	0	P292666	0.131	0.129	1.527	0.287	0.29	1.045
PAU-12-150	0	P292789	0.131	0.129	1.527	0.287	0.30	4.530
PAU-12-151	0	P292888	0.131	0.131	0.000	0.287	0.29	1.045
PAU-12-152	0	P292967	0.131	0.132	0.763	0.287	0.28	2.439
PAU-12-153	360	P293052	0.131	0.128	2.290	0.287	0.28	2.439

Table 11.3.17 SY-4 Standard Assay Results Paul Zone – 2012 after PAU-12-123

Certification of PMRI10 Standard

PMRI10 was a in-house standard which is made of concentrate from the Paul Zone. It was used to verify high values in P_2O_5 and TiO_2. The compilation of available data on 499 readings showed an average of 10,318% P_2O_5 (min: 9.175%; max: 10.899%) with a standard deviation of 0.1182%; results for TiO_2 showed an average of 5.470% (min: 5.13%; max: 5.55%) with a standard deviation of 0.0559%. Using the average value as the theoretical target value, the assays results at the laboratory showed relative errors ranging from 0.07 to 1.39% for P_2O_5 and varied from 0 to 2.38% for TiO_2 as presented in Table 11.3.18.

Hole No.	Depth (m)	Sample Nº	Standard Value P_2O_5 (%)	Laboratory Value P_2O_5 (%)	Relative Error (%)	Standard Value TiO_2 (%)	Laboratory Value TiO_2 (%)	Relative Error (%)
PAU-12-124	45	N141474	10.318	10.248	0.68	5.47	5.47	0.00
PAU-12-124	151.9	N141512	10.318	10.282	0.35	5.47	5.51	0.73
PAU-12-125	61	N141535	10.318	10.270	0.47	5.47	5.40	1.28
PAU-12-125	174	N141574	10.318	10.268	0.48	5.47	5.48	0.18
PAU-12-126	132	N141597	10.318	10.392	0.72	5.47	5.50	0.55
PAU-12-127	44	N141618	10.318	10.265	0.51	5.47	5.48	0.18
PAU-12-127	243	N141660	10.318	10.212	1.03	5.47	5.48	0.18
PAU-12-128	34	N141702	10.318	10.210	1.05	5.47	5.47	0.00
PAU-12-128	198	N141743	10.318	10.245	0.71	5.47	5.46	0.18
PAU-12-128	298.8	N141780	10.318	10.239	0.77	5.47	5.44	0.55
PAU-12-129	234	N141808	10.318	10.257	0.59	5.47	5.50	0.55
PAU-12-130	125	N141864	10.318	10.311	0.07	5.47	5.44	0.55
PAU-12-130	327	N141903	10.318	10.236	0.79	5.47	5.46	0.18

Hole No.	Depth (m)	Sample Nº	Standard Value P_2O_5 (%)	Laboratory Value P_2O_5 (%)	Relative Error (%)	Standard Value TiO_2 (%)	Laboratory Value TiO_2 (%)	Relative Error (%)
PAU-12-131	114	N141927	10.318	10.277	0.40	5.47	5.49	0.37
PAU-12-131	255	N142018	10.318	10.235	0.80	5.47	5.47	0.00
PAU-12-132	36	N142059	10.318	10.275	0.42	5.47	5.46	0.18
PAU-12-132	150.4	N142099	10.318	10.253	0.63	5.47	5.48	0.18
PAU-12-132	258	N142138	10.318	10.286	0.31	5.47	5.48	0.18
PAU-12-133	33	N142167	10.318	10.259	0.57	5.47	5.46	0.18
PAU-12-133	144	N142209	10.318	10.274	0.43	5.47	5.48	0.18
PAU-12-133	252	N142249	10.318	10.279	0.38	5.47	5.46	0.18
PAU-12-134	44.4	N142276	10.318	10.257	0.59	5.47	5.48	0.18
PAU-12-134	147	N142313	10.318	10.295	0.22	5.47	5.46	0.18
PAU-12-135	108	N142366	10.318	10.235	0.80	5.47	5.50	0.55
PAU-12-135	231	N142404	10.318	10.242	0.74	5.47	5.50	0.55
PAU-12-136	42	N142461	10.318	NSS	--	5.47	NSS	--
PAU-12-136	231	N142513	10.318	10.260	0.56	5.47	5.46	0.18
PAU-12-136	333	N142550	10.318	10.296	0.21	5.47	5.47	0.00
PAU-12-137	99	N142576	10.318	10.248	0.68	5.47	5.47	0.00
PAU-12-137	216	N142615	10.318	10.216	0.99	5.47	5.45	0.37
PAU-12-137	321	N142653	10.318	10.263	0.53	5.47	5.49	0.37
PAU-12-138	48	N142684	10.318	10.302	0.16	5.47	5.44	0.55
PAU-12-139	45	N142720	10.318	10.229	0.86	5.47	5.47	0.00
PAU-12-139	177	N142759	10.318	10.276	0.41	5.47	5.49	0.37
PAU-12-140	72	N142798	10.318	10.426	1.05	5.47	5.50	0.55
PAU-12-140	312	N142837	10.318	10.358	0.39	5.47	5.42	0.91
PAU-12-141	141	P292160	10.318	10.393	0.73	5.47	5.51	0.73
PAU-12-141	261	P292197	10.318	10.461	1.39	5.47	5.55	1.46
PAU-12-141	364	P292235	10.318	10.292	0.25	5.47	5.50	0.55
PAU-12-142	42	P292259	10.318	10.286	0.31	5.47	5.48	0.18
PAU-12-143	54	P292316	10.318	10.280	0.37	5.47	5.46	0.18
PAU-12-145	69.5	P292418	10.318	10.328	0.10	5.47	5.44	0.55
PAU-12-146	37	P292474	10.318	10.410	0.89	5.47	5.44	0.55
PAU-12-146	135	P292513	10.318	10.311	0.07	5.47	5.44	0.55

Hole No.	Depth (m)	Sample Nº	Standard Value P_2O_5 (%)	Laboratory Value P_2O_5 (%)	Relative Error (%)	Standard Value TiO_2 (%)	Laboratory Value TiO_2 (%)	Relative Error (%)
PAU-12-146	240	P292550	10.318	10.301	0.16	5.47	5.38	1.65
PAU-12-147	33	P292578	10.318	10.260	0.56	5.47	5.44	0.55
PAU-12-148	42	P292628	10.318	10.287	0.30	5.47	5.46	0.18
PAU-12-149	48	P292680	10.318	10.359	0.40	5.47	5.48	0.18
PAU-12-149	183	P292721	10.318	10.283	0.34	5.47	5.48	0.18
PAU-12-149	285	P292761	10.318	10.311	0.07	5.47	5.46	0.18
PAU-12-150	46	P292804	10.318	10.225	0.90	5.47	5.47	0.00
PAU-12-150	150	P292843	10.318	10.281	0.36	5.47	5.44	0.55
PAU-12-150	249	P292882	10.318	10.259	0.57	5.47	5.42	0.91
PAU-12-151	48	P292902	10.318	10.283	0.34	5.47	5.49	0.37
PAU-12-151	153.6	P292942	10.318	10.232	0.83	5.47	5.47	0.00
PAU-12-152	48	P292982	10.318	10.266	0.50	5.47	5.48	0.18
PAU-12-152	153	P293021	10.318	10.215	1.00	5.47	5.47	0.00
PAU-12-153	432	P293066	10.318	10.261	0.55	5.47	5.34	2.38

Table 11.3.18 PMRI10 Standard Assay Results Paul Zone – 2012 after PAU-12-123

Certification of SARM-39 Standard

The SARM-39 standard was prepared by MINTEK and was also used as reference material by the Geological Survey of Canada (GSC). Target values were: 1.46% P_2O_5 and 1.58% TiO_2. Assays results displayed relative errors ranging from 0.068% to 3.63% for P_2O_5 and 0% to 5.06% for TiO_2 as shown in Table 11.3.19.

Hole No.	Depth (m)	Sample Nº	Standard Value P_2O_5 (%)	Laboratory Value P_2O_5 (%)	Relative Error (%)	Standard Value TiO_2 (%)	Laboratory Value TiO_2 (%)	Relative Error (%)
PAU-12-124	81	N141487	1.46	1.414	3.151	1.58	1.57	0.63
PAU-12-125	96	N141548	1.46	1.440	1.370	1.58	1.63	3.16
PAU-12-127	123	N141632	1.46	1.439	1.438	1.58	1.60	1.27
PAU-12-127	279	N141673	1.46	1.422	2.603	1.58	1.59	0.63
PAU-12-128	126	N141716	1.46	1.414	3.151	1.58	1.62	2.53
PAU-12-128	234	N141756	1.46	1.407	3.630	1.58	1.66	5.06

Hole No.	Depth (m)	Sample Nº	Standard Value P_2O_5 (%)	Laboratory Value P_2O_5 (%)	Relative Error (%)	Standard Value TiO_2 (%)	Laboratory Value TiO_2 (%)	Relative Error (%)
PAU-12-129	276	N141822	1.46	1.439	1.438	1.58	1.61	1.90
PAU-12-130	240	N141878	1.46	1.425	2.397	1.58	1.63	3.16
PAU-12-131	179	N141940	1.46	1.425	2.397	1.58	1.61	1.90
PAU-12-131	291	N142031	1.46	1.432	1.918	1.58	1.60	1.27
PAU-12-132	75	N142073	1.46	1.425	2.397	1.58	1.61	1.90
PAU-12-132	180	N142111	1.46	1.431	1.986	1.58	1.61	1.90
PAU-12-133	71	N142181	1.46	1.427	2.260	1.58	1.60	1.27
PAU-12-133	183	N142223	1.46	1.430	2.055	1.58	1.60	1.27
PAU-12-134	77.8	N142288	1.46	1.430	2.055	1.58	1.61	1.90
PAU-12-134	178.5	N142326	1.46	1.422	2.603	1.58	1.59	0.63
PAU-12-135	149	N142380	1.46	1.432	1.918	1.58	1.60	1.27
PAU-12-135	270.9	N142417	1.46	1.425	2.397	1.58	1.59	0.63
PAU-12-135	339	N142442	1.46	1.431	1.99	1.58	1.64	3.80
PAU-12-136	117	N142473	1.46	1.420	2.740	1.58	1.63	3.16
PAU-12-136	264	N142525	1.46	1.425	2.397	1.58	1.59	0.63
PAU-12-137	147	N142589	1.46	1.421	2.671	1.58	1.59	0.63
PAU-12-137	252	N142628	1.46	1.420	2.740	1.58	1.64	3.80
PAU-12-138	84	N142697	1.46	1.417	2.945	1.58	1.62	2.53
PAU-12-139	81	N142733	1.46	1.427	2.260	1.58	1.61	1.90
PAU-12-139	351.1	N142771	1.46	1.422	2.603	1.58	1.60	1.27
PAU-12-140	204	N142811	1.46	1.432	1.918	1.58	1.60	1.27
PAU-12-140	350.5	N142850	1.46	1.428	2.192	1.58	1.61	1.90
PAU-12-141	191.9	P292172	1.46	1.436	1.644	1.58	1.62	2.53
PAU-12-141	297	P292210	1.46	1.431	1.986	1.58	1.60	1.27
PAU-12-142	78	P292272	1.46	1.421	2.671	1.58	1.61	1.90
PAU-12-143	91.6	P292329	1.46	1.427	2.260	1.58	1.61	1.90
PAU-12-144	40.5	P292364	1.46	1.438	1.51	1.58	1.62	2.53
PAU-12-144	72	P292376	1.46	1.439	1.438	1.58	1.62	2.53
PAU-12-145	147	P292431	1.46	1.413	3.219	1.58	1.61	1.90
PAU-12-146	72	P292487	1.46	1.432	1.918	1.58	1.64	3.80
PAU-12-146	171	P292526	1.46	1.424	2.466	1.58	1.65	4.43

Hole No.	Depth (m)	Sample Nº	Standard Value P_2O_5 (%)	Laboratory Value P_2O_5 (%)	Relative Error (%)	Standard Value TiO_2 (%)	Laboratory Value TiO_2 (%)	Relative Error (%)
PAU-12-147	63	P292591	1.46	1.424	2.466	1.58	1.61	1.90
PAU-12-148	80.25	P292642	1.46	1.470	0.685	1.58	1.57	0.63
PAU-12-149	105	P292694	1.46	1.456	0.274	1.58	1.58	0.00
PAU-12-149	216	P292734	1.46	1.458	0.137	1.58	1.58	0.00
PAU-12-149	324	P292775	1.46	1.469	0.616	1.58	1.58	0.00
PAU-12-150	76	P292816	1.46	1.435	1.712	1.58	1.63	3.16
PAU-12-150	181	P292855	1.46	1.426	2.329	1.58	1.61	1.90
PAU-12-151	81	P292915	1.46	1.453	0.479	1.58	1.59	0.63
PAU-12-151	189.3	P292955	1.46	1.458	0.137	1.58	1.59	0.63
PAU-12-152	81	P292995	1.46	1.453	0.479	1.58	1.58	0.00
PAU-12-152	226	P293035	1.46	1.461	0.068	1.58	1.59	0.63

Table 11.3.19 SARM-39 Standard Assay Results Paul Zone – 2012 after PAU-12-123

All results obtained with this program were judged acceptable by Arianne and by the Author. Most relative errors were low and QA/QC procedures were considered adequate. Only the results for SY-4 standard presented higher relative errors. The analysis obtained from laboratory values showed small deviations from the standard values; higher relative errors occurred on standards of lower values, which is why numbers were still considered acceptable.

Finally, the Author as well as Arianne's technical team are at ease to use analytical values provided by the ALS Chemex Laboratory for all samples of this drilling campaign.

11.3.3 Manouane QA/QC

The reliability of analytical results for TiO_2 and P_2O_5 from ALS Chemex Laboratory was verified. A total of 103 blanks and 179 standards were sent to this laboratory.

The blanks used in this drill program were blocks of quartz from the SITEQ quarry at St-François-de-Sales. They were brushed and cleaned with oxalic acid before being sent for analysis. These rocks showed no enrichment in TiO_2 and nor P_2O_5. Values in P_2O_5 and TiO_2 are shown in Table 11.3.20. They vary from 0 to 0.55% TiO_2 and from 0 to 0.543% P_2O_5.

In holes MAN-11-21 and MAN-11-22, blank samples J414331, J414366 and J414541 were reversed by the lab with samples J414330, J414366 and J414540 respectively. The data results were corrected.

Hole No.	Depth (m)	Sample No.	Lab Value P_2O_5 (%)	Lab Value TiO_2 (%)
MAN-11-14	150	H855803	0.013	-0.01
	248	H855836	0.012	-0.01
MAN-11-15	0	H855839	0.011	-0.01
	123	H855879	0.021	-0.01
	219.4	H855912	0.012	-0.01
MAN-11-16	0	H855918	0.011	0.01
	111	H855960	0.011	0.06
	177	H855979	0.010	-0.01
MAN-11-17	0	H855982	0.011	0.01
	120	J414019	0.035	0.06
	216	J414060	0.013	-0.01
	246	J414072	0.011	-0.01
MAN-11-18	0	J414075	0.010	-0.01
	105	J414112	0.034	-0.01
	159	J414133	0.014	-0.01
MAN-11-19	0	J414136	0.012	-0.01
	111	J414173	0.038	0.06
	117	J414176	0.013	0.02
MAN-11-20	0	J414179	0.010	-0.01
	180	J414218	0.033	-0.01
	275.05	J414257	0.042	0.04
	351	J414292	0.019	-0.01
MAN-11-21	15	J414295	0.012	-0.01
	96	J414331	0.025	-0.01
	180.4	J414366	0.059	0.06
	253.2	J414402	0.056	0.05
MAN-11-21	300	J414423	0.016	-0.01
MAN-11-22	0	J414426	0.013	-0.01
	138	J414465	0.016	-0.01
	234	J414504	0.041	0.02
	345	J414541	0.036	-0.01
	366	J414550	0.018	-0.01
MAN-11-23	12	J414553	0.00	-0.01
	100.9	J414591	0.017	-0.01

Hole No.	Depth (m)	Sample No.	Lab Value P_2O_5 (%)	Lab Value TiO_2 (%)
	144	J414607	0.00	-0.01
MAN-11-24	0	J414610	-0.01	-0.01
	111.6	J414649	0.004	-0.01
	171	J414674	0.001	-0.01
MAN-11-25	0	J414677	0.001	-0.01
	93	J414707	0.020	0.02
MAN-11-26	0	J414710	-0.010	-0.01
	126	J414749	0.015	-0.01
	222	J414785	-0.010	-0.01
MAN-11-27	0	J414788	0.011	-0.01
	122.8	J414826	0.024	-0.01
	220	J414866	0.014	-0.01
MAN-11-28	0	J414869	0.013	-0.01
	107	J414907	0.028	0.01
	141	J414922	0.014	0.21
MAN-11-29	0	J414925	0.001	-0.01
	105	J414959	0.001	-0.01
MAN-11-30	0	J414962	0.001	-0.01
	96	J414996	0.001	-0.01
MAN-11-31	21	J414999	0.010	0.02
	124.4	J415041	-0.010	0.01
	138	J415047	-0.010	-0.01
MAN-11-32	0	J415050	-0.010	-0.01
	114	J415087	0.001	-0.01
MAN-11-33	0	J415090	0.015	-0.01
	183	J415118	0.013	-0.01
MAN-11-34	0	J415121	0.010	-0.01
	114	J415158	0.027	-0.01
	195.6	J415191	0.062	0.44
MAN-11-35	0	J415194	-0.010	-0.01
	222	J415287	0.011	0.08
MAN-11-35	102	J415232	0.003	-0.01
	177	J415270	0.001	-0.01
MAN-11-36	0	J415290	0.013	-0.01

Hole No.	Depth (m)	Sample No.	Lab Value P_2O_5 (%)	Lab Value TiO_2 (%)
	120	J415330	0.033	-0.01
	205	J415368	0.026	-0.01
	222	J415377	0.012	-0.01
MAN-11-37	12.3	J415380	0.001	-0.01
	102	J415419	0.017	0.06
	185	J415444	-0.010	-0.01
MAN-11-38	13	J415447	0.001	-0.01
	111	J415488	0.023	0.04
	177	J415510	0.001	-0.01
MAN-11-39	12.4	J415513	0.020	0.01
	120	J415553	0.543	0.55
	207	J415589	-0.010	-0.01
MAN-11-40	15.2	J415592	0.010	-0.01
	97.3	J415629	0.016	-0.01
	168	J415653	0.015	-0.01
MAN-11-41	3.5	J415656	0.011	-0.01
	102	J415698	0.011	-0.01
	204.2	J415739	0.012	-0.01
MAN-11-42	0	J415742	-0.010	-0.01
	96.7	J415779	0.012	-0.01
	180	J415813	-0.010	0.12
MAN-11-43	0	J415816	-0.010	0.07
	117	J415853	0.024	0.04
	225	J415889	0.002	-0.01
MAN-11-44	9	J415892	0.076	0.08
	120	J415934	0.014	0.03
MAN-11-45	3.5	J415937	0.015	-0.01
	126	J415972	-0.010	-0.01
MAN-11-46	11.4	J415975	-0.010	-0.01
	112.7	H900516	-0.010	-0.01
	219	H900559	0.001	-0.01
MAN-11-47	6.5	H900562	-0.010	-0.01
	135	H900613	-0.010	-0.01

Hole No.	Depth (m)	Sample No.	Lab Value P_2O_5 (%)	Lab Value TiO_2 (%)
MAN-11-48	17.5	H900616	-0.010	-0.01
	132	H900665	-0.010	-0.01

Table 11.3.20 Arianne Blank Check Samples Sent to ALS Chemex Laboratory in Val d'Or

In addition, four standards were used to validate the analytical results. There were two certified standards, DC79003 and SY-4, one approved standard, FER-1, and one in-house standard, PMRI10.

The SY-4 standard was certified by CANMET Mining and Mineral Services (CANMET) in Ontario. It was used to check the values for P_2O_5 and TiO_2. The certified values were: 0.131% of P_2O_5 and 0.287% of TiO_2.

The values obtained with the laboratory analysis for this drilling campaign gave relative errors ranging from 1.527% to 4.580% for P_2O_5 and absolute relative errors ranging between 1.045% and 2.439% for TiO_2.

The other certified standard, DC 79003, was only valid for P_2O_5. It was certified by the China National Analysis Center for Iron and Steel. The standard value was 6.06% for P_2O_5. The values obtained during laboratory tests showed an absolute error that varied from 4.323% to 5.033%.

The FER-1 standard was prepared by CANMET and used as a material reference by the Geological Survey of Canada. Standard values were: 2.39% P_2O_5 and 75.86% Fe_2O_3. The results obtained in laboratory tests showed absolute errors ranging from 0.00% to 4.77% for Fe_2O_3 and 3.389% to 15.230% for P_2O_5.

Finally, the PMRI10 in-house standard which was made with rock from the Paul Zone stripping. It was used to check the P_2O_5 and TiO_2 values. Results show an average of 10.286% P_2O_5 (min: 9.175%, max: 10.435%) with a standard deviation of 0.134, and an average of 5.576% TiO_2 (min: 5.13%, max: 5.54%) with a standard deviation of 0.044. Using the previous averages, the lab tests showed errors ranging from 0.010% to 0.350% for P_2O_5 and 0,073% to 1.205% for TiO_2.

Analytical results of standards and the percentage of errors in the calibration values are presented in Tables 11.3.21 to 11.3.24. Samples of drill hole MAN-11-17 were reversed by the laboratory. Analyses of recovery were made. The Laboratory confirmed that the samples were reversed and that the good results to be considered were these of the last analysis. The certificates of the first analysis and the reanalysis were provided for validation.

Moreover sample J414191 from hole MAN-11-20, supposed to be a FER-1 standard, was analysed as a blank, since an error occurred while inserting the standard. This result was removed from the database.

Hole #	Depth (m)	Sample #	Standard Value P_2O_5 (%)	Obtained Value P_2O_5 (%)	Relative Error (%)	Standard Value TiO_2 (%)	Obtained Value TiO_2 (%)	Relative Error (%)
MAN-11-14	150	H855801	0.131	0.129	-1.527	0.287	0.29	1.045
MAN-11-15	0	H855837	0.131	0.126	-3.817	0.287	0.28	-2.439
MAN-11-16	0	H855916	0.131	0.126	-3.817	0.287	0.29	1.045
MAN-11-17	0	H855980	0.131	0.125	-4.580	0.287	0.28	-2.439
MAN-11-18	0	J414074	0.131	0.126	-3.817	0.287	0.28	-2.439
MAN-11-19	0	J414135	0.131	0.126	-3.817	0.287	0.28	-2.439
MAN-11-20	0	J414178	0.131	0.128	-2.290	0.287	0.28	-2.439
MAN-11-21	15	J414294	0.131	0.128	-2.290	0.287	0.28	-2.439
MAN-11-22	0	J414425	0.131	0.126	-3.817	0.287	0.28	-2.439
MAN-11-23	12	J414552	0.131	0.128	-2.290	0.287	0.29	1.045
MAN-11-24	0	J414609	0.131	0.127	-3.053	0.287	0.28	-2.439
MAN-11-25	0	J414676	0.131	0.127	-3.053	0.287	0.29	1.045
MAN-11-26	0	J414709	0.131	0.127	-3.053	0.287	0.29	1.045
MAN-11-27	0	J414787	0.131	0.127	-3.053	0.287	0.28	-2.439
MAN-11-28	0	J414868	0.131	0.127	-3.053	0.287	0.28	-2.439
MAN-11-29	0	J414924	0.131	0.127	-3.053	0.287	0.29	1.045
MAN-11-30	0	J414961	0.131	0.126	-3.817	0.287	0.28	-2.439
MAN-11-31	21	J414998	0.131	0.126	-3.817	0.287	0.29	1.045
MAN-11-32	0	J415049	0.131	0.127	-3.053	0.287	0.29	1.045
MAN-11-33	0	J415089	0.131	0.126	-3.817	0.287	0.28	-2.439
MAN-11-34	0	J415120	0.131	0.126	-3.817	0.287	0.28	-2.439
MAN-11-35	0	J415193	0.131	0.127	-3.053	0.287	0.29	1.045
MAN-11-36	0	J415289	0.131	0.127	-3.053	0.287	0.29	1.045
MAN-11-37	12.3	J415379	0.131	0.128	-2.290	0.287	0.29	1.045
MAN-11-38	13	J415446	0.131	0.127	-3.053	0.287	0.28	-2.439
MAN-11-39	12.4	J415512	0.131	0.128	-2.290	0.287	0.28	-2.439
MAN-11-40	15.2	J415591	0.131	0.126	-3.817	0.287	0.28	-2.439
MAN-11-41	3.5	J415655	0.131	0.128	-2.290	0.287	0.29	1.045
MAN-11-42	0	J415741	0.131	0.127	-3.053	0.287	0.29	1.045
MAN-11-43	0	J415815	0.131	0.128	-2.290	0.287	0.29	1.045

Hole #	Depth (m)	Sample #	Standard Value P_2O_5 (%)	Obtained Value P_2O_5 (%)	Relative Error (%)	Standard Value TiO_2 (%)	Obtained Value TiO_2 (%)	Relative Error (%)
MAN-11-44	9	J415891	0.131	0.129	-1.527	0.287	0.29	1.045
MAN-11-45	3.5	J415936	0.131	0.128	-2.290	0.287	0.28	-2.439
MAN-11-46	11.4	J415974	0.131	0.126	-3.817	0.287	0.29	1.045
MAN-11-47	6.5	H900561	0.131	0.129	-1.527	0.287	0.29	1.045
MAN-11-48	17.5	H900615	0.131	0.126	-3.817	0.287	0.29	1.045

Table 11.3.21 Arianne SY-4 Standard Check

Hole #	Depth m	Sample #	Standard Value P_2O_5 (%)	Obtained Value P_2O_5 (%)	Relative Error (%)
MAN-11-14	150	H855802	6.06	5.782	-4.587
MAN-11-15	0	H855838	6.06	5.798	-4.323
MAN-11-16	0	H855917	6.06	5.788	-4.488
MAN-11-17	0	H855981	6.06	5.782	-4.587
MAN-11-18	0	J414073	6.06	5.791	-4.439
MAN-11-19	0	J414134	6.06	5.782	-4.587
MAN-11-20	0	J414177	6.06	5.792	-4.422
MAN-11-21	15	J414293	6.06	5.791	-4.439
MAN-11-22	0	J414424	6.06	5.781	-4.604
MAN-11-23	12	J414551	6.06	5.791	-4.439
MAN-11-24	0	J414608	6.06	5.786	-4.521
MAN-11-25	0	J414675	6.06	5.789	-4.472
MAN-11-26	0	J414708	6.06	5.791	-4.439
MAN-11-27	0	J414786	6.06	5.785	-4.538
MAN-11-28	0	J414867	6.06	5.762	-4.917
MAN-11-29	0	J414923	6.06	5.772	-4.752
MAN-11-30	0	J414960	6.06	5.791	-4.439
MAN-11-31	21	J414997	6.06	5.792	-4.422
MAN-11-32	0	J415048	6.06	5.773	-4.736
MAN-11-33	0	J415088	6.06	5.782	-4.587
MAN-11-34	0	J415119	6.06	5.791	-4.439
MAN-11-35	0	J415192	6.06	5.763	-4.901
MAN-11-36	0	J415288	6.06	5.783	-4.571
MAN-11-37	12.3	J415378	6.06	5.760	-4.950

Hole #	Depth m	Sample #	Standard Value P_2O_5 (%)	Obtained Value P_2O_5 (%)	Relative Error (%)
MAN-11-38	13	J415445	6.06	5.771	-4.769
MAN-11-39	12.4	J415511	6.06	5.780	-4.620
MAN-11-40	15.2	J415590	6.06	5.772	-4.752
MAN-11-41	3.5	J415654	6.06	5.771	-4.769
MAN-11-42	0	J415740	6.06	5.798	-4.323
MAN-11-43	0	J415814	6.06	5.780	-4.620
MAN-11-44	9	J415890	6.06	5.769	-4.802
MAN-11-46	11.4	J415973	6.06	5.815	-4.043
MAN-11-47	6.5	H900560	6.06	5.765	-4.868
MAN-11-48	17.5	H900614	6.06	5.755	-5.033

Table 11.3.22 Arianne DC79003 Standard Check

Hole #	Depth (m)	Sample #	Standard Value Fe_2O_3 (%)	Obtained Value Fe_2O_3 (%)	Relative Error (%)	Standard Value P_2O_5 (%)	Obtained Value P_2O_5 (%)	Relative Error (%)
MAN-11-14	217	H855830	75.86	75.75	-0.15	2.39	2.251	-5.816
MAN-11-15	96	H855866	75.86	75.85	-0.01	2.39	2.261	-5.397
	189	H855900	75.86	75.85	-0.01	2.39	2.261	-5.397
MAN-11-16	78	H855947	75.86	75.75	-0.15	2.39	2.261	-5.397
MAN-11-17	87	J414007	75.86	76.08	0.29	2.39	2.262	-5.356
	183	J414046	75.86	75.89	0.04	2.39	2.28	-4.603
MAN-11-18	69.5	J414099	75.86	75.61	-0.33	2.39	2.253	-5.732
MAN-11-19	78.65	J414160	75.86	75.55	-0.41	2.39	2.251	-5.816
MAN-11-20	249	J414244	75.86	75.60	-0.34	2.39	2.251	-5.816
	333	J414283	75.86	75.42	-0.58	2.39	2.26	-5.439
MAN-11-21	72	J414319	75.86	75.47	-0.51	2.39	2.264	-5.272
	156	J414355	75.86	75.49	-0.49	2.39	2.251	-5.816

Hole #	Depth (m)	Sample #	Standard Value Fe_2O_3 (%)	Obtained Value Fe_2O_3 (%)	Relative Error (%)	Standard Value P_2O_5 (%)	Obtained Value P_2O_5 (%)	Relative Error (%)
MAN-11-22	100.1	J414452	75.86	75.55	-0.41	2.39	2.252	-5.774
	198	J414491	75.86	75.55	-0.41	2.39	2.261	-5.397
	312	J414528	75.86	75.58	-0.37	2.39	2.261	-5.397
MAN-11-23	69	J414578	75.86	75.75	-0.15	2.39	2.251	-5.816
MAN-11-24	78	J414635	75.86	75.70	-0.21	2.39	2.251	-5.816
MAN-11-25	81.1	J414702	75.86	75.85	-0.01	2.39	2.251	-5.816
MAN-11-26	93	J414736	75.86	75.58	-0.37	2.39	2.261	-5.397
	156	J414760	75.86	75.75	-0.15	2.39	2.251	-5.816
MAN-11-27	94.65	J414813	75.86	75.72	-0.18	2.39	2.261	-5.397
	184.6	J414851	75.86	75.59	-0.36	2.39	2.242	-6.192
MAN-11-28	72.2	J414894	75.86	75.84	-0.03	2.39	2.251	-5.816
MAN-11-30	81	J414988	75.86	75.51	-0.46	2.39	2.251	-5.816
MAN-11-31	90	J415028	75.86	75.72	-0.18	2.39	2.251	-5.816
MAN-11-32	87	J415075	75.86	75.53	-0.44	2.39	2.261	-5.397
MAN-11-33	150	J415114	75.86	75.65	-0.28	2.39	2.251	-5.816
MAN-11-34	84	J415146	75.86	75.55	-0.41	2.39	2.251	-5.816
	186	J415184	75.86	75.58	-0.37	2.39	2.246	-6.025
MAN-11-35	75	J415220	75.86	75.75	-0.15	2.39	2.209	-7.573
	152	J415258	75.86	75.84	-0.03	2.39	2.269	-5.063
MAN-11-36	84	J415316	75.86	75.94	0.11	2.39	2.294	-4.017
	178.5	J415355	75.86	75.61	-0.33	2.39	2.218	-7.197
MAN-11-37	71.6	J415405	75.86	75.58	-0.37	2.39	2.291	-4.142

Hole #	Depth (m)	Sample #	Standard Value Fe_2O_3 (%)	Obtained Value Fe_2O_3 (%)	Relative Error (%)	Standard Value P_2O_5 (%)	Obtained Value P_2O_5 (%)	Relative Error (%)
MAN-11-38	78	J415475	75.86	75.83	-0.04	2.39	2.258	-5.523
MAN-11-39	87.5	J415540	75.86	75.29	-0.75	2.39	2.234	-6.527
	183	J415579	75.86	75.97	0.15	2.39	2.245	-6.067
MAN-11-40	69	J415617	75.86	75.95	0.12	2.39	2.245	-6.067
MAN-11-41	68.6	J415684	75.86	75.90	0.05	2.39	2.238	-6.360
	168	J415725	75.86	75.79	-0.09	2.39	2.239	-6.318
MAN-11-43	177.3	J415878	75.86	75.82	-0.05	2.39	2.250	-5.858
MAN-11-44	96	J415921	75.86	79.48	4.77	2.39	2.026	-15.230
MAN-11-45	91	J415964	75.86	75.74	-0.16	2.39	2.270	-5.021
MAN-11-46	84	H900503	75.86	75.58	-0.37	2.39	2.223	-6.987
	180	H900543	75.86	75.71	-0.20	2.39	2.309	-3.389
MAN-11-47	81.3	H900590	75.86	75.86	0.00	2.39	2.244	-6.109
MAN-11-48	80	H900643	75.86	76.00	0.18	2.39	2.229	-6.736

Table 11.3.23 Arianne FER-1 Standard Check

Hole #	Depth (m)	Sample #	Value standard P_2O_5 (%)	Value obtained P_2O_5 (%)	Relative error (%)	Value standard TiO_2 (%)	Value obtained TiO_2 (%)	Relative error (%)
MAN-11-14	186	H855817	10.286	10.302	0.156	5.476	5.47	-0.110
MAN-11-15	49.2	H855853	10.286	10.320	0.331	5.476	5.50	0.438
	153	H855889	10.286	10.300	0.136	5.476	5.50	0.438
MAN-11-16	48	H855932	10.286	10.310	0.233	5.476	5.47	-0.110
	147	H855973	10.286	10.310	0.233	5.476	5.48	0.073
MAN-11-17	48	H855995	10.286	10.294	0.078	5.476	5.42	-1.023
	153.2	J414033	10.286	10.282	-0.039	5.476	5.41	-1.205
MAN-11-18	51	J414088	10.286	10.310	0.233	5.476	5.48	0.073
	139	J414125	10.286	10.321	0.340	5.476	5.47	-0.110
MAN-11-19	48	J414148	10.286	10.312	0.253	5.476	5.49	0.256
MAN-11-20	141	J414205	10.286	10.312	0.253	5.476	5.46	-0.292
	210	J414230	10.286	10.321	0.340	5.476	5.48	0.073
	309	J414270	10.286	10.295	0.087	5.476	5.49	0.256
MAN-11-21	42.2	J414307	10.286	10.310	0.233	5.476	5.50	0.438
	126	J414343	10.286	10.316	0.292	5.476	5.48	0.073
	208.65	J414378	10.286	10.321	0.340	5.476	5.49	0.256
	281	J414414	10.286	10.294	0.078	5.476	5.46	-0.292
MAN-11-22	59.3	J414439	10.286	10.310	0.233	5.476	5.5	0.438
	168.5	J414478	10.286	10.310	0.233	5.476	5.49	0.256
	267	J414516	10.286	10.310	0.233	5.476	5.46	-0.292
MAN-11-23	42	J414566	10.286	10.310	0.233	5.476	5.50	0.438
MAN-11-24	45	J414623	10.286	10.311	0.243	5.476	5.47	-0.110
	143	J414662	10.286	10.283	-0.029	5.476	5.47	-0.110
MAN-11-25	51	J414690	10.286	10.281	-0.049	5.476	5.47	-0.110

Hole #	Depth (m)	Sample #	Value standard P_2O_5 (%)	Value obtained P_2O_5 (%)	Relative error (%)	Value standard TiO_2 (%)	Value obtained TiO_2 (%)	Relative error (%)
MAN-11-26	57	J414722	10.286	10.301	0.146	5.476	5.46	-0.292
	195.1	J414774	10.286	10.281	-0.049	5.476	5.49	0.256
MAN-11-27	60	J414800	10.286	10.310	0.233	5.476	5.47	-0.110
	153	J414838	10.286	10.281	-0.049	5.476	5.54	1.169
MAN-11-28	42	J414882	10.286	10.310	0.233	5.476	5.50	0.438
	135.2	J414919	10.286	10.310	0.233	5.476	5.51	0.621
MAN-11-29	53.2	J414938	10.286	10.274	-0.117	5.476	5.47	-0.110
MAN-11-30	54	J414976	10.286	10.302	0.156	5.476	5.49	0.256
MAN-11-31	60	J415015	10.286	10.301	0.146	5.476	5.49	0.256
MAN-11-32	57	J415062	10.286	10.300	0.136	5.476	5.46	-0.292
MAN-11-33	85.2	J415102	10.286	10.321	0.340	5.476	5.50	0.438
MAN-11-34	51	J415134	10.286	10.312	0.253	5.476	5.48	0.073
	153	J415172	10.286	10.292	0.058	5.476	5.47	-0.110
MAN-11-35	45	J415207	10.286	10.355	0.671	5.476	5.44	-0.657
	128	J415245	10.286	10.258	-0.272	5.476	5.42	-1.023
	213	J415283	10.286	10.273	-0.126	5.476	5.47	-0.110
MAN-11-36	54	J415303	10.286	10.281	-0.049	5.476	5.49	0.256
	151.1	J415343	10.286	10.289	0.029	5.476	5.49	0.256
MAN-11-37	43.8	J415392	10.286	10.285	-0.010	5.476	5.48	0.073
	130.5	J415431	10.286	10.280	-0.058	5.476	5.49	0.256
MAN-11-38	48	J415461	10.286	10.292	0.058	5.476	5.47	-0.110
	148.3	J415500	10.286	10.280	-0.058	5.476	5.49	0.256

Hole #	Depth (m)	Sample #	Value standard P_2O_5 (%)	Value obtained P_2O_5 (%)	Relative error (%)	Value standard TiO_2 (%)	Value obtained TiO_2 (%)	Relative error (%)
MAN-11-39	51	J415527	10.286	10.292	0.058	5.476	5.49	0.256
	152.4	J415566	10.286	10.290	0.039	5.476	5.49	0.256
MAN-11-40	42	J415604	10.286	10.282	-0.039	5.476	5.47	-0.110
	126	J415641	10.286	10.274	-0.117	5.476	5.49	0.256
MAN-11-41	36.4	J415670	10.286	10.283	-0.029	5.476	5.50	0.438
	134	J415712	10.286	10.250	-0.350	5.476	5.48	0.073
MAN-11-43	34.2	J415828	10.286	10.296	0.097	5.476	5.49	0.256
	148	J415866	10.286	10.291	0.049	5.476	5.49	0.256
MAN-11-44	58.5	J415907	10.286	10.279	-0.068	5.476	5.48	0.073
MAN-11-45	58.5	J415951	10.286	10.297	0.107	5.476	5.48	0.073
MAN-11-46	56	J415990	10.286	10.295	0.087	5.476	5.49	0.256
	144.9	H900530	10.286	10.272	-0.136	5.476	5.47	-0.110
MAN-11-47	37.5	H900576	10.286	10.300	0.136	5.476	5.46	-0.292
	117	H900605	10.286	10.285	-0.010	5.476	5.48	0.073
MAN-11-48	51.9	H900630	10.286	10.287	0.010	5.476	5.48	0.073
	103.5	H900653	10.286	10.284	-0.019	5.476	5.49	0.256

Table 11.3.24 Arianne PMRI10 Standard Check

11.3.4 Reliability of Results

Arianne made the appropriate effort to control the data quality and analytical results reported by ALS Laboratory. Controlled deficiencies were addressed and corrected. It is the Author’s opinion that the data used is reliable for estimating the resources.

11.4 Security

There is no reason to believe that there was any tampering with the assays or samples. In the opinion of GoldMinds Geoservices, work was done in a professional manner. ALS Chemex, the Arianne geologists and their teams of professionals have a good reputation for their standard and quality work.

12. DATA VERIFICATION

The Author verified the database assay table against the logs on a random basis and did not find major errors. Extensive verification by colleagues of the Author also took place.

The collar location, azimuth, dip, holes length, assay values, and assay length were checked. Available historical cross sections on paper were reviewed and compared with on screen equivalent cross sections.

Independent samples were taken from witness core holes by the Author and QP, Mr. Claude Duplessis. He supervised the preparation and sampling protocol, participated in sealing the sample bags, and sent them to the SGS Lakefield Laboratory facilities.

No field duplicate were collected by the Author. No independent samples were taken during the 2012 drilling campaign. SGS check samples for this resource update were done on the ¼ witness core, pulp and “crushed” samples.

12.1 Independent Sampling – Personal Inspection

The Author visited the site and the Property several times. The last visit with independent sampling took place on February 14 to 17, 2011. Workers involved in exploration campaigns lived at the Pavillon des Passes permanent camp (logging and splitting were done in the Arianne mobile core shack). The drill cores were cross piled on wooden pallets and temporarily stored into the core racks behind the office (Figure 12.1.1). The site was constantly monitored.

Drill sites were identified using numbered wooden sticks. The Author was able to locate the drill holes and verified their location using a hand held GPS. The crosschecked holes had a GPS position consistent with what was recorded in the database. SGS was satisfied with evidence of exploration on site and had no reason to doubt the authenticity of boreholes. Pictures in Figures 12.1.1 and 12.1.2 were taken during the personal inspection of 2011 with Arianne exploration staff, outside the core review set-up (with hole MAN-11-20), core logging and splitting.

Figure 12.1.1 Core Logging Facility and Core Splitting

Figure 12.1.2 Opening Boxes and Reviewing Core Prior to Logging

The personal inspection was positive; sites were clean and well maintained, organization and work process were up to standards and best practices. The site visit is described below.

On Monday February 14, 2011, the Author travelled from Blainville to Saguenay for a meeting at the IOS Laboratory facilities for the presentation of the sample reduction procedures. On Tuesday morning, there was a meeting at Arianne's office followed by travelling to Chute-des-Passes. The site visit included a stop at the drill site in the Manouane Zone followed by a quick review of drill core at a mobile core shack installation. Wednesday consisted of core inspection and selection of samples for independent sampling from two holes. The group then returned back to Saguenay for a meeting at Arianne's office. The Author returned to Blainville on Thursday.

The Author had already extensively sampled and controlled previous drilling campaigns; work was therefore focused on new drilling samples. Core witness samples were taken directly while sub-samples from IOS storage were prepared according to Author's instructions and sent to SGS Blainville.

Samples were put in plastic bags with sample tag identification numbers and sealed with a tie-wrap. Samples in plastic bags were then put into rice bags with sample numbers written on the bags; these were also sealed with tie-wraps and put into the SGS Geostat vehicle. Samples were later transported to the SGS Geostat warehouse in Blainville. Samples were wrapped and shipped to SGS Laboratory by a commercial carrier. Core samples from MAN-11-18 and 19 were taken on site; samples from MAN-11-22 were taken from the IOS storage (these were split samples from the MAN-11-22 1kg crushed samples and their associated 250 grams pulverized sample). See Tables 12.1.1 and 12.1.2 for more details.

Échantill	numéro attr	Trou	1000 g concassé
J414424	19710958	MAN-11-22	Standard DC79003
J414425	19710957	MAN-11-22	Standard SY-4
J414426	19710956	MAN-11-22	blanc
J414464	19710955	MAN-11-22	876
J414465	19710954	MAN-11-22	Blanc 930
J414466	19710953	MAN-11-22	1275
J414467	19710952	MAN-11-22	1138
J414468	19710951	MAN-11-22	1031
J414469	19710950	MAN-11-22	1023
J414470	19710949	MAN-11-22	1125
J414471	19710948	MAN-11-22	1298
J414472	19710947	MAN-11-22	1160
J414473	19710946	MAN-11-22	1463
J414474	19710945	MAN-11-22	1004
J414475	19710944	MAN-11-22	1061
J414476	19710943	MAN-11-22	1023
J414477	19710942	MAN-11-22	1216
J414478	19710941	MAN-11-22	Standard PMRI10
J414479	19710940	MAN-11-22	979
J414480	19710939	MAN-11-22	1428
J414481	19710938	MAN-11-22	1205
J414482	19710937	MAN-11-22	1202
J414483	19710936	MAN-11-22	1212
J414484	19710935	MAN-11-22	1294
J414485	19710934	MAN-11-22	1140
J414486	19710933	MAN-11-22	1459
J414487	19710932	MAN-11-22	952
J414488	19710931	MAN-11-22	942
J414489	19710930	MAN-11-22	1375
J414490	19710929	MAN-11-22	1126
J414491	19710928	MAN-11-22	Standard FER-1
J414492	19710927	MAN-11-22	1014
J414493	19710926	MAN-11-22	1469
J414494	19710925	MAN-11-22	1012
J414495	19710924	MAN-11-22	954
J414496	19710923	MAN-11-22	1070
J414497	19710922	MAN-11-22	1005
J414498	19710921	MAN-11-22	1066
J414499	19710920	MAN-11-22	952
J414500	19710919	MAN-11-22	983
J414501	19710918	MAN-11-22	1053
J414502	19710917	MAN-11-22	1316
J414503	19710916	MAN-11-22	1122
J414504	19710915	MAN-11-22	Blanc 1189
J414505	19710914	MAN-11-22	1026
J414506	19710913	MAN-11-22	1005
J414507	19710912	MAN-11-22	955
J414508	19710911	MAN-11-22	1024
J414509	19710910	MAN-11-22	1041
J414510	19710909	MAN-11-22	1019
J414511	19710908	MAN-11-22	1180
J414512	19710907	MAN-11-22	1372
J414513	19710906	MAN-11-22	1024
J414514	19710905	MAN-11-22	1289
J414515	19710904	MAN-11-22	1015
J414516	19710903	MAN-11-22	Standard PMRI10
J414517	19710902	MAN-11-22	1172
J414518	19710901	MAN-11-22	860
J414541	19710900	MAN-11-22	Blanc

Échantillon	Trou	250 g pulvérisé
J414424	MAN-11-22	Standard DC79003
J414425	MAN-11-22	Standard SY-4
J414426	MAN-11-22	blanc
J414464	MAN-11-22	228.6
J414465	MAN-11-22	Blanc 216,4
J414466	MAN-11-22	226.4
J414467	MAN-11-22	229.0
J414468	MAN-11-22	229.4
J414469	MAN-11-22	245.0
J414470	MAN-11-22	240.0
J414471	MAN-11-22	250.2
J414472	MAN-11-22	245.8
J414473	MAN-11-22	224.6
J414474	MAN-11-22	214.0
J414475	MAN-11-22	216.0
J414476	MAN-11-22	233.3
J414477	MAN-11-22	226.0
J414478	MAN-11-22	Standard PMRI10
J414479	MAN-11-22	223.2
J414480	MAN-11-22	246.8
J414481	MAN-11-22	248.5
J414482	MAN-11-22	223.8
J414483	MAN-11-22	221.3
J414484	MAN-11-22	246.5
J414485	MAN-11-22	236.3
J414486	MAN-11-22	225.9
J414487	MAN-11-22	246.5
J414488	MAN-11-22	236.6
J414489	MAN-11-22	230.0
J414490	MAN-11-22	222.2
J414491	MAN-11-22	Standard FER-1
J414492	MAN-11-22	233.9
J414493	MAN-11-22	211.6
J414494	MAN-11-22	244.8
J414495	MAN-11-22	213.6
J414496	MAN-11-22	211.5
J414497	MAN-11-22	220.9
J414498	MAN-11-22	240.5
J414499	MAN-11-22	237.4
J414500	MAN-11-22	219.8
J414501	MAN-11-22	223.6
J414502	MAN-11-22	245.4
J414503	MAN-11-22	252.3
J414504	MAN-11-22	239.9
J414505	MAN-11-22	Blanc 211,5
J414506	MAN-11-22	229.5
J414507	MAN-11-22	222.2
J414508	MAN-11-22	238.7
J414509	MAN-11-22	237.5
J414510	MAN-11-22	249.4
J414511	MAN-11-22	224.1
J414512	MAN-11-22	232.0
J414513	MAN-11-22	222.1
J414514	MAN-11-22	219.8
J414515	MAN-11-22	228.8
J414516	MAN-11-22	Standard PMRI10
J414517	MAN-11-22	223.3
J414518	MAN-11-22	230.8
J414541	MAN-11-22	Blanc

Table 12.1.1 List of Samples for Verification of the Reduction Process

		SGS data		Ressources Ariannes Data				
Sample #	Type	TiO2	P2O5	NomSondage	NuEchantillon	TiO2	P2O5	
15451	Core	10.8	5.99	MAN-11-18	J414089	10.78	5.68	C
15452	Core	10.7	7.57	MAN-11-18	J414090	10.79	7.58	
15453	Core	8.54	6.43	MAN-11-18	J414091	8.55	6.33	
15454	Core	10.9	7.6	MAN-11-18	J414092	10.57	7.44	
15455	Core	9.87	7.15	MAN-11-18	J414093	9.91	6.97	
15456	Core	4.81	4.37	MAN-11-18	J414094	5.23	4.46	
15457	Core	11.1	8.31	MAN-11-18	J414095	11.7	8.04	
15458	Core	11	7.21	MAN-11-18	J414101	11.35	7.11	
15459	Core	9.76	8.19	MAN-11-18	J414102	10.34	8.00	
15460	Core	9.55	7.27	MAN-11-18	J414103	10.23	7.69	
15462	Core	9.94	6.38	MAN-11-19	J414163	4.04	2.46	
15463	Core	9.73	7.14	MAN-11-19	J414164	9.85	6.23	
15464	Core	9.33	6.65	MAN-11-19	J414165	9.9	6.56	
15465	Core	8.7	6.66	MAN-11-19	J414166	9.89	6.65	
15466	Core	10.5	6.81	MAN-11-19	J414167	9.38	6.79	
15467	Core	10.3	7.08	MAN-11-19	J414168	11.12	6.58	
15468	Core	10.5	5.72	MAN-11-19	J414169	11.52	7.30	
15469	Core	4.97	2.62	MAN-11-19	J414170	11.71	5.67	
15470	Core	4.93	2.66	MAN-11-19	J414171	5.69	2.34	
15471	Core	10.4	7.13	MAN-11-19	J414172	5.14	2.60	

Table 12.1.2 List of Samples for Verification of the Witness Quarter Core

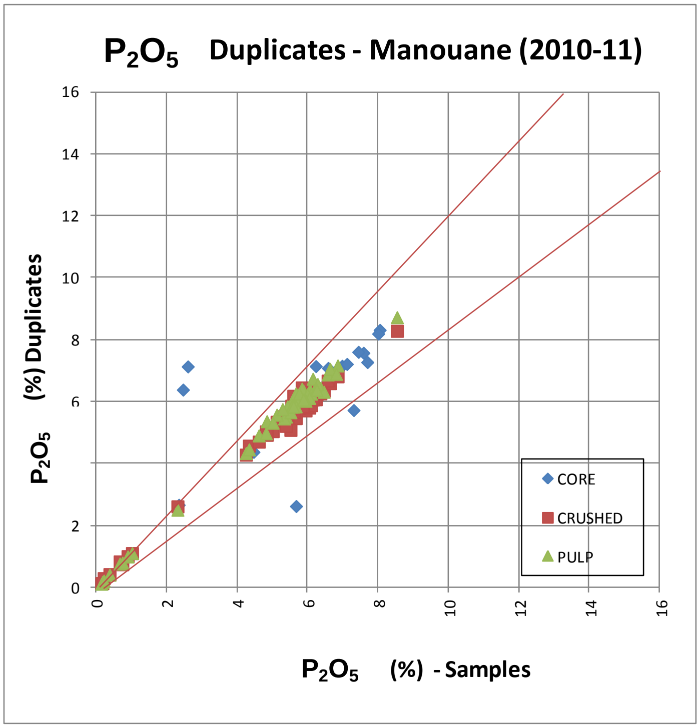


Figure 12.1.3 Correlation Graph Between Original and Control Data

The crushing and reduction stage at the IOS facilities did not indicate a bias. The samples ½ core vs. ¼ core samples showed discrepancies (see Figure 12.1.3). In the Author's opinion, it cannot be said that there is an issue due to the limited number of samples. The discrepancy may come from the different sample size or a physical error in sampling by the Author. The sign-test is good. The control data made by the Author with the core, crushed material and pulp indicated that results in the database were reproducible and reliable for resource estimation.

12.2 Pulp Duplicate Verification

Laboratory duplicates were verified by SGS personnel under the Author's supervision. Results for P_2O_5 and TiO_2 were reviewed. The pulp analysis results are considered reliable and repeatable as shown in Figures 12.2.1 and 12.2.2 for the Manouane and Paul Zones.

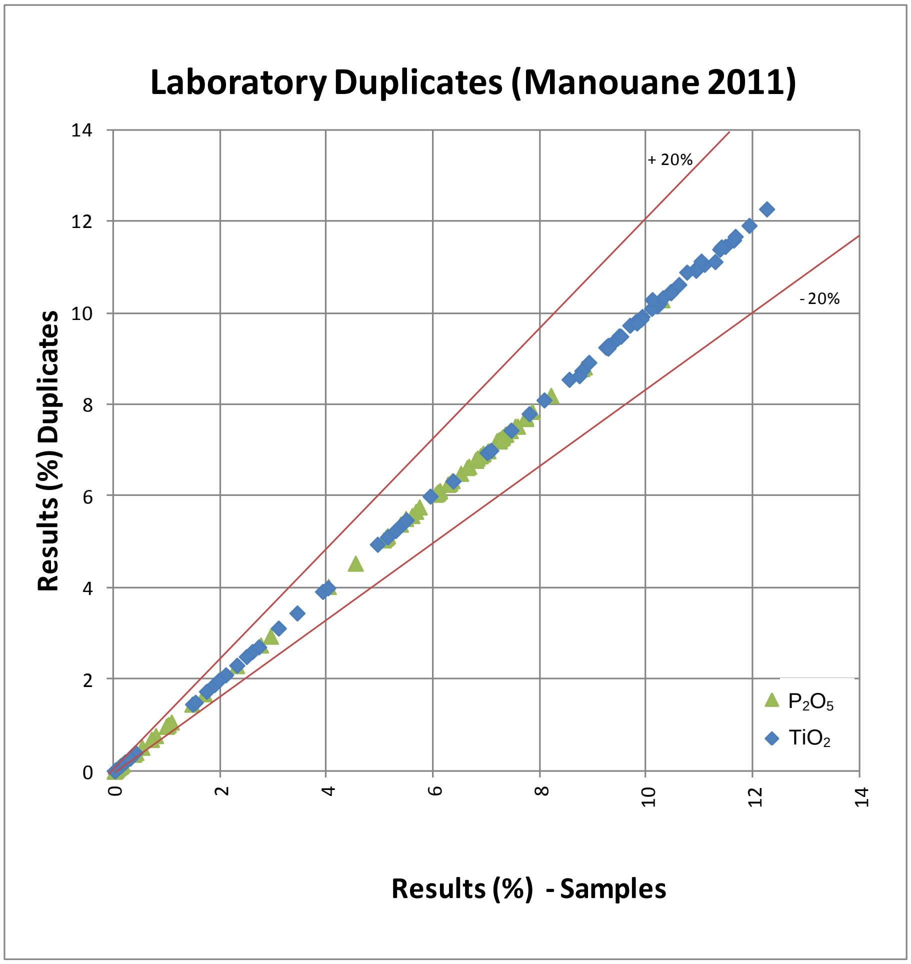


Figure 12.2.1 Correlation Graph Between Original Data and Lab Duplicates (Manouane P_2O_5 and TiO_2)

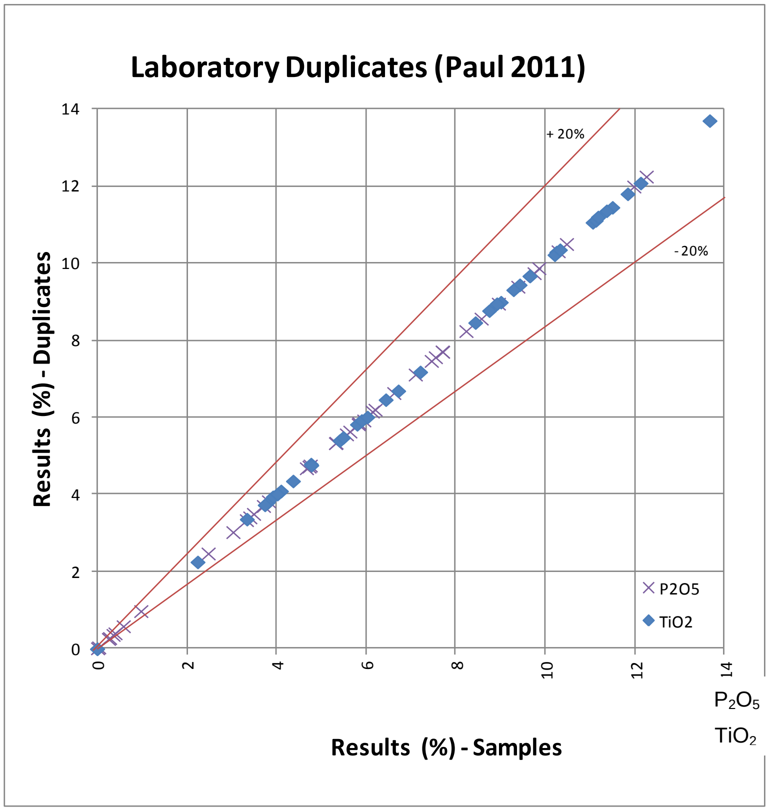


Figure 12.2.2 Correlation Graph Between Original Data and Lab Duplicates (Paul P_2O_5 and TiO_2)

12.2.1 2012 Personal Inspection

The Author, Claude Duplessis, Eng. and QP, visited the Lac a Paul Property site a total of six (6) times: on August 22-23, 2008, November 12-14, 2008, February 1-4, 2009, February 14-17, 2011, February 6-7, 2012, and November 12-15, 2012, including a meeting in Chicoutimi and a site visit. Pictures were taken during the 2012 site visits and are included in Figures 12.2.3 and 12.2.4.

Figure 12.2.3 Cores at the Pavillon des Passes Facilities in Winter 2012

New Core Racks

Mobile Core Splitting Facilities

Inside of the Clean and Well Maintained Splitter **Fresh Core at the Drill**

Core Inspection by Mr. Henry Lamb **Discussions Between H. Guérin and H. Lamb**

Figure 12.2.4 Arianne's Exploration Camp Set-up in Fall 2012

13. MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 Introduction

Preliminary metallurgical investigation of the Lac a Paul deposit was first carried out in 2008 by SGS (Lakefield). In 2011, COREM was contracted to carry out test work to establish physical and mineralogical properties of a sample of Paul Zone ore and to evaluate the flotation response of apatite utilizing both laboratory scale and pilot scale equipment. In the spring of 2012, COREM also investigated the potential of processing ilmenite and magnetite as by-products from the apatite beneficiation process.

In June 2012, Arianne awarded a contract to Jacobs Engineering (Jacobs) for metallurgical testing of ore from the Paul and Manouane deposits. Core and bulk samples from the Paul deposit and core samples from the Manouane deposit were received at Jacobs' Lakeland, Florida laboratory facility in July 2012. Testing was configured into three components:

- A drill core test program consisting of ore characterization and size reduction tests, bench-scale desliming evaluation, and bench scale flow sheet confirmation and optimization.
- A bulk sample pilot test program to evaluate apatite recovery from the Paul ore. Mechanically agitated flotation cells were used for the test program.

- A supplemental testing program to develop design criteria for dewatering of tails and concentrates and to develop data for environmental purposes was to be conducted on products of the pilot plant testing.

In late 2012 and early 2013, COREM also conducted bench and pilot scale testing of an identical bulk sample of Paul ore. The test program was designed to evaluate the flotation response of the Paul ore using column flotation cells. The goals of the column flotation pilot plant test program were:

- To determine if 39% P_2O_5 or higher concentrate grade with at least 90% P_2O_5 recovery could be attained using flotation columns.
- To provide process performance data to support the selection of either flotation columns or mechanically agitated flotation cells for the feasibility study (FS).
- To provide engineering data to support the ongoing FS conducted by Cegertec WorleyParsons.
- Provide samples of concentrate and tailings for supplemental testing by outside vendors.

The following sections summarize previous test work and describe the results from the 2012/2013 test programs conducted by COREM, Jacobs and others.

13.2 Previous Test Work Summary

13.2.1 SGS Test Program, 2008

SGS (Lakefield, Ontario) conducted a preliminary metallurgical test program in 2008. The test program objective was to assess the concentrate quality of the apatite.

SGS Lakefield's report was first referenced in a previous NI 43-101 Technical Report and the complete test report can be found in Appendix 1 of the SGS Geostat Ltd. report entitled: "Technical Report Phosphate and Titanium Resource Estimation of the Lac a Paul Property Deposit", dated May 8, 2009. Some results are referenced in Section 13.2.2 of said report.

13.2.2 COREM Test Program, 2011

In 2011, COREM was contracted to carry out ore characterization and variability testing, mineralogical analysis, bench scale flotation testing, and pilot plant flotation testing on a sample of Paul ore Zone.

Additional bench scale grinding and flotation test work were performed on three samples from Paul and Manouane Zones. The test program objective was to evaluate the P_2O_5 recovery of lower grade Paul Zone ore and obtain preliminary indications of P_2O_5 recovery for the Manouane zone.

The pilot plant test program was also conducted to generate a nominal 150 kg sample of apatite concentrate from the Paul Zone for subsequent phosphoric acid pilot plant testing.

COREM also conducted a comparative analysis of the effect of using magnetic separation at the grinding mill discharge (prior to flotation) and of the flotation concentrate.

Results and findings from the 2011 COREM test program are summarized as follows.

- Ore characterization showed the following:
  - The major gangue minerals are magnetite, ilmenite, pyroxene, and micas (chlorite and phlogopite).
  - Apatite liberation is in the 75 µm to 150 µm range.
- Grinding and work index determination testing showed that:
  - There is a direct link between apatite ore grade and work index; with ball mill work indices of 14.8, 11.6 and 10.3 kWh/T for low, medium, and high grade ore, respectively. The same relationship was shown to apply for rod mill and crushing work indices.
  - Apatite is reduced in size preferentially when compared to its harder gangue components.
  - Removal of ferrous bearing minerals was successfully applied pre-flotation via a hand magnet. Apatite losses to the magnetic concentrate were low and varied from 1.7% to 3.3% by weight.
- Bench scale flotation test work showed that:
  - Reagent conditioning at pulp densities >45% by weight resulted in improved flotation performance compared to conditioning at pulp densities <45%.
  - Conditioning and flotation at a pH >10.5 gave improved performance compared to conditioning at a lower pH.
  - The reagent suite that gave the highest P_2O_5 recovery and grade consisted of a phosphate collector (Liacid) and depressants (sodium silicate and starch). Sodium hydroxide was used as a pH regulator.

COREM also conducted a bench scale locked cycle test to determine the impact of recycle middling streams on flotation performance. The locked cycle test was terminated after 7 cycles with a final concentrate grade of 38.5% P_2O_5 at 94.2% P_2O_5 recovery. It should be noted that the locked cycle test results also indicated that equilibrium had not been attained after 7 cycles and therefore should have been extended until consecutive cycles showed similar (stable) flotation response.

Finally, COREM conducted pilot plant testing of the bulk Paul ore sample using the process flow sheet derived from the bench test program; namely, ball mill grinding in closed circuit with a vibrating screen, magnetite removal using a Low Intensity Magnetic Separator (LIMS), and reagent conditioning and froth flotation using mechanically agitated flotation cells configured as a rougher/scavenger with two cleaners. Pilot plant test results, 32.4% P_2O_5 final product grade at 78.2% P_2O_5 recovery, were inferior to that obtained on the bench. COREM suggested that the reason for the inferior pilot plant performance was that that the pilot plant feed had been too finely ground (the flotation feed F_{80} used for the pilot plant test was 138 µm compared to the bench test feed F_{80} of 200 µm). COREM further speculated that, due to the fineness of grind, the sodium silicate depressant dosage was too high and also resulted in the secondary depression of fine apatite. COREM concluded that acceptable flotation performance could be attained with a suitable grind and proper depressant dosages.

13.2.3 COREM Test Program, 2012

In 2012, COREM was contracted to conduct a series of ilmenite concentration tests and to develop a preliminary process flow sheet to evaluate the feasibility of upgrading ilmenite to produce a saleable concentrate.

The program consisted of mineralogical analysis, grinding tests, gravity concentration tests, magnetic concentration (separation) tests, and flotation tests on a sample of the Paul ore.

When the test campaign was initiated, the ilmenite separation circuit was located ahead of the apatite concentration circuit and therefore tests were carried out on a head sample. However, as test results became available, COREM relocated the ilmenite circuit after the apatite flotation circuit in order to minimize apatite losses. Accordingly, apatite flotation tailings from the previous test work campaign were retrieved and subjected to ilmenite concentration tests.

Findings from the test work carried out on the head sample and on the apatite tailings sample were reported by COREM and are summarized below.

- Froth flotation, consisting of a rougher/scavenger and two (2) cleaners, resulted in a concentrate grade of 44.9% TiO_2 at 51.5% recovery.
- Mineralogical evaluation showed that upgrading the magnetite to >65% Fe was not viable due to very small ilmenite inclusions (<2 micron) that prevent complete liberation of the magnetite.

13.3 FS Test Programs

At the Feasibility Study (FS) kick-off meeting in September, 2012, Arianne made the following key decisions:

- The FS would be based on recovery of the phosphate bearing minerals only. Therefore, by-product recovery of magnetite or ilmenite would not be included in the FS.
- The FS would address the exploitation of the Paul resource only. The potential exploitation of the Manouane deposit would be addressed at some future date.

Accordingly, the FS Test Program Report will address test work associated only with recovery of apatite from the Paul resource.

FS test programs were conducted by multiple contractors as summarized below:

- Samples of bulk Paul ore and concentrate were shipped to Jenike & Johanson (J&J) to evaluate the material flow characteristics.
- A sample of final concentrate was shipped to FLSmidth for drying tests.
- COREM conducted preliminary bench and pilot plant testing of flotation columns. Concentrate and tailings samples generated from pilot plant testing were subsequently tested by Outotec (filtration) and FLSmidth (thickening).
- Jacobs conducted ore characterization testing and preliminary bench scale flotation tests on core and bulk samples from the Paul deposit. Jacobs also subcontracted tests to vendors to determine the Bond abrasion index, JK drop weight, Bond ball mill work index, and Qemscan analysis.

13.3.1 Material Flow Characteristics (J&J)

Jenike & Johanson Limited (J&J) conducted flow Property tests on samples of coarse ore and phosphate rock concentrate product. The test results are to be used in the FS to provide data for design of the material storage and reclaim systems to ensure reliable handling.

The flow Property program consisted of the tests listed below performed at moisture contents that varied between 2% and 8.3% for concentrate; as-received ore at 0.3% moisture; and -8 mesh (Tyler) ore where the moisture was varied from 4.5% to 9.5%.

- Particle density - liquid displacement using a 100 ml graduated cylinder.
- Compressibility - determines the bulk density vs. consolidating pressure relationship.
- Flow Function - for calculating the critical outlet dimensions.
- Wall Friction - for calculating mass-flow hopper angles.
- Permeability - for predicting critical steady state flow rates of de-aerated material.
- Critical Chute Angle - for calculating critical chute angle.

- Bench Scale Angle of Repose and Drawdown - for determining angles of repose and drawdown.
- Frozen Unconfined Strength - for various moisture contents at low pressure.
- Frozen Unconfined Strength - for selected moisture content at various pressures.

The flow function and wall friction tests were performed to represent conditions of continuous flow and, for some moisture contents, flow after 24 hours and 72 hours of storage at rest.

The test data by J&J shows that the test materials are somewhat cohesive and have the ability to form a rathole if stored in a funnel-flow bin. The material can be handled in a funnel-flow or an expanded flow bin if:

- The opening is large enough to overcome arching and ratholing,
- A first-in last-out flow pattern is acceptable,
- The material does not degrade with time, and
- Particle segregation is not a concern.

The material may also be handled in a mass-flow bin, which provides a first-in first-out flow pattern and eliminates ratholes and the accompanying stagnant material. One of the requirements for achieving mass-flow is to size the outlet large enough to prevent arching.

Tests were run to determine the minimum chute angles required for non-converging flat chutes to reinitiate flow after an impact that causes the material velocity to go to zero. The results indicate that the material is slightly sensitive to impact pressure. A low drop height is recommended to minimize the impact of material falling onto the chute.

Bench scale angle of repose tests were performed on the concentrate and the minus 8-mesh fraction of the ore. At both moisture contents, 2% and 8.3%, the angle of repose was found to be steepest towards the center of the pile and shallowest at the toe of the pile. The results are shown in the Table 13.3.1.

Material	Moisture Content (%)	Angle of Repose (from horizontal)	Drawdown Angle (from horizontal)
Concentrate	8.3	38 - 54	67 - 80
	2.0	44 - 50	73 - 87
Ore, -8 mesh	9.5	40 - 50	60 - 80
	4.5	40 - 45	55 - 70

Table 13.3.1 Bench Scale Angles of Repose

The flow Property test results are presented in the J&J report titled “Flow Property Test Results for Phosphate Concentrate and Ore, dated July 5, 2013.

13.3.2 Concentrate Drying Tests

FLSmidth Inc. conducted a test program to evaluate the feasibility of using a gas suspension flash drying system to reduce the moisture content of the apatite concentrate from approximately 8% to <1% (by weight).

The as-received apatite (phosphate) concentrate contained less than 1% moisture. FLSmidth mixed water with the material to obtain a moisture content approaching the commercial feed moisture specification of 8 wt.% (7.5% actual). This material demonstrated flow properties suitable for processing in the flash dryer. Additional mixing tests revealed that the material became sticky and demonstrated poor handling properties when the moisture content was increased to 10%.

The conditioned feed was then processed using flash dryer exit gas temperatures in the range of 90-150°C to generate products with moisture levels in the range of 0.14% to 0.16% by weight. The extent of drying was found to be consistent across the temperature range evaluated. No operational issues were observed during the operation of the flash dryer.

The testing demonstrated that the flash dryer system is suitable for reducing the moisture content in the apatite to <1%. Larger scale flash dryer testing is recommended using a representative filter cake sample to confirm the results of this study and to generate additional data required to finalize commercial dryer system sizing.

13.3.3 Test Work by Jacobs and Subcontractors to Jacobs

Core and bulk samples from the Paul deposit and core samples from the Manouane deposit were received at Jacobs’ Lakeland, Florida laboratory facilities in July 2012. The test program was originally configured into three components as shown below; however, the bulk sample and some supplemental test programs were not performed by Jacobs.

- A drill core test program consisting of ore characterization and size reduction tests, bench-scale desliming evaluation, and bench scale flow sheet confirmation and optimization.
- A bulk sample pilot test program to evaluate apatite and ilmenite recovery from Paul ore. Mechanically agitated flotation cells were used for the test program.
- A supplemental testing program to develop design criteria for dewatering of tails and concentrates and to develop data for environmental purposes was to be conducted on products from the pilot plant testing.

Ore characterization and size reduction tests were performed by Jacobs, Hazen Research Inc., Phillips Enterprises, LLC, SGS Mineral Services, and the Colorado School of Mines. The objective of the test work program was to obtain specific data on the ore and determine if a 40% P_2O_5 concentrate grade could be obtained with a high level of P_2O_5 recovery.

The findings from the test program conducted by Jacobs are summarized as follows:

- Provided design data for beneficiation of Lac a Paul ore and completed the Manouane and Paul ore characterization and size reduction test program.
- Demonstrated that ore from the Paul deposit can achieve a 40% P_2O_5 grade with 87% P_2O_5 recovery and acceptable MER and CaO/P_2O_5 ratio. This finding is based on bench-scale tests using mechanical flotation cells by Jacobs and pilot-scale column flotation testing by COREM.
- Demonstrated that magnetic separation and desliming are not needed prior to flotation.
- Demonstrated by ore variability tests that the nine ore types with head grades assaying from 3.9 to 12.8% P_2O_5 can consistently achieve a 40% P_2O_5 concentrate grade with P_2O_5 recovery ranging from 63% to 92%.
- The same bulk ore sample was floated using pilot scale column flotation cells and mechanical flotation cells. After reviewing the results from both cell types, it is Jacobs' opinion that column cells appear to be a superior option for beneficiating Lac a Paul ore.

A summary of the test results are given in the following sections.

13.3.3.1 Specific Gravity and Bulk Density Evaluation

The specific gravity of solid core fragments from the Paul deposit ranged from 2.75 to 3.63, indicating differences in mineralization. These samples represent five grades of Paul ore ranging from very low (Paul LL) to very high (Paul HH). Negligible difference in dry and moist densities indicates a lack of porosity within the core fragments. Results of these tests are provided in Table 13.3.2.

Sample I.D.	W1 (g)	W2 (g)	Ww (g)	Dry Density	Moist Density
LL	163.3	163.3	59.3	2.75	2.75
L	251.3	251.3	85.3	2.94	2.95
A	321.2	321.2	100.6	3.19	3.19
H	242.9	242.9	68.6	3.54	3.54
HH	317.6	317.6	87.6	3.63	3.63

Table 13.3.2 Specific Gravity of Paul Core Samples

Bulk density was determined using core samples which were crushed to pass 8 mesh (2.83 mm). Table 13.3.3 gives the results for those tests.

Sample I. D.	Weight (g)	Loose Volume (cc)	Tamped Volume (cc)	Loose Density	Tamped Density
LL	1472.7	980	900	1.50	1.64
L	1651.7	990	900	1.67	1.84
A	1934.3	990	900	1.95	2.15
H	1969.4	985	890	2.00	2.21
HH	1983.6	990	900	2.00	2.20

Table 13.3.3 Bulk Density of Crushed Paul Ore

As part of the ore characterization, Jacobs also completed sieve and chemical analyses of crushed ore from average and below average grade samples. These data are presented in Jacobs' Interim Testing Report, dated October, 2012.

13.3.3.2 Bond Abrasion Test and JK Drop Weight Tests

Samples were shipped to Hazen Research, Inc. (Hazen) for the following tests:

- Manouane Deposit – SAG mill comminution (SMC) test to determine A and B parameters.
- Paul Deposit – JK Drop Weight Test to determine A and B parameters.
- Paul Deposit – Bond Abrasion Test.

Five 80-kg samples from the Paul deposit were sent to Hazen for the JK Drop Test to determine A and b parameters. Based on these tests, the resistance to breakage for Paul ore ranged from very soft to soft. The Ta parameter indicates resistance to abrasion breakage. Like the A*b parameter, a smaller value of Ta indicates greater resistance to breakage. Bimodality refers to relative density histograms for 30 particles of each sample. No bimodality indicates that there is no evidence of a dense component that could concentrate in the mill load and cause power problems. Likewise, slight and definite bimodality indicates that there is, respectively, slight and definite evidence of a dense component that could concentrate in the mill, cause power problems, and result in a loss of throughput. Table 13.3.4 show the Drop test results.

Sample	A*b	Resistance to Breakage	Ta	Abrasion	Mean Density	Bimodality
Paul LL	96	soft	0.40	moderate	2.88	no
Paul L	75.7	soft	0.29	hard	3.06	slight
Paul A	116.8	very soft	1.04	soft	3.60	definite
Paul H	123.3	very soft	0.85	soft	3.54	definite
Paul HH	93	soft	0.47	moderate	3.56	definite

Table 13.3.4 JK Drop Test Results Summary

The two 1.6-kg samples of Paul ore sent to Hazen for Bond abrasion testing represent below average (Paul L) and average (Paul A) grades of ore. Details and equations for calculating wear rates are in the Hazen report presented in Jacobs' Interim Testing Report, dated October, 2012. The Abrasion Index (Ai) is the difference in original weight and final weight in grams of a test coupon. The Ai for below average grade (Paul L) was low but about 3 times greater than for average grade (Paul A), which was very low. The resulting calculations indicate that Paul L ore has greater wear rates for rod mills, ball mills, and crushers. Table 13.3.5 shows the Bond Abrasion test results.

Abrasion Index (g)	P_{80} (µm)	Wear Rate (lb/kWh)							
		Wet Rod Mill		Wet Ball Mill		Dry Ball Mill		Crusher	Roller Crusher
		Rods	Liner	Balls	Liner	Balls	Liner	Liner	Roll
0.2433	11,960	0.2593	0.0225	0.2150	0.0167	0.0247	0.0025	0.0421	0.0839
0.0843	10,177	0.2022	0.0157	0.1450	0.0117	0.0145	0.0015	0.0277	0.0414

Table 13.3.5 Bond Abrasion Test Results Summary (Paul L = 1st line, Paul A = 2nd line)

13.3.3.3 Bond Impact and Ball Mill Work Index Tests

Samples were shipped to Phillips Enterprises, LLC (Phillips) to conduct the following tests:

- Bond low-energy impact test.
- Bond ball mill work index.

Results are summarized in Tables 13.3.6 and 13.3.7.

The Bond low-energy impact test requires 20 pieces of rock that are generally between 2 to 3 inches thick. The Crusher Work Index (CWi) is calculated from the averaged impact energy for breakage of the 20 pieces of rock.

Sample ID	Specific Gravity	Average Impact Energy for	CrusherWork Index(kW)
Paul L	3.02	0.607	10.75
Paul A	3.58	0.413	6.17

Table 13.3.6 Bond Low-Energy Impact Test Results Summary

Bond ball-mill grindability tests were conducted on eight 15-kg samples of core crushed to -6 mesh (-3.36 mm). The ball-mill work indices for low grade (L and LL) Paul material indicate hard ore. Indices for all other grades of Paul ore and Manouane ore are an indication of medium hardness.

Sample ID	F_{80}	P_{100} (microns)	P_{80}	Grams per Revolution	Ball Mill Work Index (kW-hr/tonne)
Paul LL	2191	150	126	1.643	15.23
Paul L	2500	150	121	1.628	14.66
Paul A	2131	150	127	2.126	12.45
Paul H	2400	150	123	2.060	12.28
Paul HH	2201	150	126	2.191	12.02

Table 13.3.7 Bond Ball Mill Grindability Test Results Summary

13.3.3.4 Autogenous Grindability Test

Two 175 kg samples of Paul core were evaluated by SGS Mineral Services (SGS) using the MacPherson Autogenous Grindability Test. Table 13.3.8 and 13.3.9 below summarize results of testing by SGS.

Per the SGS Autogenous Work Index data base, Paul A ore is very soft and Paul L rock is of medium hardness. The interim results are provided in the Jacobs' Interim Testing Report, dated October, 2012.

Sample	Feed -1/4" Density*	Charge -1/4" Density*	Charge +1/2" Relative Density**
Paul A	3.64	3.70	3.59
Paul L	3.19	3.19	3.06

* Gas Pycnometer in g/cm^3
** Water Displacement

Table 13.3.8 Ore Density Summary

Sample	Feed (kg/h)	F_{80} (µm)	P_{80} (µm)	Gross Work Index (kWh/tonne)	Correlated Work Index (kWh/tonne)	Hardness Percentile	Gross Energy Input (kWh/tonne)
Paul A	30.3	22,205	272	5.4	5.4	3	2.92
Paul L	13.3	22,213	304	12.6	12	27	6.39

Table 13.3.9 MacPherson Autogenous Grindability Test Results Summary

13.3.3.5 Qemscan Analysis

Four size fractions of ore from Manouane A, Paul A, and the average grade bulk Arianne sample were evaluated by the Colorado School of Mines (CSM) using Qemscan analysis.

Per the CSM definition, a mineral is completely liberated if >85% of the particle consists of only the respective mineral. A mineral is locked if the area of the respective mineral is <35% in the entire particle. Everything between locked and completely liberated is termed a middling.

Apatite liberation in the Paul A sample and in the bulk sample is greatest in the -35 mesh (-425 µm) fractions, ranging from 81% to 91% of volume in the bulk sample and from 85% to 90% of volume in the Paul A sample. Based on this result, initial grinding for bench-scale flow sheet confirmation and optimization will be to 100% passing 35 mesh (Tyler), or 425 µm.

The test report results by CSM are provided in Jacobs' Interim Testing Report, dated October, 2012.

13.3.3.6 Bench Scale Desliming Evaluation

This phase of testing was designed to determine the particle size distributions from ball mill and rod mill grinding of average and high grade core samples and the bulk ore sample from the Paul deposit. Testing was to involve sieving and chemical analysis of twelve ground products to establish the distribution of phosphate, ilmenite, and impurities by size fraction. However, analytical issues prevented Jacobs from completing this task and, based on subsequent bench scale and pilot plant testing by COREM, the completion of this work was considered redundant and unnecessary.

13.3.3.7 Ore Variability Testing

Ore variability tests were conducted on nine samples from the Paul deposit. The nine samples have varying P_2O_5 head grades with varying levels of gangue material. Ore variability tests were conducted to determine flotation response (P_2O_5 grade and recovery) differences of the samples tested. The ore variability tests were conducted on the following samples:

- Five samples from low, average and high grade identified as: Paul LL, Paul L, Paul A, Paul H and Paul HH.

- Four additional samples that Arianne identified as follows:
  - Sample P1 composite of samples 1 and 2 for test 1 consisting of anorthositic gabbro.
  - Sample P2 composite of samples 3 and 4 for test 2 consisting of gabbro with insert of nelsonite.
  - Sample P3 is sample 5 for test 3 consisting of olivine-rich nelsonite.
  - Sample P4 is sample 6 for test 4 consisting of olivine-poor nelsonite.

Head assays were carried out on each sample and are presented in Table 13.3.10.

Sample ID	P_2O_5 %	SiO_2 %	TiO_2 %	Fe_2O_3 %	Al_2O_3 %	MgO %	CaO %	Na_2O %	K_2O %
Paul LL	3.32	37.78	2.57	9.23	9.51	3.41	7.93	4.76	1.09
Paul L	4.65	33.97	4.51	13.69	9.65	5.01	8.73	3.52	0.88
Paul A	7.05	24.57	9.15	31.44	4.65	11.00	9.65	0.63	0.35
Paul H	9.92	21.24	9.10	30.97	4.08	11.19	12.07	0.48	0.28
Paul HH	11.79	16.88	7.73	28.35	3.22	9.33	15.02	0.60	0.20
Sample P1	4.05	30.75	4.22	11.39	11.58	5.38	9.26	3.70	1.03
Sample P2	5.77	30.45	5.67	19.34	6.48	5.83	10.08	2.06	0.56
Sample P3	8.38	18.33	6.46	37.90	1.41	13.04	11.03	0.39	0.01
Sample P4	11.48	15.79	9.83	33.25	1.75	12.51	14.42	0.33	0.07

Table 13.3.10 Head Sample Assays

Figures 13.3.1 and 13.3.2, show that the % P_2O_5 is predominantly in the minus 100 mesh (-150 µm size fractions. Jacobs concluded that de-sliming at minus 635 mesh (-23 µm) prior to flotation is not necessary as this would significantly reduce P_2O_5 recovery and would not improve product grade.

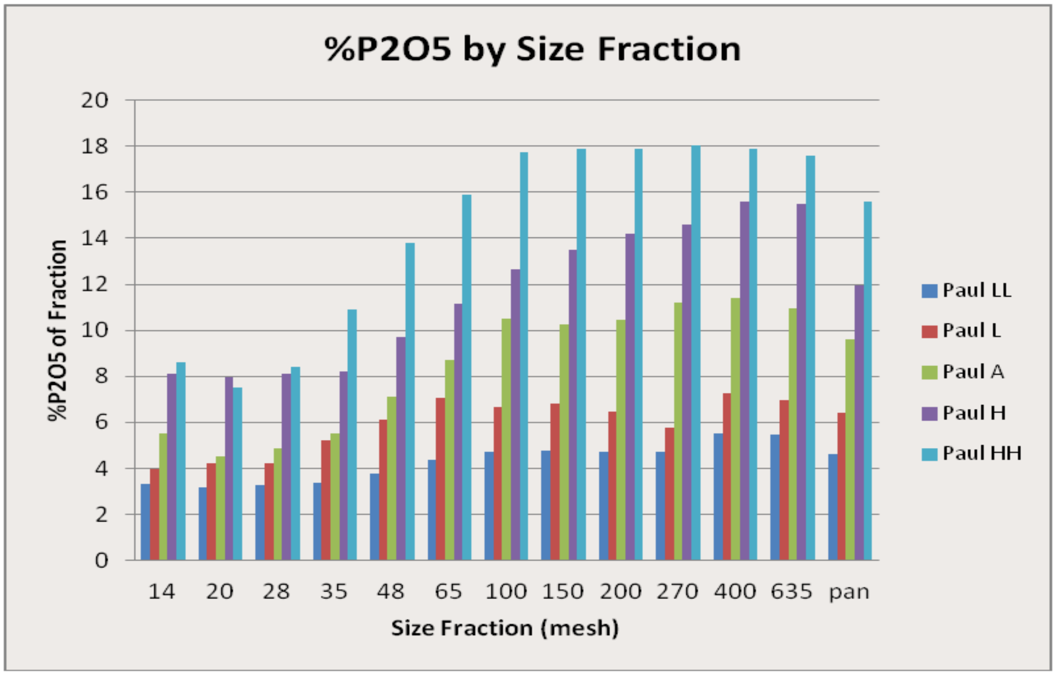


Figure 13.3.1 P_2O_5 Distribution by Sieve Fraction, Paul Samples

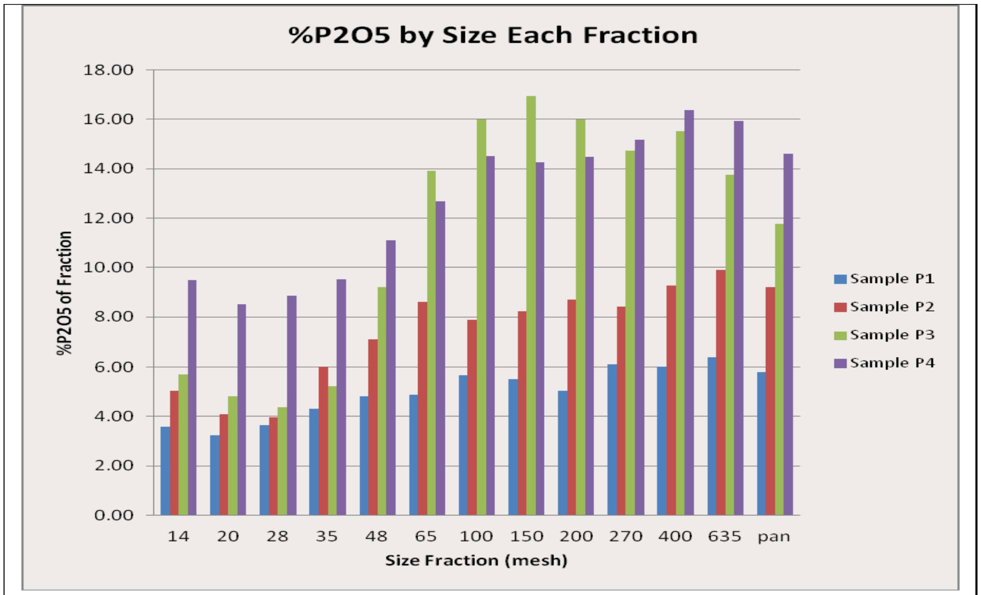


Figure 13.3.2 P_2O_5 Distribution by Sieve Fraction, Paul Composite Samples

Flotation tests were conducted on milled samples (100% passing 100 mesh) with no magnetic separation or de-sliming. The flotation flow sheet (Figure 13.3.3) was comprised of rougher and three cleaner flotation stages in open circuit. The reagent scheme for the rougher conditioning was comprised of soda ash (Na_2CO_3) as the pH modifier, caustic starch as the iron depressant, and FA2 as the phosphate collector. Conditioning was 13 minutes at a pulp density of 72% solids. A pulp pH of 9.9 was maintained using caustic soda for all flotation stages. In the cleaner circuits, caustic starch and sodium silicate were used as a depressant to produce a final cleaner concentrate. Five products were collected for each flotation test as shown in Figure 13.3.3.

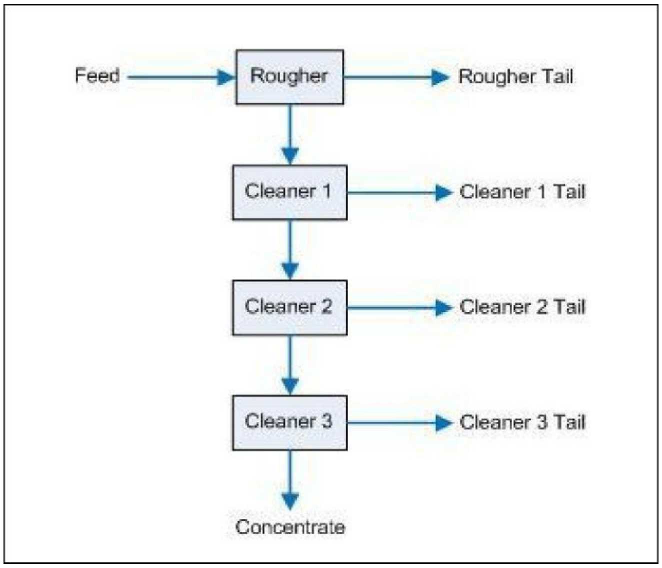


Figure 13.3.3 Flotation Test Flow Diagram, Ore Variability Tests

A total of thirty-six open-circuit bench-scale tests were carried out to examine ore variability of the nine samples. Four tests were completed on each sample, each with varying dosages of FA2 phosphate collector.

Figure 13.3.4 illustrates the head grade % P_2O_5, the cleaner 3 concentrate % P_2O_5, and the % P_2O_5 recovery at the optimum dosage of phosphate collector for each sample. It can be seen that the concentrate grade was similar for all the samples tested; however, the P_2O_5 recovery varied between the samples tested. The highest recovery, 92.5% P_2O_5, was attained on the Paul HH sample. The variability test work results are summarized in Table 13.3.11.

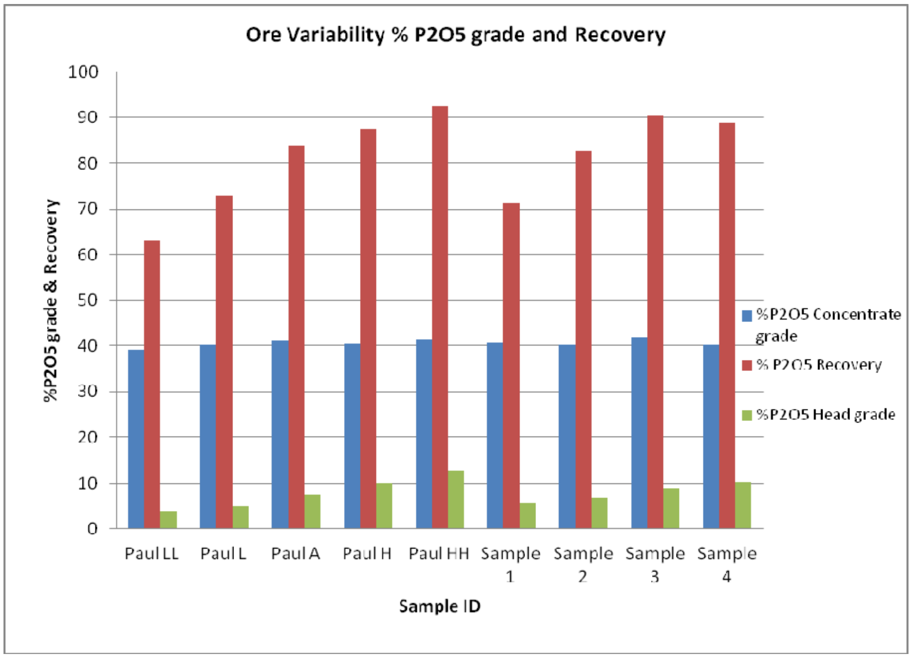


Figure 13.3.4 Ore Variability Test Results

Sample ID	Assays (%)						Recovery (%)		Ratios	
	Feed			Cleaner3 concentrate			P_2O_5	Weight	MER	CaO/ P_2O_5
	P_2O_5	Fe_2O_3	TiO_2	P_2O_5	Fe_2O_3	TiO_2				
Paul LL	3.86	8.94	2.52	39.09	0.67	0.06	63.10	6.2	0.035	1.295
Paul L	4.95	13.82	4.45	40.40	0.71	0.11	72.81	8.9	0.031	1.268
Paul A	7.54	31.31	9.04	41.22	0.79	0.24	83.76	15.3	0.039	1.222
Paul H	10.13	30.88	8.85	40.47	1.42	0.63	87.41	21.9	0.070	1.272
Paul HH	12.71	28.80	7.58	41.26	1.00	0.64	92.42	28.5	0.053	1.222
Sample P1	5.69	10.98	4.26	40.70	0.54	0.05	71.29	10.0	0.034	1.242
Sample P2	6.93	18.64	5.53	40.21	0.70	0.12	82.78	14.3	0.026	1.281
Sample P3	8.88	37.72	6.37	41.80	0.67	0.11	90.30	19.2	0.031	1.222
Sample P4	12.07	34.84	9.92	40.19	1.45	1.02	88.81	26.7	0.075	1.264
Paul Bulk	7.69	20.45	5.99	39.40	1.30	0.38	82.17	16.1	0.088	1.249

Table 13.3.11 Summary of Flotation Test Results

The results obtained from the ore variability test program are similar to those obtained on the Paul bulk ore sample. The P_2O_5 grade for the bulk Paul ore sample ranged from 39.09% to 41.80%, with a P_2O_5 recovery ranging from 63.1% to 92.4%, and a mass weight recovery to concentrate varying from 6.2% to 28.5%.

13.3.3.8 Locked Cycle Testing (Paul Average Ore)

The main objective of locked-cycle flotation tests on Paul average ore was to investigate the flotation behavior with mine-site water and verify the reproducibility of results using the recycled water. In total, 9 tests (cycles) were completed while maintaining the flotation test parameters such as % solids, reagents addition, pH, and conditioning time at constant levels. The locked-cycle test was configured as shown in Figure 13.3.5 where the second and third cleaner tailings were recycled to the rougher feed, and the final tails consisted of the rougher tails and the cleaner 1 tails.

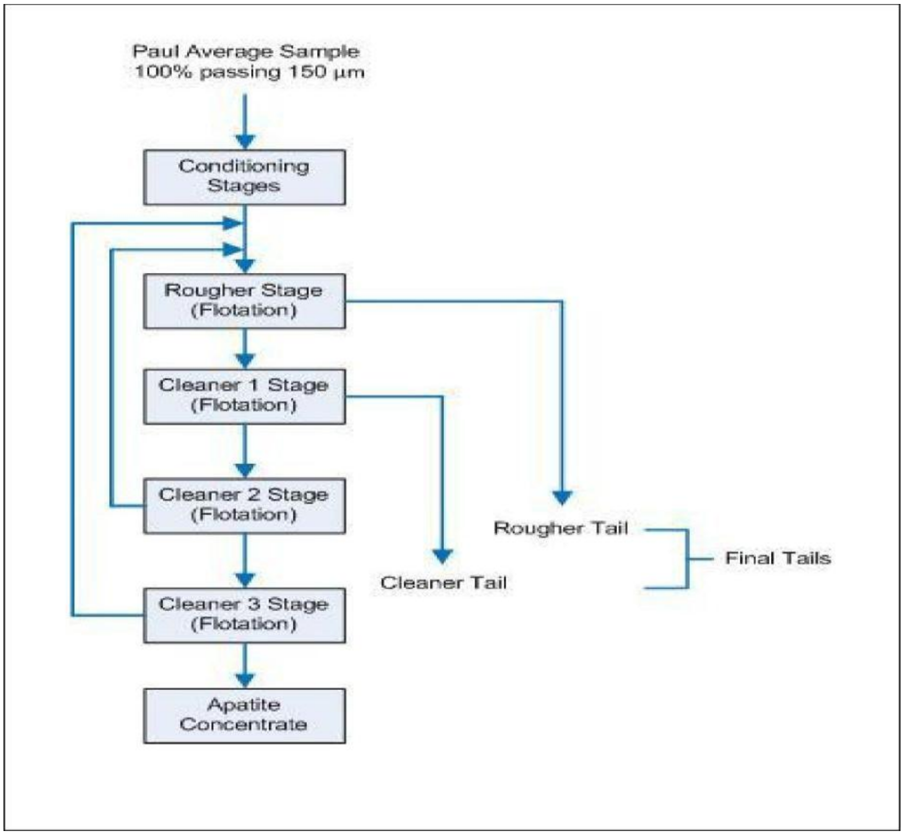


Figure 13.3.5 Locked Cycle Test Block Flow Diagram

The bench-scale locked-cycle tests performed on Paul average ore produced excellent phosphate concentrate grades at acceptable recoveries. The variation of the percent P_2O_5 grade and recovery for the locked-cycle tests is given in Figure 13.3.6.

The locked-cycle tests produced an average concentrate grade of 40.45% P_2O_5 with a P_2O_5 recovery of 85%. The final tailings contained an average P_2O_5 grade of 1.37%, which calculates to a 15% P_2O_5 loss with high content of magnetic material and other gangue minerals.

The MER and CaO/P_2O_5 from the locked-cycle tests were acceptable with values of <0.08 and <1.3, respectively. The concentrate analyzed 631 ppm total chloride and 2.82% F.

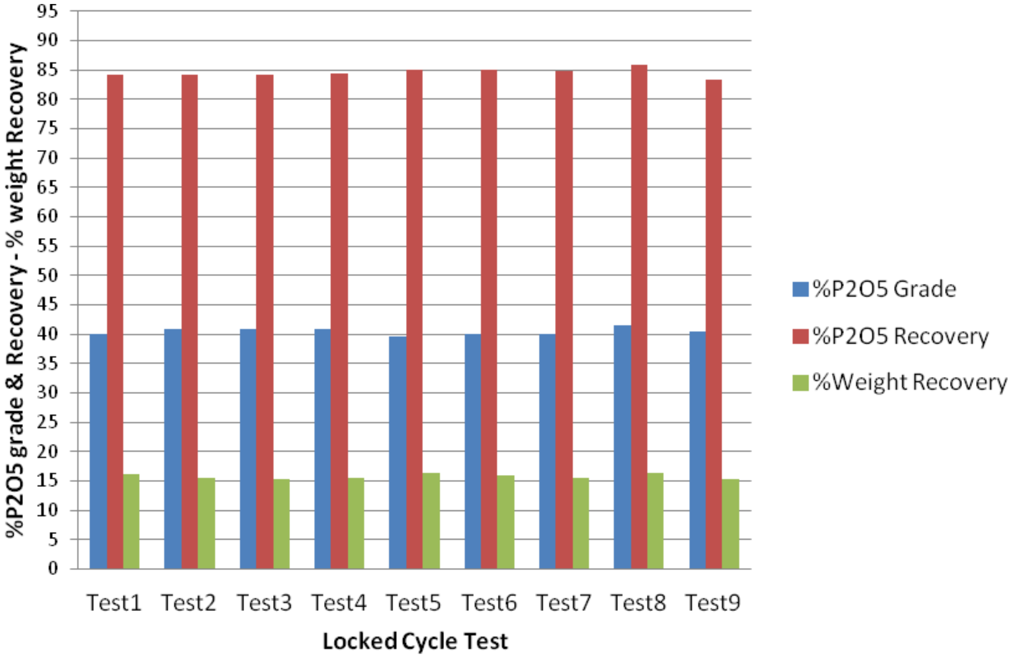


Figure 13.3.6 P_2O_5 Grade and Recovery Variability for the Locked-Cycle Tests

13.3.3.9 Pilot Plant Testing of Bulk Paul Ore by COREM

Because of schedule delays and conflicts with other projects, Jacobs agreed to subcontract the pilot plant test program to COREM. Accordingly, 33 tons of ore from the Lac a Paul deposit were processed through COREM's pilot plant from March 28 to April 11, 2013. During this time period, one 48-hour continuous test run was conducted. The average feed grade of the bulk Paul sample was 6.55% P_2O_5, which agrees closely with the bulk samples previously processed by COREM.

The flow sheet used during the pilot plant testing differed from the column flotation test program described shown in Figure 13.3.6 and included grinding and LIMS in closed circuit followed by flotation using mechanically agitated cells configured as a rougher/scavenger. The tailings were sent to the ilmenite circuit while the concentrate was sent to the apatite cleaner section. To reach a higher grade, the first cleaner concentrate was cleaned twice. The first cleaner tailings exited the process while the second cleaner tailings were recirculated to the first cleaner stage. The third cleaner tailings were recirculated to the second cleaner stage.

The ilmenite circuit consisted of a Slon (WHIMS) fed by the flotation circuit tailings. The ilmenite circuit produced a magnetic concentrate and non-magnetic tailings. A P_2O_5 recovery of 90% at a final grade of 39% P_2O_5 was targeted for the test program.

Overall, the best final concentrate grade from the continuous 48-hour test was 39.4% P_2O_5 at a P_2O_5 recovery of only 45.4%. The best P_2O_5 recovery was 78.8% with a corresponding final concentrate grade of 36.4% P_2O_5.

There were several issues noted by COREM regarding the 48-hour continuous test run: (1) The data presented by COREM every 4 hours shows that the pilot plant was not at equilibrium (as indicated by the significant variation in mass pull to the final product); (2) the average grind F80 utilized by COREM was 204 micron; which is coarser than previously used by COREM for the column flotation test program; and (3) the multiple recycle steams likely contributed to the equilibrium issues previously noted.

13.3.4 COREM Test Program

13.3.4.1 Introduction

Arianne contracted with COREM to determine if acceptable flotation performance could be attained using column flotation cells that utilize the CPT (Eriez) technology. To this end, COREM conducted bench scale laboratory tests and a pilot scale test program. The flow sheet development was based, in part, on preliminary bench test work conducted by COREM in 2011 and 2012 and preliminary bench testing conducted on the new bulk Paul ore sample.

The main objectives of the project were to demonstrate the following:

- That column flotation technology can provide acceptable flotation performance. Specifically, the column flotation pilot plant test program was carried out to demonstrate that P_2O_5 recovery of at least 90% with a concentrate grade of 39% P_2O_5 or higher could be attained.
- Identify the flow sheet scheme and process conditions required for development of process engineering data for the Feasibility Study (FS) conducted by Cegertec WorleyParsons.

Optimization of pilot plant test parameters was not included as part of the contractual scope of services provided by COREM but should be considered by Arianne as a requisite for further evaluation of the process prior to detail design of the beneficiation facility.

13.3.4.2 Bulk Paul Ore Sample Receipt and Preparation

Two different shipments of the same bulk ore sample were received at COREM for the pilot plant test program. The initial 12.8 tonnes sample, identified by COREM as sample A, was shipped directly from the site in February 2012. However, the quantity of sample A proved to be inadequate to complete the test program, so a second sample, identified as sample C, was shipped from Jacobs' facility in Lakeland, Florida. Sample C was approximately 5 tonnes.

The bulk samples were crushed to >90% passing 3.35 mm in a jaw crusher followed by a cone crusher in closed circuit with a Sweco vibrating screen equipped with a 3.35 mm (6 mesh Tyler) screen cloth. The screen oversize was returned to the cone crusher feed. After homogenization of the bulk sample, 50 kg were split out for Bond ball mill index determination, chemical assays, sieve analysis and mineralogy. Bulk sample preparation is shown Figure 13.3.7.

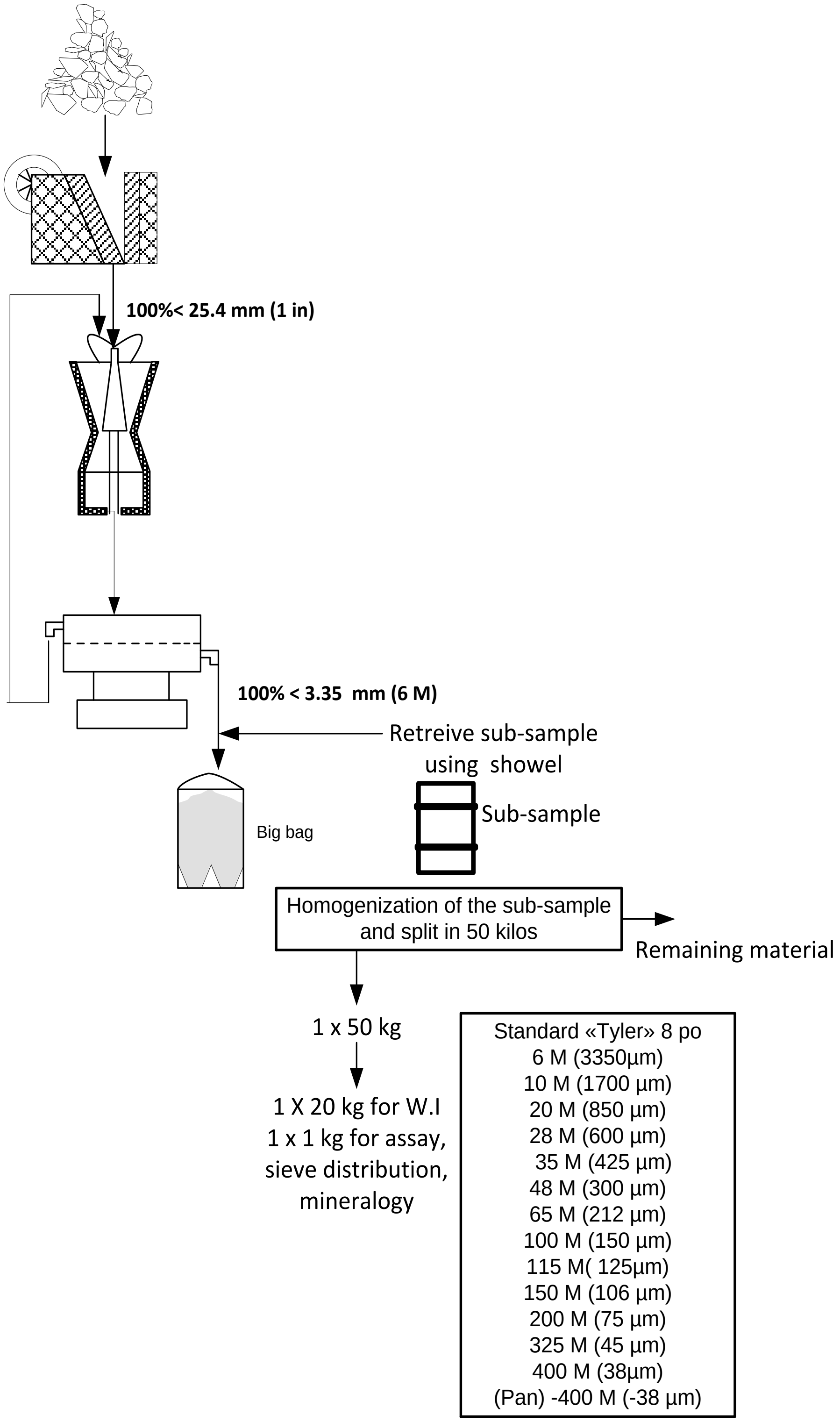

100%< 25.4 mm (1 in)
100% < 3.35 mm (6 M)
Retreive sub-sample using showel
Big bag
Sub-sample
Homogenization of the sub-sample and split in 50 kilos
Remaining material
1 x 50 kg
1 X 20 kg for W.I
1 x 1 kg for assay, sieve distribution, mineralogy
Standard «Tyler» 8 po
6 M (3350µm)
10 M (1700 µm)
20 M (850 µm)
28 M (600 µm)
35 M (425 µm)
48 M (300 µm)
65 M (212 µm)
100 M (150 µm)
115 M(125µm)
150 M (106 µm)
200 M (75 µm)
325 M (45 µm)
400 M (38µm)
(Pan) -400 M (-38 µm)

Figure 13.3.7 Bulk Paul Ore Sample Preparation Schematic

The particle size distribution (PSD) of the individual bulk samples after crushing is given in Table 13.3.12.

Fraction µm	Cumulative passing %	
	Sample (A)	Sample (C)
4750	99.68	---
3350	86.57	91.74
2360	62.60	79.53
1700	46.66	68.01
1180	31.21	---
850	27.08	47.42
600	22.87	40.25
425	18.98	34.66
300	14.99	29.04
212	11.28	23.58
150	9.26	18.50
106	8.06	14.66
75	0.00	11.40
53	0.00	2.25
-53	0.00	0.00
P80	3078.7	2398.3

Table 13.3.12 PSD of Paul Ore Samples A and C (After Crushing)

The chemical analysis and size distribution (P_{80} and P_{50}) for samples A and C are presented in Table 13.3.13. Chemical assays as well as sieve distributions for individual batch samples are presented in the COREM report titled "Validation of Apatite Flow Sheet Using Column Flotation", Final Report Revision 2, dated June 3, 2013.

Batch	Weight (kg)	Sieve dist (µm)		SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	MgO (%)	CaO (%)	TiO_2 (%)	P_2O_5 (%)	Cl (%)
		p80	p50								
Sample A	12800	3079	n.d.	34.1	12.0	20.0	7.09	11.8	5.18	6.24	0.016
Sample C	5443	2398	957	30.8	9.7	24.0	8.58	11.3	6.38	6.31	n.d.
Total	**18243**	**2739**	**n.d.**	**32.5**	**10.9**	**22.0**	**7.84**	**11.6**	**5.78**	**6.28**	**0.016**

Table 13.3.13 Selected Chemical and Sieve Analysis of Ore Samples A and C

The average P_2O_5 of samples A and C was 6.28%.

13.3.4.3 Bond Work Index Determination

A sub-sample of sample A, was ground to a P100 of - 3.35 mm and used for determining the Bond ball mill work index (WI) for optimizing the pilot plant grind. The WI was calculated at 11.8 kWh/T, which was utilized for the calculation of the ball mill feed rate according to the Moly-Corp Tools^{TM} simulator for the estimation of the ball mill grinding capacity. The WI of sample C was assumed to be similar to sample A since it was collected from the same bulk sample; thus, no Bond work index determination was performed on ore sample C.

13.3.4.4 Mineralogical Examination Using MLA

Five sieve fractions from head sample A were analyzed using a FEI Mineral Liberation Analyzer (MLA) in order to determine the distribution and liberation of apatite and ilmenite minerals. The sieve fractions examined were: +425 µm, -425 +212 µm, -212+106 µm, -106+75 µm and -75 µm. An average of 20,000 particles per sample was studied. The main minerals identified were apatite, titano-magnetite, ilmenite, plagioclase, chlorite, biotite, pyroxene, and orthoclase.

The results of apatite and ilmenite liberation analysis show that below 425 µm, both the apatite and ilmenite are mainly free (liberated). In mixed particles, apatite is mainly associated with ilmenite, biotite and chlorite; whereas ilmenite is mainly associated with pyroxene, apatite and biotite. The technical note describing the complete mineralogy for sample A using MLA is in the COREM report titled “Validation of Apatite Flow Sheet Using Column Flotation”, Final Report Revision 2, dated June 3, 2013.

13.3.4.5 Bench Scale Laboratory Test Work

Bench scale laboratory flotation tests were conducted on head samples A and C and on the non-magnetic fraction of these samples. The bench scale test samples were generated from the pilot plant grinding and magnetic removal circuit described in Section 13.3.3.6, where the non-magnetic stream was sampled regularly to collect material for bench scale testing.

The purpose of these tests was to further develop the bench scale flow sheet and benchmark the collector (Liacid) addition, pH requirements, iron depressant dosage, and sodium silicate dispersant dosage. During the laboratory testing program, a new reagent (Custofloat J2) was also tested to determine its potential as an alternative collector for apatite flotation. Laboratory flotation conditions and test results are documented in the COREM report titled “Validation of Apatite Flow Sheet Using Column Flotation”, Final Report Revision 2, dated June 3, 2013.

Bench testing showed that the reagent scheme had to be adjusted due to the presence of silicate sheet material (mica) that adversely affected the apatite concentrate grade. Specifically, it was discovered that reducing the pH from about 10.5 to 8.0 during the cleaner stage can significantly reduce mica flotation. Accordingly, several additional flotation tests were conducted on the non-magnetic material to evaluate the impact of reducing the pH from 10.8 to 8 to improve concentrate grade.

Table 13.3.14 summarizes the flotation test sequence, feed material, test purpose, flow sheet configuration, and apatite concentrate quality and recovery. Based on these tests, the most suitable conditions for flotation of the LIMS non-mag feed were those of test 16:

- Flow sheet configuration: 1 rougher, 1 scavenger, and 3 cleaners.
- Use of Custofloat J2 collector instead of Liacid at a use rate at 250 g/t.
- Starch consumption of 617 g/t as an iron depressant.
- Sodium silicate consumption of 183 g/t as a gangue depressant.
- pH of 10.5 for rougher flotation and approximately 8.0 for the cleaner stages.
- Sulfuric acid consumption of 220 g/t.

The best conditions for flotation of feed without magnetic separation were given in test 18:

- Flow sheet configuration: 1 rougher,1 scavenger, and 3 cleaners.
- Use of Custofloat J2 collector instead of Liacid at a use rate of 250 g/t.
- Starch consumption of 1050 g/t as an iron depressant.
- Sodium silicate consumption of 250 g/t as a gangue depressant.
- pH of 10.5 for rougher flotation and approximately 8.0 for the cleaner stages.
- Sulfuric acid consumption of 360 g/t.

Flotation test #	Sample ID	Test purpose	Configuration	Apatite Concentrate		
				Weight	P_2O_5 (%)	
				(%)	Grade	Rec.
1	LIMS Non-Mag	Duplicate the reagent scheme	**	4.72	39.40	30.9
2	LIMS Non-Mag	Increase apatite recovery	**	7.62	37.10	45.8
5	LIMS Non-Mag	Increase collector + Na silicate	**	N.A	N.A	N.A
6	LIMS Non-Mag	Reduce collector dosage	Rghr+Scav+Clnr1	N.A	N.A	N.A
7	LIMS Non-Mag	Reduce Na silicate + starch	**	2.38	34.00	12.9
11(*)	LIMS Non-Mag	Flotation test performed at	Rghr+Scav	N.A	N.A	N.A
12(*)	LIMS Non-Mag	Remove Na Silicate, improve grade+ recovery	***	7.40	39.60	49.2
13(*)	LIMS Non-Mag	Reduce collector, Na silicate, starch	Rghr+Scav+Cl1+Cl 2	9.41	39.90	60.4
14(*)	LIMS Non-Mag	Increase collector+ starch, improve recovery	**	14.20	38.10	89.8
16(*)	LIMS Non-Mag	Change LIACID for J2	**	13.96	38.50	89.3
17(*)	LIMS Non-Mag	Adjusting starch dosage	**	14.25	40.60	81.9
20(*)	LIMS Non-Mag	Adjusting starch dosage	**	14.30	39.90	81.1
3C(*)	**LIMS Non-**	**Duplication of test 20**	**	**12.65**	**38.80**	**72.1**
Tests performed with Lac a Paul water						

Flotation test #	Sample ID	Test purpose	Configuration	Apatite Concentrate		
				Weight	P_2O_5 (%)	
				(%)	Grade	Rec.
3	LIMS feed	Duplicate the reagent scheme with magnetic	**	2.13	39.50	13.6
4	LIMS feed	Reagent scheme adjustment + stream	Rghr+Scav+Clnr1	N.A	N.A	N.A
8	LIMS feed	Reduce Na silicate + starch	**	10.42	38.40	63.6
9	LIMS feed	Test Na2SiO3 +WW82 addition together	**	1.43	35.40	8.10
18(*)	LIMS feed	Change LIACID for J2	**	15.30	39.30	91.6
19(*)	LIMS feed	Kept LIACID + increase starch	**	11.48	39.40	69.9
4C(*)	**LIMS feed**	**Duplication of test 18 + increase starch**	**	**13.18**	**39.60**	**80.2**
Tests performed with Lac a Paul water						

(*): pH at 10.8 for Rgh+Scav and decrease at 8 for cleaners

**: Configuration: Rghr+Scav+Clnr1+Clnr2+Clnr3

***: Configuration: Rghr+Scav+Clnr1+Clnr2+Clnr3 +Clnr4

N.A.: not analysed

Table 13.3.14 Bench Test Results Summary

Finally, two bench tests were performed to compare the relative flotation performance using Lac a Paul water compared to Québec City tap water. COREM reported that "the test data showed that there was no significant difference in flotation performance when using Lac a Paul or Québec city tap water (test 3C and 4C)". However, the tests results appear to indicate that the use of Lac a Paul water may have some impact on P_2O_5 recovery. Although the concentrate grade was >39% P_2O_5 for the comparative tests, the P_2O_5 recovery was 9% to 10% lower when using Lac a Paul water. COREM noted that there were quality issues with the site water sample that may have contributed to the P_2O_5 recovery difference. Also, Jacobs' locked cycle test results (Ref. Section 13.3.4.8) further indicated that excellent P_2O_5 recovery and grade can be attained using Lac a Paul site water. Nevertheless, the impact of Lac a Paul water on flotation response should be evaluated thoroughly before proceeding to engineering detail design.

13.3.4.6 Bulk Paul Ore Grinding and Preparation for Pilot Plant Flotation Testing

The pilot plant set-up used for grinding and magnetic separation of samples A and C is shown in Figure 13.3.8. The screen aperture was adjusted during the operation to obtain the targeted P80 of nominally 200 micron for subsequent flotation. Sieve analyses of representative samples of the ball mill feed, screen oversize, screen undersize, LIMS magnetic products, LIMS non-magnetic products were determined periodically in order to monitor and control the grinding circuit particle size distribution (PSD).

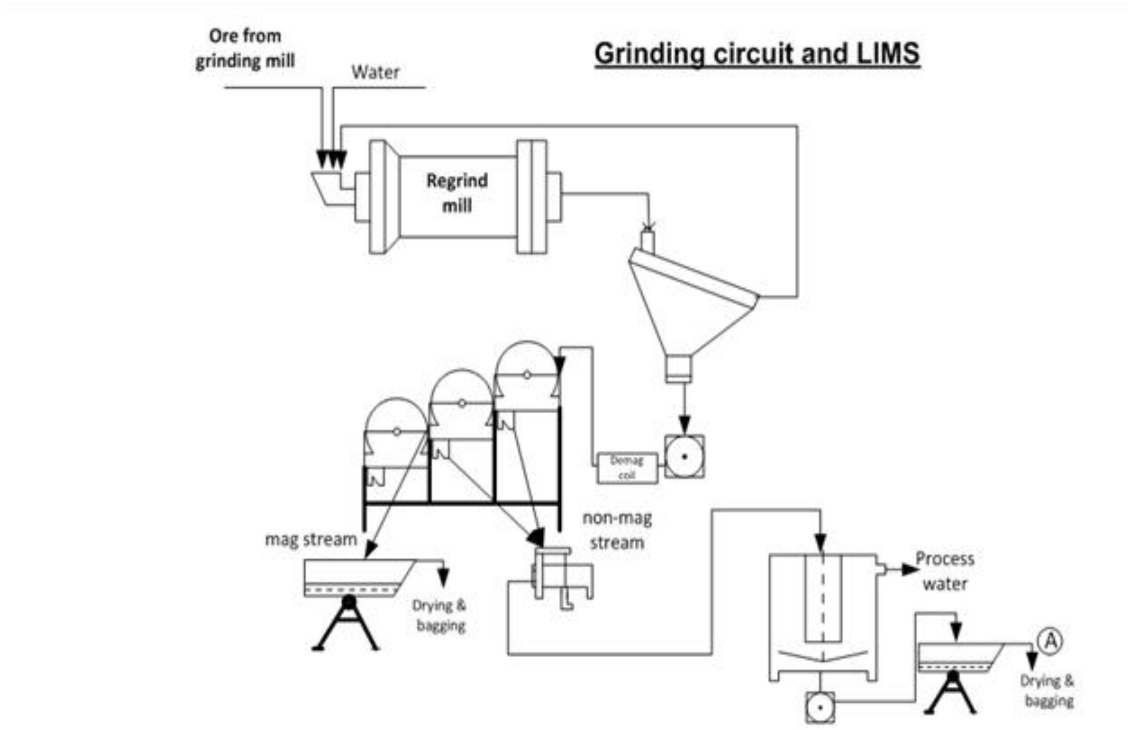


Figure 13.3.8 Arrangement of the Grinding and LIMS Circuit

A two-drum low intensity magnetic separator (LIMS) was used to remove magnetic materials, mainly magnetite, prior to flotation. The magnetic field intensity of the first drum was adjusted to 1125 Gauss as a rougher; whereas the second drum was adjusted to 1050 Gauss as a cleaner. The non-magnetic product was pumped to a 6-foot diameter thickener. The magnetic material was dewatered in a filter pan, dried on a hot plate, and stored in lined steel drums.

The 6-foot thickener underflow (non-magnetics) was also dewatered in tilting filter pans. The filter cake was stored in lined steel drums until it was used in the column pilot plant. The thickener overflow was discarded after verification that no fine particles were carried into the thickener overflow.

The average P_{80} for the non-magnetics from the grinding circuit during the preparation of bulk samples A and C was 189 µm. As expected, the LIMS magnetics size distribution was coarser; and averaged 244 µm.

For the sample A magnetic product, the weight recovery represented 2.8% of the weight of the bulk sample and the P_2O_5 grade averaged 1.47% for a recovery loss of 0.7%. For the sample A non-magnetic product (flotation feed), the weight recovery was 97.2% of the bulk sample and the P_2O_5 grade averaged 6.19%, resulting in a recovery of 99.3%.

For the sample C magnetic products, the weight recovery represented 6.2% of the weight of the bulk sample and the P_2O_5 grade average 1.56% for a recovery loss of 1.5%. For the sample C non-magnetic product (flotation feed), the weight recovery was 93.9% of the bulk sample and the P_2O_5 grade average 6.80%, resulting in a recovery of 98.5%.

13.3.4.7 Preliminary Testing, Column Flotation Circuit

Debugging of the pilot plant was performed on January 23 and 24, 2013. No formal sampling campaigns were performed during these two days. Testing was in open circuit to examine the stability of the pilot plant and obtain a feel for the mass pull at all processing nodes. Initial operation in open circuit is commonly practiced in pilot plant testing programs in order to facilitate diagnosis of unit operation performance without the complication (influence) of recycle streams. Operation in closed circuit simulates commercial operations; accordingly, the subsequent pilot plant process verification tests were conducted in closed circuit operation. Preliminary testing was conducted using flow sheet 1 shown in Figure 13.3.9.

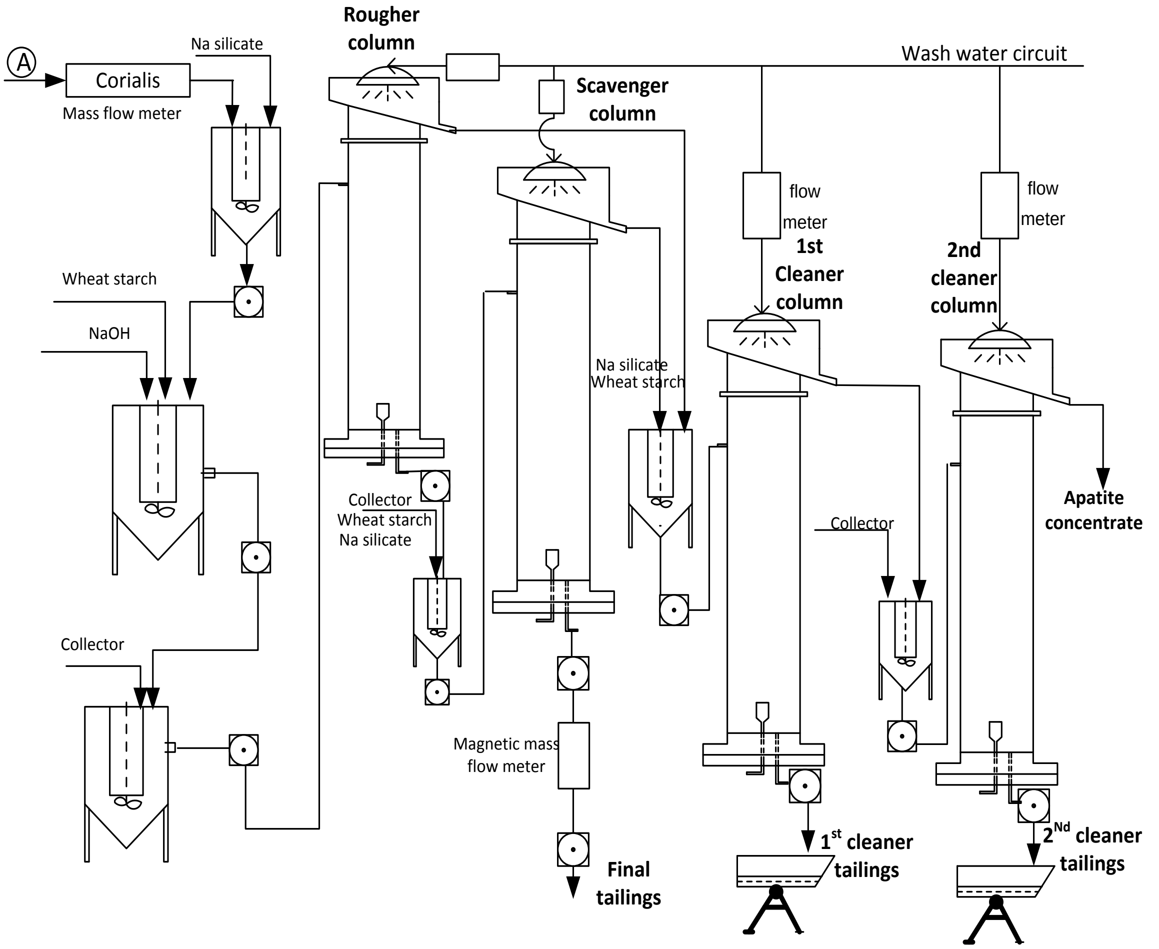


Figure 13.3.9 Schematic of Pilot Plant Column Flow Sheet 1

A Corialis flow meter on the pilot plant slurry feed line was used to determine the pulp flow rate and dry feed rate to the pilot plant.

13.3.4.8 Development Tests, Column Flotation Circuit

During the column flotation pilot plant development tests, several days were dedicated to bench marking the operating conditions (% solids, reagent scheme distribution through the flotation circuit, air flow rates, wash water requirements, etc.) for each individual column in order to achieve apatite grades and recoveries that mimic the best bench scale test (test 16). The developmental tests were conducted using Liacid collector due to the short term unavailability of Custofloat J2. All tests were conducted using the LIMS non-magnetic material prepared per Section 13.3.3.6. The development tests were initially conducted using flow sheet 1 (see Figure 13.3.9), but this flow sheet was subsequently modified to flow sheets 2, 3, and 4 (Figure 13.3.12) as the test work evolved.

Pilot plant development test results are documented in the COREM report titled “Validation of Apatite Flow Sheet Using Column Flotation”, Final Report Revision 2, dated June 3, 2013.

Sample A was processed during 10 days, between January 23 and February 8, 2013, using three flow sheets (1, 2 and 3). The most suitable operating conditions were obtained for the test conducted on February 6, 13h15 using flow sheet 3. The metallurgical balance for this test is given in Figure 13.3.10.

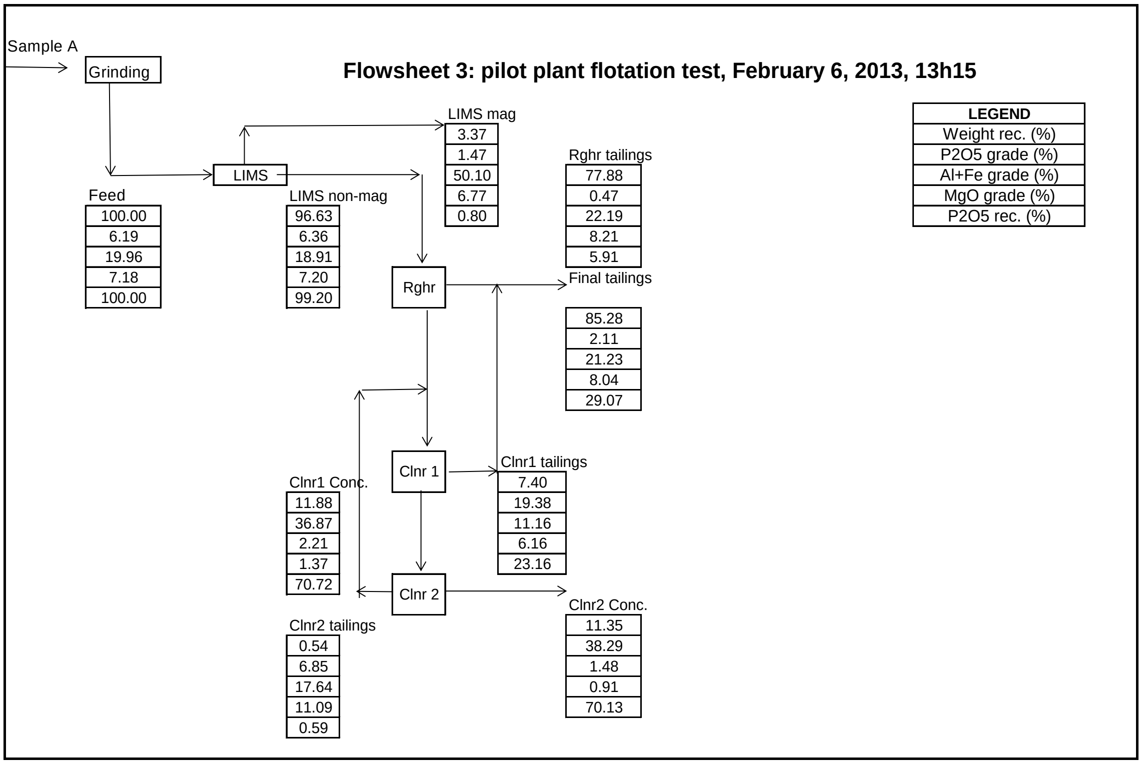


Figure 13.3.10 Development Test Material Balance, Flow Sheet 3

The operating conditions for the February 6, 13h15 test are summarized as follows.

- Flow sheet configuration: 1 rougher-scavenger and 2 cleaners.
- Liacid 1800 collector consumption at 265 g/t.

- Starch consumption at 380 g/t for depression of iron and sodium silicate consumption at 380 g/t as the gangue depressant.
- pH of approximately 8.0 for the cleaner stages.

Most of the P_2O_5 lost in the above referenced test occurred in the cleaner tailings.

A bulk sample of Custofloat J2 was received in early March and was utilized on March 7 for the last sampling campaign of the day.

At this point, sample A had been exhausted, so sample C was used for all subsequent tests by COREM.

Sample C was processed from March 5 to March 13 using flow sheet 4 (see Figure 13.3.12) in both open and closed circuit. The most suitable operating conditions, but not the optimal, were those of the test conducted on March 7, 16h45 as detailed in Figure 13.3.5. Test results are summarized as follows:

- Flow sheet configuration: 1 rougher-scavenger, 2 cleaners, and 1 scavenger cleaner.
- Custofloat J2 collector consumption at 285 g/t.
- Starch consumption at 600 g/t as an iron depressant and sodium silicate consumption at 220 g/t as a gangue depressant.
- pH of approximately 8.0 for the cleaner stages and controlled by dilute H_2SO_4 (10%).

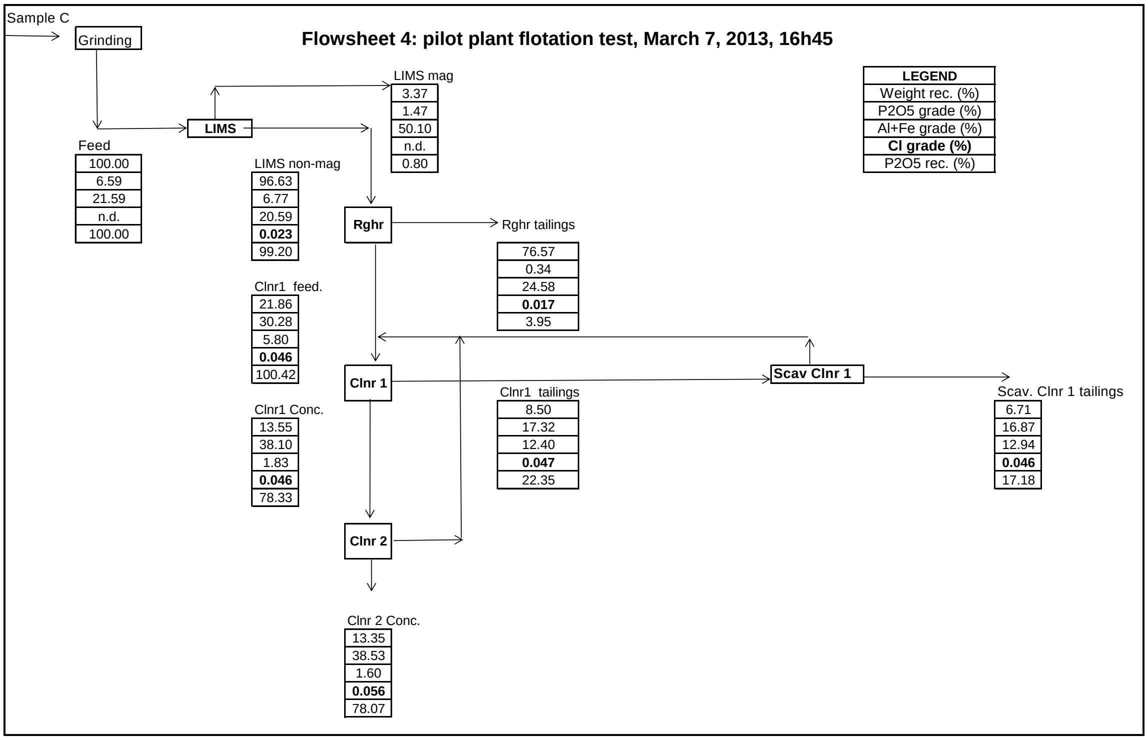


Figure 13.3.11 Development Test Material Balance, Flow Sheet 4

The concentrate grade produced on March 7 assayed 38.53% P_2O_5 with a P_2O_5 recovery of 78.07%, representing a concentrate weight recovery of 13.35%. Most of the P_2O_5 loss was in scavenger cleaner tailings. During the same sampling campaign, additional samples were taken for chlorine assays on each exit stream including the concentrate. The concentrate analyzed 0.056% Cl.

13.3.4.9 Confirmation Tests, Column Flotation Circuit (LIMS Non-magnetics)

The operating conditions identified during the development tests that concluded on March 7 were modified slightly and lead to the development of flow sheet 4 (see Figure 13.3.12) for the subsequent Process Verification Tests. The Process Verification Test was conducted to demonstrate the process efficiency for sustained continuous operation of at least 8 hours. The formal process verification tests began on March 15.

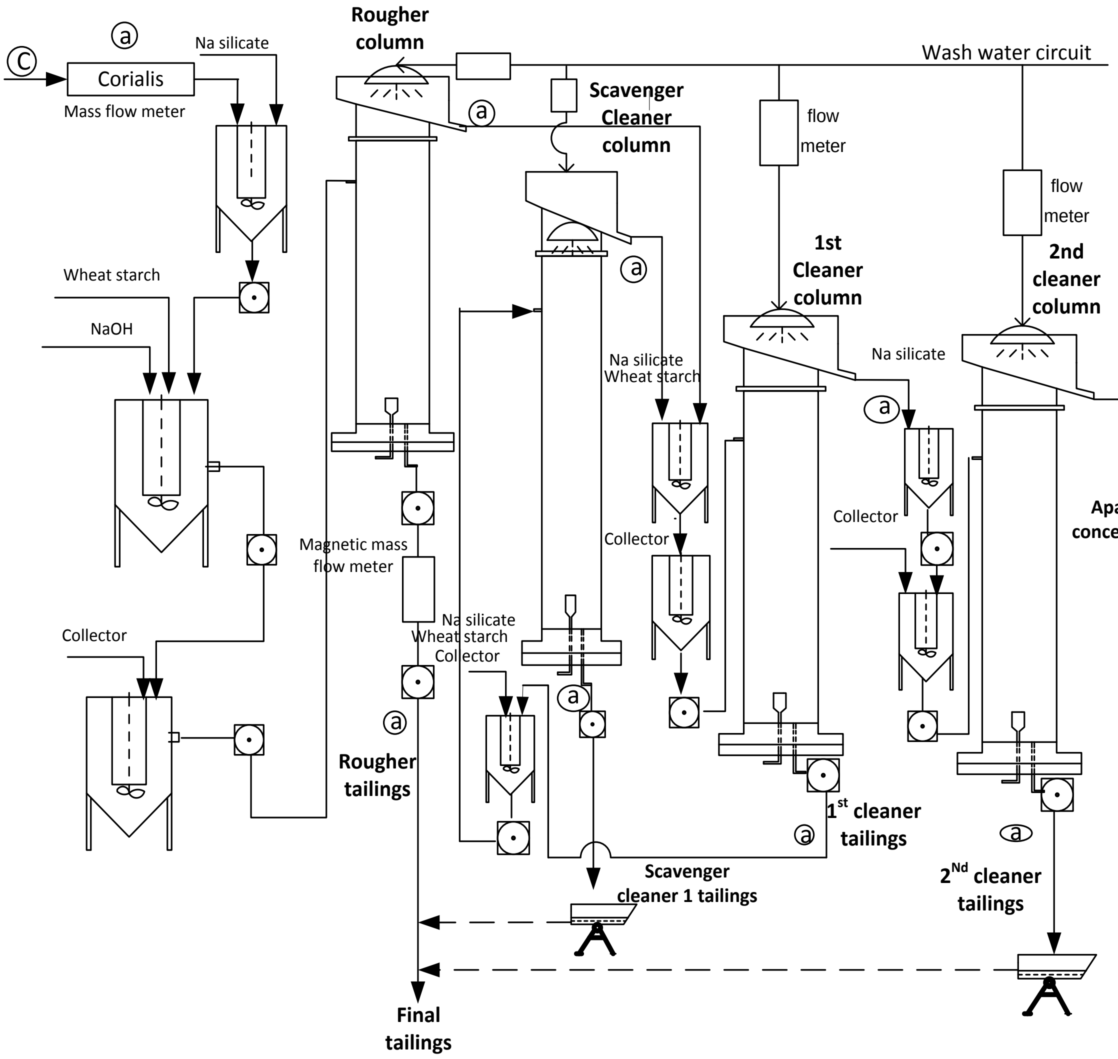


Figure 13.3.12 Schematic of Pilot Plant Column Flow Sheet 4

The flotation circuit was started at 9h00 and quickly ramped up to nearly steady state conditions. The circuit appeared stable and around 10h00 in the morning, samples were collected to determine % solids and mass pull for the apatite concentrate, rougher froth, and other process streams. Overall, three sampling campaigns were performed during the 8-hour process confirmation test. The first complete sampling campaign was performed at 12h15. The material balance is illustrated in Figure 13.3.13.

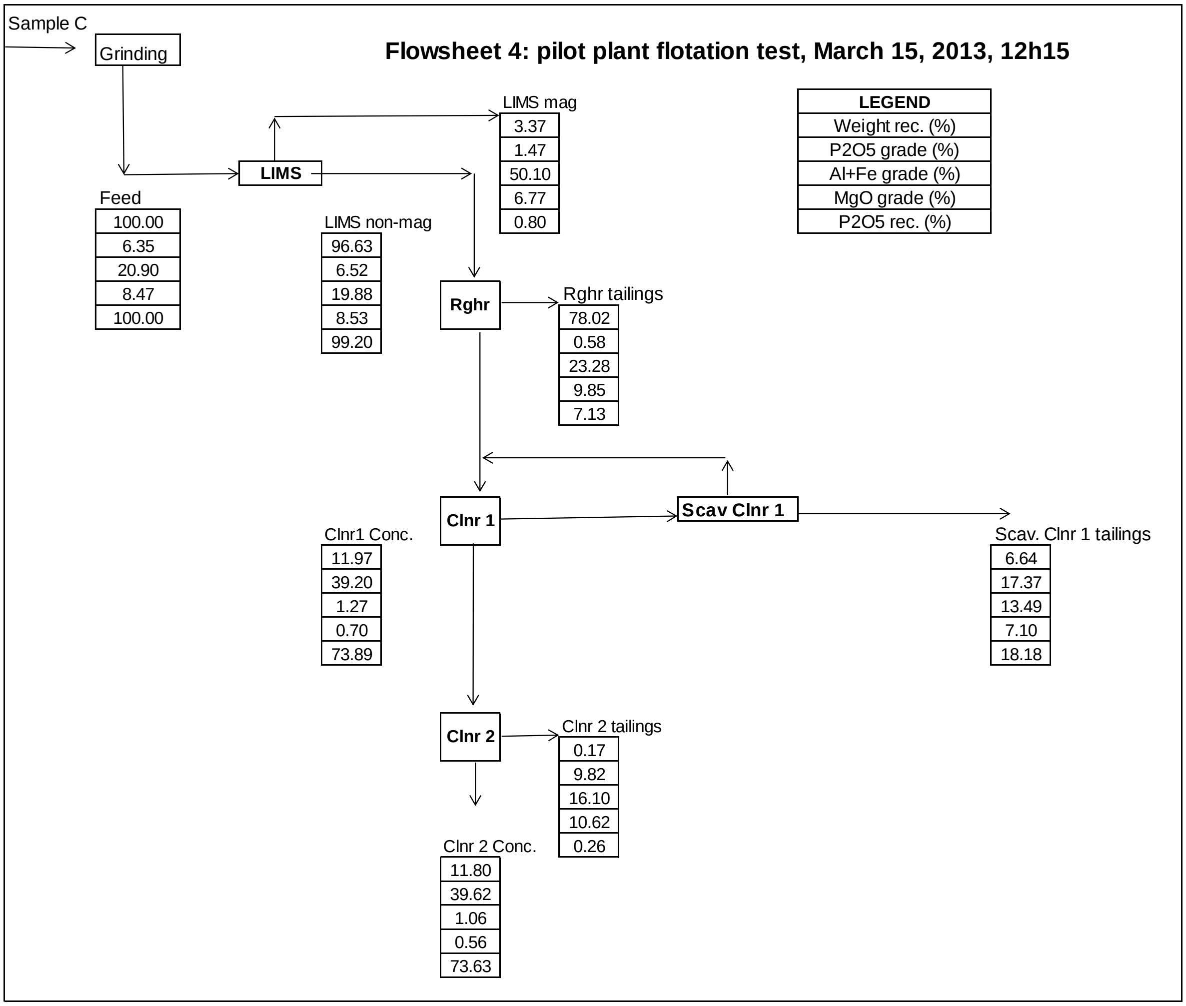


Figure 13.3.13 Confirmation Test Material Balance, First Sampling Campaign

After the initial sampling campaign was completed, minor adjustments were made to improve flotation performance and maintain equilibrium before the second sampling campaign was initiated. The second sampling campaign was conducted at 15h00. The material balance for the second sampling campaign is given in Figure 13.3.14 and shows that:

- The rougher tailings (main tailings) grade analyzed 0.36% P_2O_5 and contained 3.87% of the P_2O_5.
- The cleaner 2 concentrate analyzed 39.18% P_2O_5 and contained 91.10% of the P_2O_5. The weight recovery to the final concentrate was 16.30%.
- The cleaner 2 tailings analyzed 10.20% P_2O_5 resulting in a P_2O_5 loss of only 0.24%.
- The scavenger-cleaner 1 tailings grade decreased to 5.74% P_2O_5 and represented a P_2O_5 loss of only 3.99%. This result was a significant improvement over the first sampling campaign.

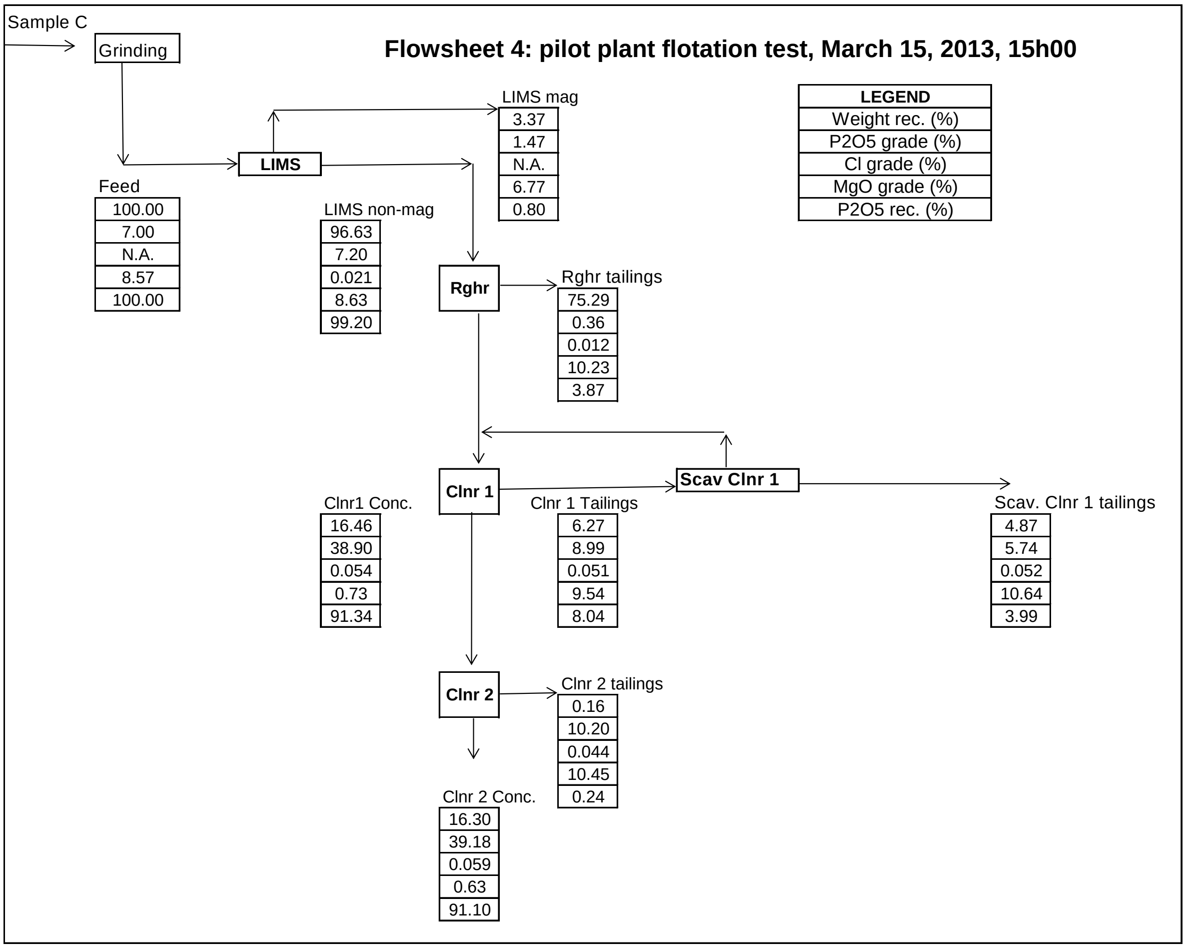


Figure 13.3.14 Confirmation Test Material Balance, Second Sampling Campaign

Figure 13.3.15 presents the metallurgical balance for the third (final) sampling campaign from the process verification test conducted on March 15, 2013, 17h00. The test results show that:

- The rougher tailings (main tailings) grade remained stable at 0.3% P_2O_5. The P_2O_5 loss to the rougher tails was only 3.03%.
- The cleaner 2 concentrate contained 90.77% of the P_2O_5. The concentrate grade was 37.99% P_2O_5 with a weight recovery of 17.35%.
- The cleaner 2 tailings analyzed 7.82% P_2O_5 and accounted for a 0.18% P_2O_5 loss.
- The scavenger-cleaner 1 tailings grade analyzed 6.56% P_2O_5 for a P_2O_5 loss of 5.23%.

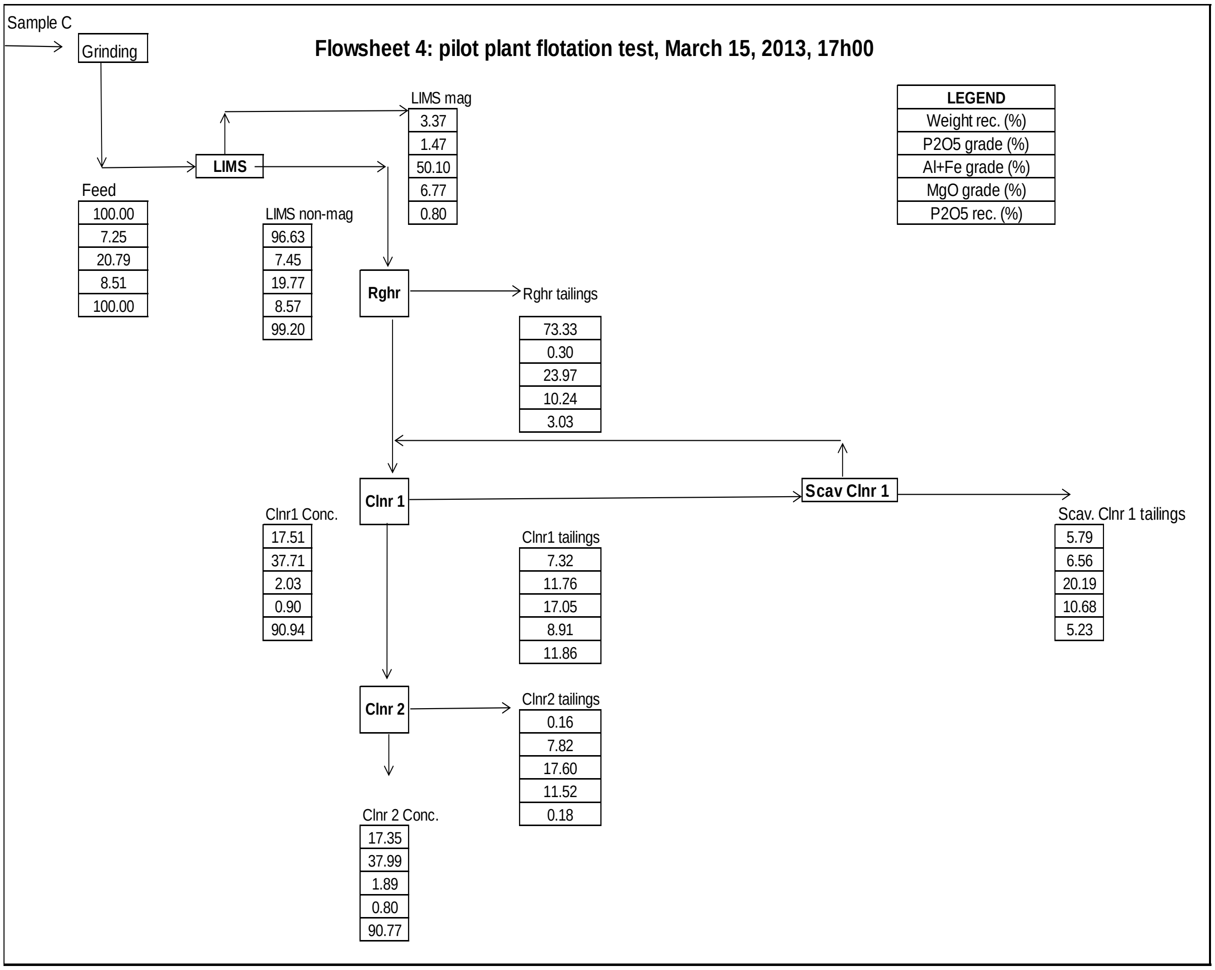


Figure 13.3.15 Confirmation Test Material Balance, Third Sampling Campaign

The mass balance data (assays and weights) for each sampling campaign of the confirmation test run were input into Bilmat. Bilmat is a standard metallurgical program that utilizes the chemical assays and weights from the pilot plant and reconciles the data by adjusting the measurements according to a statistical model of measurement errors. The pilot plant performance data, adjusted by Bilmat for the three (3) sampling campaigns of the process confirmation tests, are given in Table 13.3.15.

Testing Campaigns	Weight %	%P_2O_5	%P_2O_5 Recovery
Campaign 1	12.2	39.6	74.2
Campaign 2	16.9	39.2	91.8
Campaign 3	18.0	38.1	91.5
Average (1-3)	**15.7**	**39.0**	**85.8**
Average (2-3)	**17.6**	**38.6**	**91.6**
Recommended for FS		**38.6**	**90.0**

Table 13.3.15 Confirmation Test Results Summary

Table 13.3.5 shows that an average grade of 39.0% P_2O_5 was achieved with an average P_2O_5 recovery of 85.8% over the nominal 8-hour continuous test. The P_2O_5 recovery for the last 6 hours of the confirmation tests averaged 91.6%. Based on these data, COREM concluded that the bulk Paul ore could be effectively upgraded to the recovery and grade target specified by Arianne.

For the FS, the averaged P_2O_5 recovery was downgraded to 90% to compensate for scale-up to a commercial facility. The concentrate grade selected for the FS was 38.6% P_2O_5 although there is potential to increase the product grade to 39% P_2O_5 or even higher while still maintaining the overall P_2O_5 recovery at or near 90%.

Pictures of the pilot plant arrangement and the cleaner 2 column cell froth product (final concentrate) are shown in Figures 13.3.16 and 13.3.17, respectively. Chemical analysis of a representative sample of the final concentrate from the process verification test is given in Table 13.3.16.

Constituent	Units	Analysis
P_2O_5	%	38.60
CaO	%	51.25
MgO	%	0.70
Fe_2O_3	%	2.00
Al_2O_3	%	0.45
SiO_2	%	1.55
TiO_2	%	0.65
Na_2O	%	0.37
K_2O	%	0.19
Cl	%	0.06
F	%	1.08
LOI	%	0.54
CaO/P_2O_5	Ratio	1.33
MER	Ratio	0.08

Table 13.3.16 Concentrate Chemical Analysis

Figure 13.3.16 Column Pilot Plant Arrangement

Figure 13.3.17 Cleaner 2 Column Cell Froth Product

13.3.4.10 Confirmation Tests, Column Flotation Circuit (Magnetics Not Removed)

Arianne determined that recovery of the magnetic component of the ore is not included as part of the FS. For this reason, testing of the process flow sheet with the magnetic material present was an additional requirement for verifying the viability of the process flow sheet. Accordingly, the titano-magnetite previously removed from the ore was reintroduced in the same proportion as originally received and processed through the pilot plant utilizing flow sheet 4 (see Figure 13.3.12). Reagent adjustments that were made to adjust for the additional presence of titano-magnetite included additional starch. The material balance for this test is given in Figure 13.3.18.

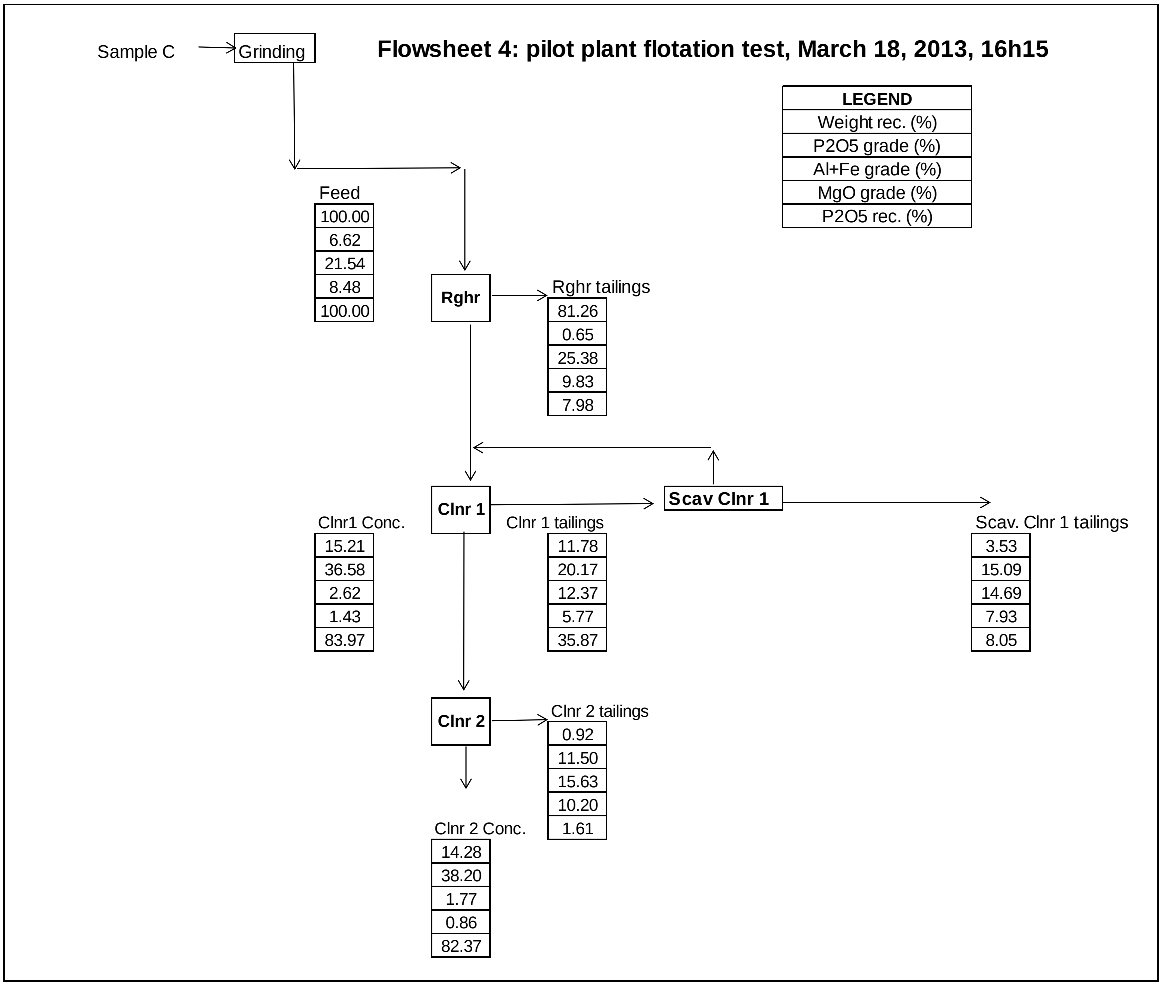


Figure 13.3.18 Confirmation Tests without Magnetite Removal

The test results show that:

- The rougher tailings (main tailings) analyzed 0.65% P_2O_5. P_2O_5 recovery was 7.98%.
- The cleaner 2 concentrate contained 82.37% of the P_2O_5 at a grade of 38.20% P_2O_5. The weight recovery to the concentrate was 14.28%.
- The cleaner 2 tailings analyzed 11.50% P_2O_5 giving a P_2O_5 loss of only 1.61%.
- The scavenger-cleaner 1 tailings grade was 15.09% P_2O_5 giving a P_2O_5 loss of 8.05%.

COREM noted that tests with the titano-magnetite not removed demonstrated that a similar grade/recovery correlation can be attained (compared to tests where the titano-magnetite was removed using LIMS) by adjusting mainly the iron depressant dosage. In conclusion, it was demonstrated in both bench and pilot scale testing, that magnetic separation prior to flotation is not required in order to attain the specified product grade and recovery. However, more piloting time is required to optimize the operating parameters and flotation response.

13.3.4.11 Analytical Methods

COREM determined the grade of major oxides (SiO_2, Al_2O_3, Fe_2O_3, MgO, TiO_2, P_2O_5, CaO) using XRF spectroscopy. Chlorine analysis was performed using a colorimeter (after an alkaline fusion). Specific gravity and size distributions were performed using COREM standard procedures on every stream from the grinding circuit and LIMS magnetic separation as well as on the flotation concentrate and tailings. During the pilot plant test program, three series of pulp samples were taken for chlorine determination in solid and in water. At the end of the pilot plant testing, a final tailings sample was taken for environmental evaluation to evaluate acid generation potential.

13.3.4.12 Supplemental Testing of Pilot Plant Samples (FLSmidth)

COREM commissioned FLSmidth Inc. to conduct bench scale thickening test work on five samples (apatite concentrate, phosphate flotation feed, Slon non-magnetics, Slon magnetics, and final tailings). Testing was conducted at COREM’s facilities in Quebec City, QC during April 2013.

The objective of the test work was to determine thickener sizing and operating parameters to predict operating conditions and full scale performance of FLSmidth thickeners. Test work involved flocculant dosing, determining feed conditioning and flocculation criteria for feed well design, conducting settling tests to determine settling rates and design criteria, and measuring thickened mud rheology to determine required rake torque and predict underflow manageability.

Analysis of the test results show thickeners will accommodate a unit loading area of 0.030 m^2/tpd for the apatite concentrate, 0.028 m^2/tpd for the flotation feed, 0.025 m^2/tpd for the Slon non-magnetics, 0.026 m^2/tpd for the Slon magnetics, and 0.025 m^2/tpd for the final tailings.

At these unit areas, the thickeners will produce underflow solids concentrations (in weight percent) of 77.5% for apatite concentrate, 76.0% for the flotation feed, 76.3% for the Slon non-magnetics, 77.5% for the Slon magnetics, and 71.0% for the final tailings. These underflow densities are achieved within a 0.5 to 1.0 hour retention time.

The overflow clarity achieved was less than 200ppm for all samples.

13.3.4.13 Supplemental Testing of Pilot Plant Samples (Outotec)

Testing was performed on a four phosphate samples provided by COREM: apatite concentrate, Slon concentrate, Slon tails, and flotation tails. Tests were conducted in Labox 25, Pannevis (Buchner), and

Scanmec leaf-tester test units in order to determine the suitability of Outotec Larox pressure filtration and vacuum filtration technology for the four samples.

Bench scale testing was conducted to evaluate filter cloth selection, filter cake thickness, filtration rate, moisture content of the cake, and cake handling characteristics. Testing of the concentrate yielded no particular issues except as noted:

- Cake thickness had little to no effect on the resulting moisture.
- Some solids reported with the filtrate.

The complete testing report by Outotec is listed in the reference documents.

13.3.4.14 Supplemental Bench Testing of Starches

Starch is typically used to depress iron minerals during froth flotation. Wheat starch, WW82, was used for the bench and all pilot plant tests conducted by COREM through March 2013. However, due to the high cost and unit consumption of this material, supplemental bench tests were performed by COREM in September 2013 to evaluate different starches and/or starch substitutes. The goal of the test program was to find a lower cost iron depressant that gave comparable flotation performance.

Of the eight (8) starches evaluated, Casco 11141, Supergel, and WW82 gave the best performance. Although acceptable (high grade) concentrate was attained using the materials tested, the overall flotation P_2O_5 recovery was low for all tests; indicating that the test parameters were not optimized. Accordingly, further testing of different starches and/or starch substitutes was recommended prior to the commencement of the final pilot plant test program.

14. MINERAL RESOURCE ESTIMATE

This sub-section describes the 2011 resource estimate of the Lac a Paul Project for which the PFS is still current with the Manouane Zone and Zone No. 2. The sub-section afterwards presents a modelling and resource estimation update of the Paul Zone in 2013. The cut-off date for the resource estimation of this report takes into account drilling of 2012 and assay results received in January 2013; therefore, all drilling campaign data for Paul Zone are included.

14.1 Paul, Manouane and Zone No. 2 - 2011

14.1.1 Data

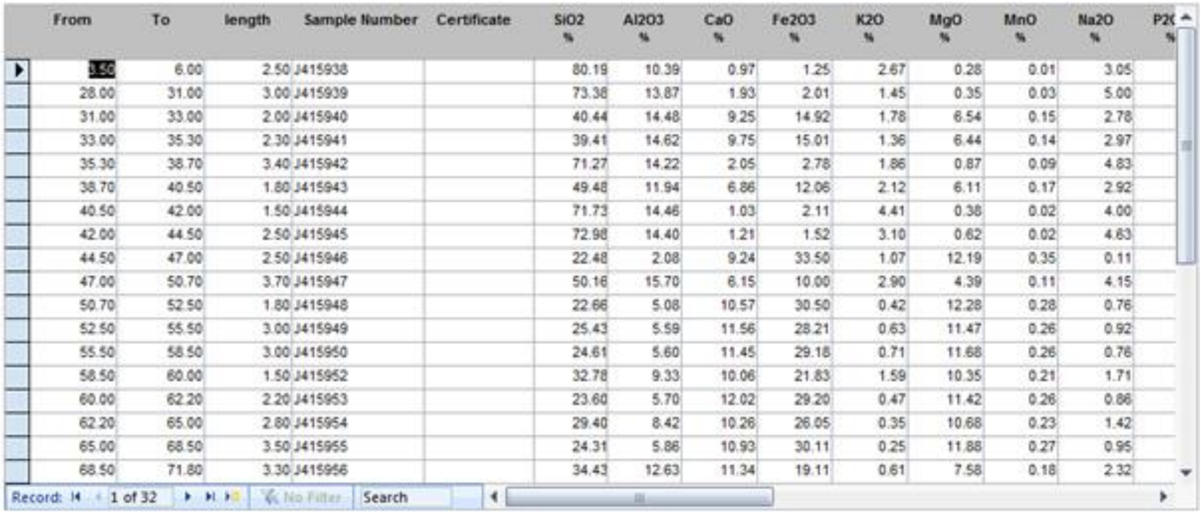
The final drill holes database used for the resource estimation of the Lac a Paul Project zones, namely Zone No 2, Paul and Manouane, is in file *LAC_PAUL_260711_final.accdb* dated July 27, 2011 (stored at the Arianne's office). The database holds information for 121 diamond drill holes. Out of the 121 holes, thirteen (13) were not used in the resource estimates: the two (2) 1997 holes and the eleven (11) exploration holes of LPA-09 group.

The surface samples are not integrated into the database at the moment. The location of this data on maps is in 2D i.e. no elevation and they are therefore not equivalent to core hole samples. They are not used in the estimation of resources.

A database in MS-Excel format was transferred to SGS Geostat from the client. SGS Geostat has imported and validated the database into GEOBASE and it was also cross checked with the laboratory certificates. See Figure 14.1.1 for typical assay view in GEOBASE.

14.1.1.1 Computerized drill hole database used for resources

- The database has information for 121 drill holes from the entire Lac a Paul Property main block.
- The total drill holes length in the database is 20,557 meters.
- There are 6,544 assay records for %P_2O_5, %TiO_2, %SiO_2, %Fe_2O_3, %Al_2O_3, %CaO, %K_2O, %Na_2O, %MnO and %MgO.
- There are 258 deviation recorded data.
- There are 2,675 lithology recorded data.
- There are no RQD (Rock Quality Designation) recorded data.



From	To	length	Sample Number	Certificate	SiO2 %	Al2O3 %	CaO %	Fe2O3 %	K2O %	MgO %	MnO %	Na2O %	P2(%
3.50	6.00	2.50	J415938		80.19	10.39	0.97	1.25	2.67	0.28	0.01	3.05	
28.00	31.00	3.00	J415939		73.38	13.87	1.93	2.01	1.45	0.35	0.03	5.00	
31.00	33.00	2.00	J415940		40.44	14.48	9.25	14.92	1.78	6.54	0.15	2.78	
33.00	35.30	2.30	J415941		39.41	14.62	9.75	15.01	1.36	6.44	0.14	2.97	
35.30	38.70	3.40	J415942		71.27	14.22	2.05	2.78	1.86	0.87	0.09	4.83	
38.70	40.50	1.80	J415943		49.48	11.94	6.86	12.06	2.12	6.11	0.17	2.92	
40.50	42.00	1.50	J415944		71.73	14.46	1.03	2.11	4.41	0.38	0.02	4.00	
42.00	44.50	2.50	J415945		72.98	14.40	1.21	1.52	3.10	0.62	0.02	4.63	
44.50	47.00	2.50	J415946		22.48	2.08	9.24	33.50	1.07	12.19	0.35	0.11	
47.00	50.70	3.70	J415947		50.16	15.70	6.15	10.00	2.90	4.39	0.11	4.15	
50.70	52.50	1.80	J415948		22.66	5.08	10.57	30.50	0.42	12.28	0.28	0.76	
52.50	55.50	3.00	J415949		25.43	5.59	11.56	28.21	0.63	11.47	0.26	0.92	
55.50	58.50	3.00	J415950		24.61	5.60	11.45	29.18	0.71	11.68	0.26	0.76	
58.50	60.00	1.50	J415952		32.78	9.33	10.06	21.83	1.59	10.35	0.21	1.71	
60.00	62.20	2.20	J415953		23.60	5.70	12.02	29.20	0.47	11.42	0.26	0.86	
62.20	65.00	2.80	J415954		29.40	8.42	10.26	26.05	0.35	10.68	0.23	1.42	
65.00	68.50	3.50	J415955		24.31	5.86	10.93	30.11	0.25	11.88	0.27	0.95	
68.50	71.80	3.30	J415956		34.43	12.63	11.34	19.11	0.61	7.58	0.18	2.32	

Figure 14.1.1 Hole MAN-11-45, Typical Assay View in Geobase

14.1.1.2 Topographic survey

The topography used is the same as the one used in 2009 when Arianne contracted an independent surveyor to perform a topography survey using a differential GPS along the geophysical survey lines, in order to have a representative and adequate surface delimitation for resource calculations.

Each zone has a local field grid line; however, UTM NAD 83 was used as the coordinate system.

The resource model used the UTM NAD 83 system and the surveyed topography model.

14.1.1.3 Mineralized envelope modelling approach

In order to adequately define the mineralized envelopes, a mineralized solid is defined using geological description and grade information along the drill hole core.

The mineralized envelopes are built on sections and are subsequently connected and sliced on levels.

The interpretation of the mineralized structures (Nelsonite mass with enriched Apatite content) was made by Mr. Claude Duplessis, geological engineer and Senior QP for the Paul and Zone No. 2, while the Manouane zone was done by Mr. Guy Desharnais, Ph.D P.Geo and QP under Claude Duplessis's supervision.

Surveyed topography and overburden thicknesses were taken into account in the calculation of mineralized solids.

In SGS Geostat's mineralized envelope interpretation, the following Zones were respectively studied:

- Paul (PAU) Zone centered on 375141.90E, 5529452.00N.
- Manouane (MAN) Zone centered on 381327.00E, 5527408.00N.
- Zone No. 2 centered on 366947.96E, 5516273.78N.

The following sections present for each Zone, the interpretation on sections, mineralized intersections, composites, estimation parameters and block models. This information is followed by classification and tabulation of mineral resource statements.

14.1.2 Paul Zone

A set of cross sections were developed with the new drilling information. Interpretation on cross sections of the Nelsonite bodies was done. Following a first cross sections interpretation, this information was revised with control level plans. The relatively rich TiO_2 layer observed on the north side of the zone with very low P_2O_5 is still used to assist in the interpretation and extensions. Once interpretation made sense, the prism on sections were linked together to create a solid. Extremities of solids were completed with stumps prior to meshing. The north-south cross sections spacing ranged from 65 to 115 meters apart and was 90 meters in general. The overburden bedrock contact was interpreted on each cross section. See Figures 14.1.2 through to 14.1.6 for visual details.

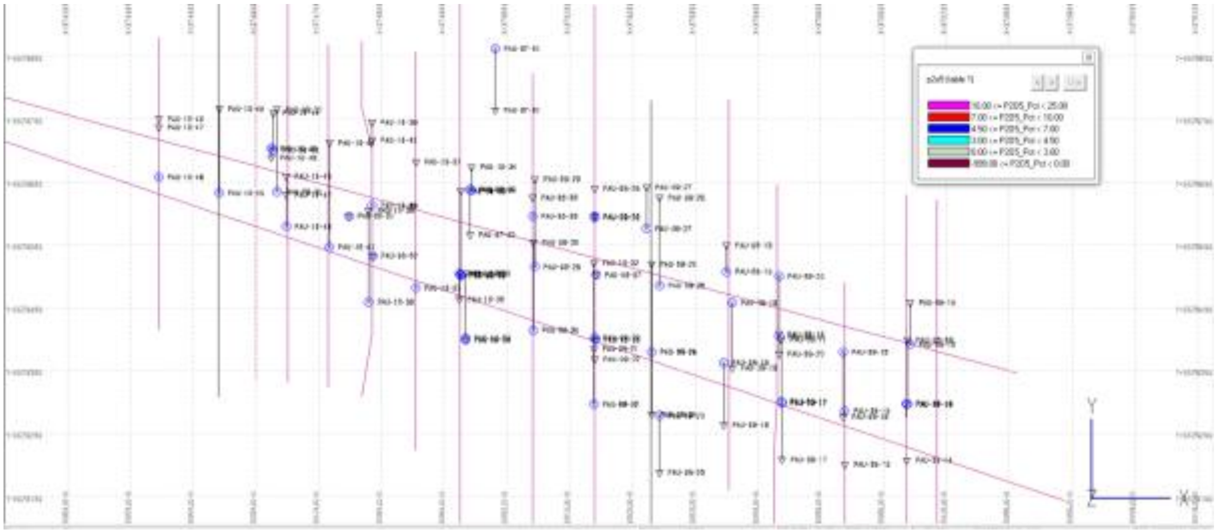


Figure 14.1.2 Drill hole layout in plan view UTM NAD 83 coordinates (Y is due North)

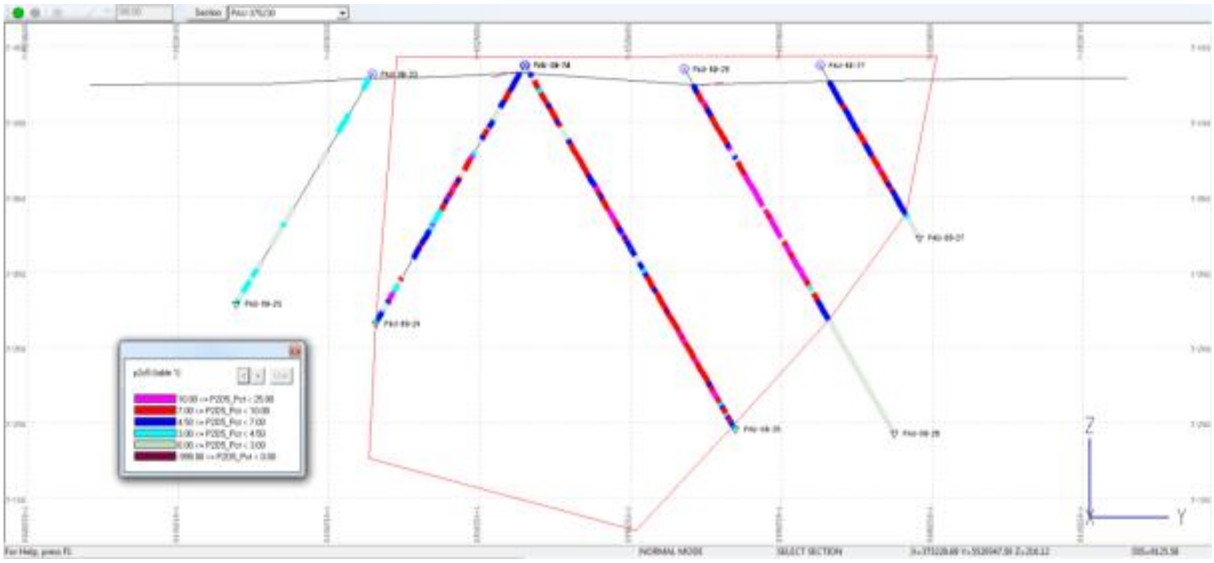


Figure 14.1.3 Cross sections looking West at 375230E with %P_2O_5 and interpretation

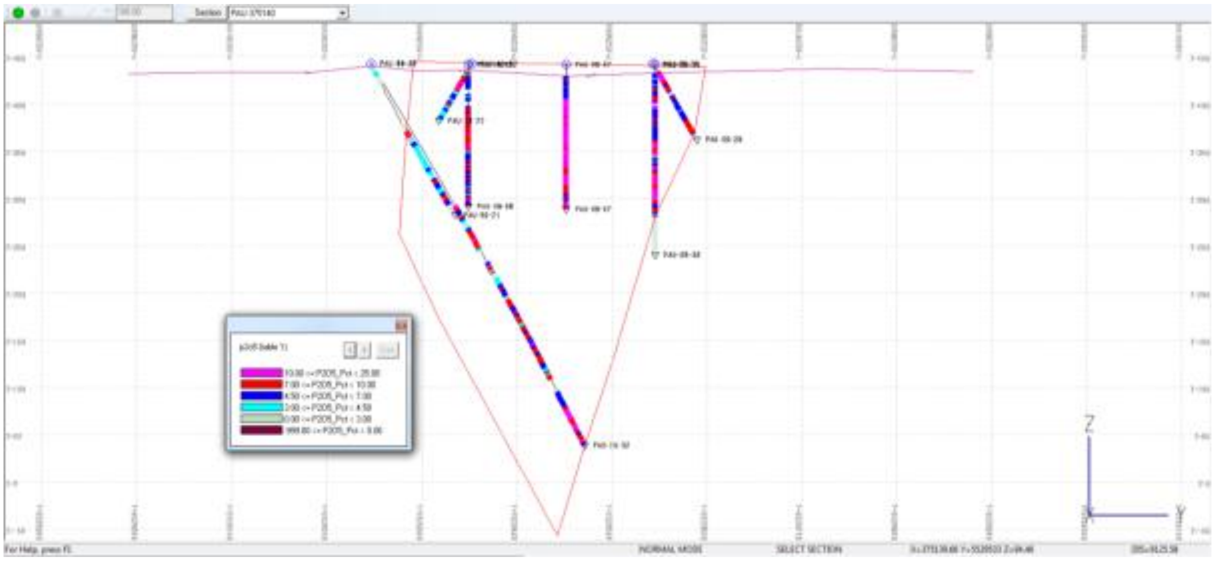


Figure 14.1.4 Cross sections looking West at 375140E with %P_2O_5 and interpretation

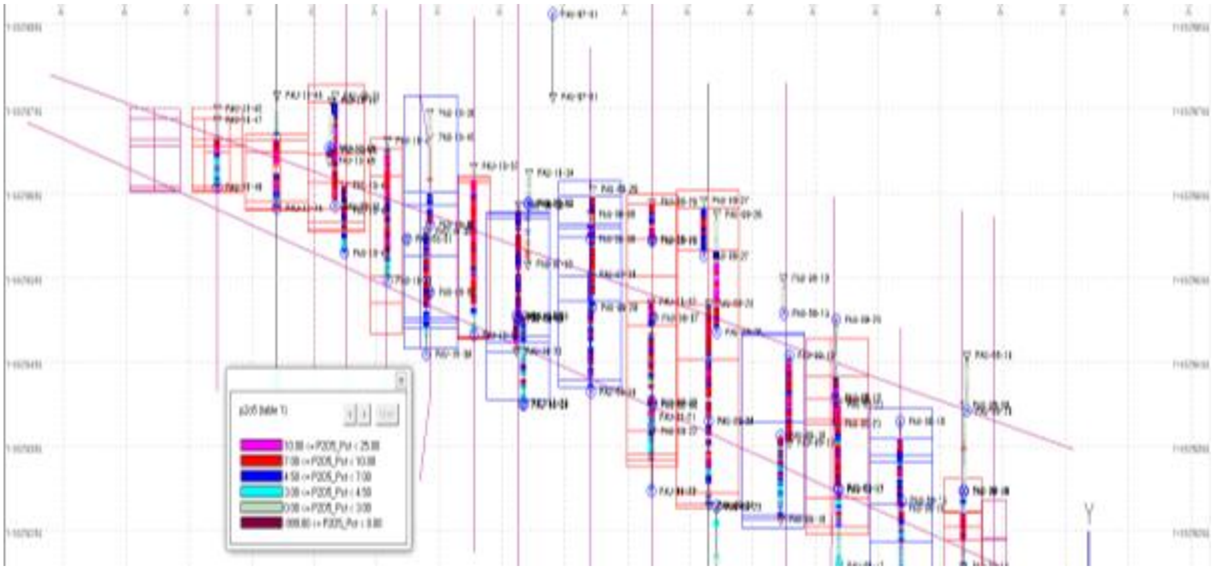


Figure 14.1.5 Plan view with %P_2O_5 and trace of section interpretation

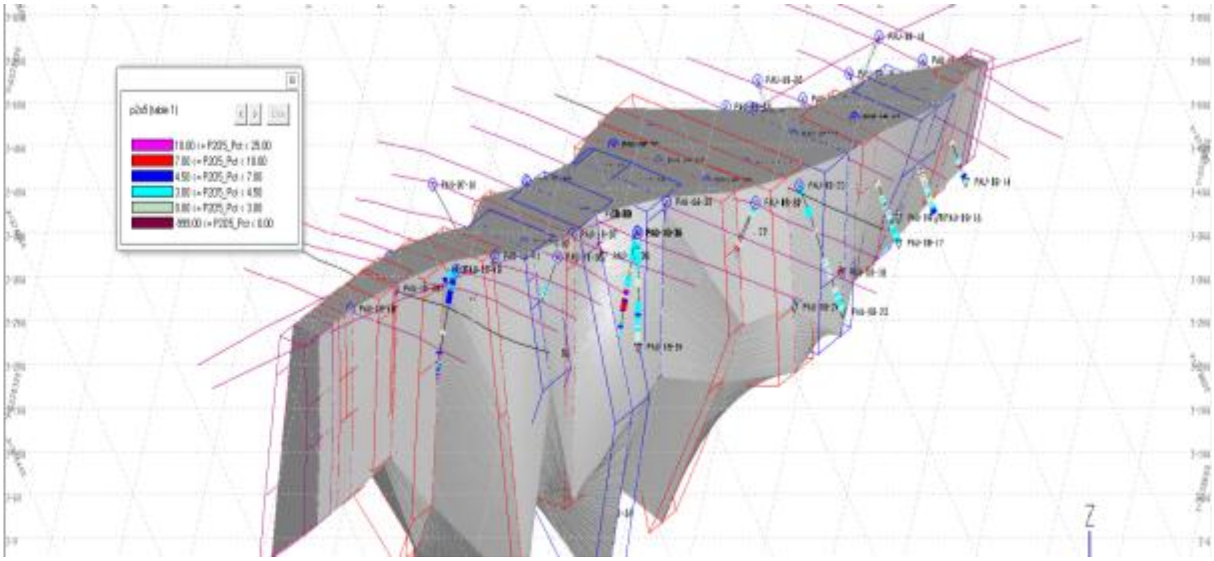


Figure 14.1.6 Oblique view of the solid looking down North East

14.1.2.1 Mineralized intersections

Mineralized intersections consist of the part of drill hole samples within the interpreted limits of mineralized zones. Most intersections in drill holes are complete (start and end points at the zone limits).

A total of 41 intersections were defined from these holes, some holes having intersected more than one zone and some were not crossing the zone. Holes which are not listed in the sequences did not cut through the apatite zone.

Table 14.1.1 is the list of the intersection limit file used for the creation of standard length composites. This is with dilution of gaps.

Hole Name	From (m)	To (m)	Length (m)	P_2O_5 Pct	TiO_2 Pct
PAU-08-01	4	164	160	7.50	8.11
PAU-08-02	4	153	149	6.20	7.33
PAU-08-03	3	159	156	7.45	7.32
PAU-08-05	9	160.3	151.3	7.80	11.01
PAU-08-06	6.5	150	143.5	7.04	5.94
PAU-08-07	12	153	141	10.32	7.80
PAU-08-08	4	38	34	6.62	10.84
PAU-08-11	3	156	153	7.99	8.70
PAU-08-12	66	126	60	8.98	10.66
PAU-09-14	48.55	113	64.45	8.74	8.33
PAU-09-15	3	99	96	5.82	6.35
PAU-09-16	42	193.5	151.5	7.06	7.38
PAU-09-17	3	87	84	6.67	5.59
PAU-09-18	3	192	189	5.42	6.28
PAU-09-19	6	201	195	8.39	8.66
PAU-09-20	135	249	114	8.31	9.30
PAU-09-21	80.7	183	102.3	4.47	4.63
PAU-09-22	6	69	63	6.32	6.21
PAU-09-24	6	198	192	5.81	5.07
PAU-09-25	6	276	270	7.48	7.27
PAU-09-26	12	192	180	8.29	8.37
PAU-09-27	12	114	102	7.02	11.13
PAU-09-28	9	85.3	76.3	6.87	10.65
PAU-09-29	6	261.6	255.6	7.18	9.27
PAU-09-30	11	279	268	5.92	7.89
PAU-09-31	6	246	240	8.50	10.71

Hole Name	From (m)	To (m)	Length (m)	P_2O_5 Pct	TiO_2 Pct
PAU-10-32	174.3	462	287.7	6.87	6.71
PAU-10-33	3.5	293.6	290.1	7.63	9.27
PAU-10-35	153.8	430	276.2	5.52	6.42
PAU-10-36	4.3	47	42.7	7.95	6.96
PAU-10-37	6.6	330.8	324.2	8.01	9.20
PAU-10-38	75	351	276	6.56	8.32
PAU-10-39	6.6	54.6	48	5.54	11.86
PAU-10-40	4.9	303.5	298.6	6.78	11.55
PAU-10-41	11.1	395.5	384.4	7.37	8.72
PAU-10-42	40.4	72	31.6	7.10	7.52
PAU-10-43	144.2	324.5	180.3	6.76	9.49
PAU-10-45	2.8	165.1	162.3	7.88	7.43
PAU-10-46	3.8	243	239.2	7.46	9.27
PAU-10-47	4.3	81.9	77.6	6.20	6.44
PAU-10-48	4.5	21	16.5	3.92	9.33

Table 14.1.1 List of mineralized intersections for mineralized zone definition

14.1.2.2 Compositing of assay intervals within mineralized intercepts

Since original assay intervals did not have all the same length, it was necessary to standardize the length of the grade “support” through numerical compositing before assigning grades in 3D space to dimensionless “points” (the composite centers) for the block grade interpolation.

The majority of assay intervals have a length of 1.5 m and three (3) m. The selectivity of 1.5 m is not commonly achievable in bulk tonnage mining; therefore a three (3) m standard length was elected. This also allowed for internal smoothing and internal dilution, since it could be difficult and unrealistic in the Lac a Paul context to exclude dykes and barren inclusions of smaller dimension within a blast. The material not analyzed was considered barren with 0% P_2O_5 and 0% TiO_2.

No capping of the grade was performed. From our professional opinion, it was not necessary due to the nature of mineralization.

Compositing was done down hole from the start of mineralized intercepts. Missing assays were assumed to be at zero grade. At the end of the mineralized intercepts, the last composite kept was the one with a minimum of 1.5 m in length. It is important to mention that only composites within the envelope and its vicinity were used to estimate the mineralized zones. The composites were calculated from original uncapped samples.

14.1.2.3 Specific gravity data

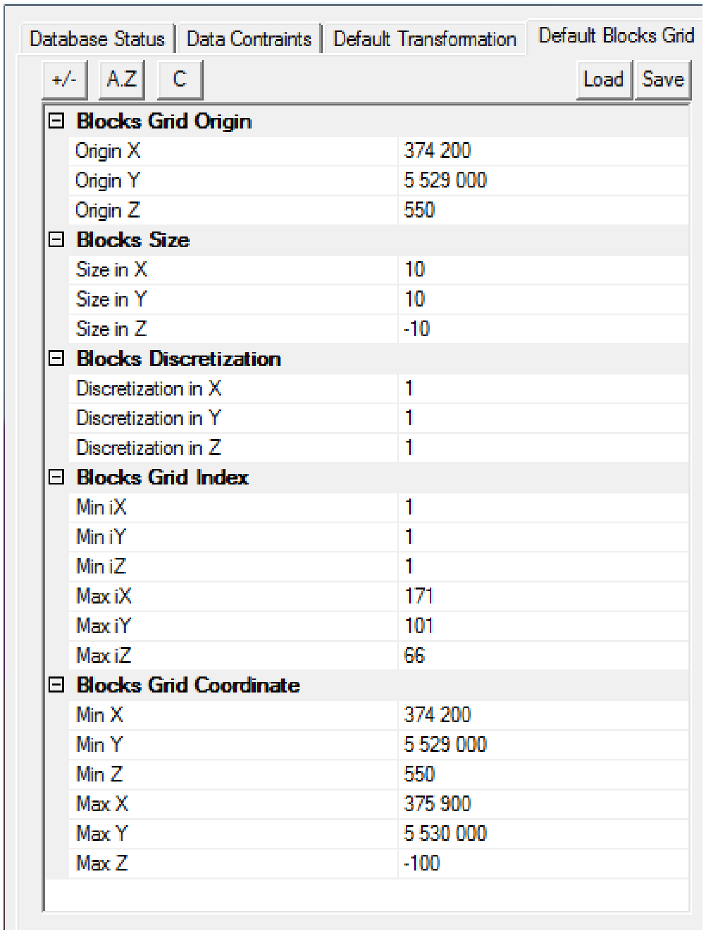
Based on previous core specific gravity (SG) measurements, the specific gravity value used to convert volumes into tonnes was set to a conservative fixed value of 3.42 t/m^3 for the Paul Zone. Additional SG measurements were performed in subsequent drilling phases in order to derive an ideal regression based on variable specific gravities. The challenge was that SG is not 100% dependent of apatite content, iron and titanium and it is also affected by low SG minerals.

Estimates were done with SGS Geostat SECTCAD Plus, which includes SGS Geostat BLKCAD block modelling and resource estimation software.

Grades were estimated in each 10 m (EW) x 10 m (NS) x 10 m (Z) block of a regular matrix of 171 columns (EW), 101 rows (NS) and 66 benches (Z) with its center within the limits of the mineralized zones. A total of 2,256 composites (data points representing 3 meters) were used to estimate the blocks (see Figure 14.1.7). The block model is cut by overburden\rock surface and the topography.

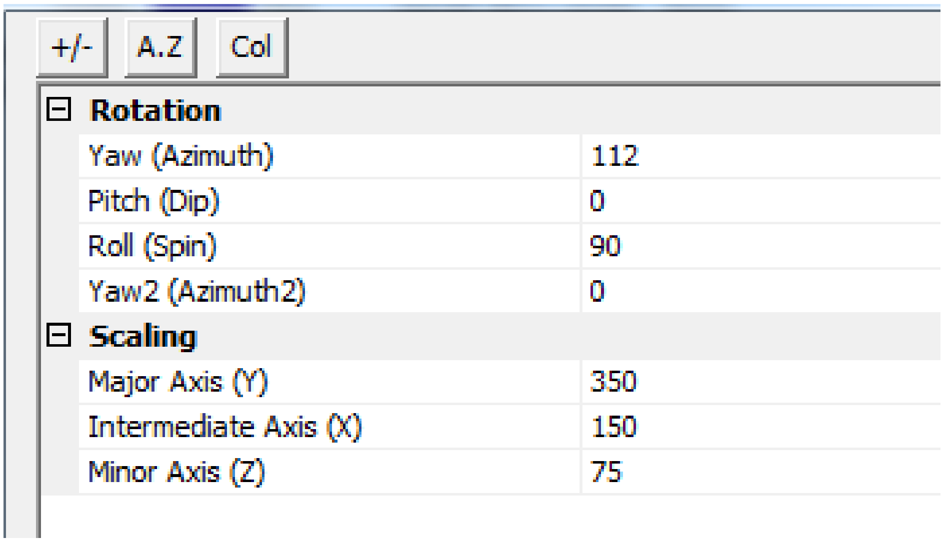
The average % P_2O_5 and % TiO_2 grade of each block was interpolated by inverse of the distance from the grades of nearby three (3) m composites.

The Author used interpolation parameters based on drill spacing, envelope extension and orientation.



⊟ **Blocks Grid Origin**	
Origin X	374 200
Origin Y	5 529 000
Origin Z	550
⊟ **Blocks Size**	
Size in X	10
Size in Y	10
Size in Z	-10
⊟ **Blocks Discretization**	
Discretization in X	1
Discretization in Y	1
Discretization in Z	1
⊟ **Blocks Grid Index**	
Min iX	1
Min iY	1
Min iZ	1
Max iX	171
Max iY	101
Max iZ	66
⊟ **Blocks Grid Coordinate**	
Min X	374 200
Min Y	5 529 000
Min Z	550
Max X	375 900
Max Y	5 530 000
Max Z	-100

Figure 14.1.7 Block model origin and extent of the Paul Zone



Rotation

Yaw (Azimuth)	112
Pitch (Dip)	0
Roll (Spin)	90
Yaw2 (Azimuth2)	0

Scaling

Major Axis (Y)	350
Intermediate Axis (X)	150
Minor Axis (Z)	75

Figure 14.1.8 Search ellipsoid parameters of the Paul Zone

For the interpolation process, estimation was made with one run:

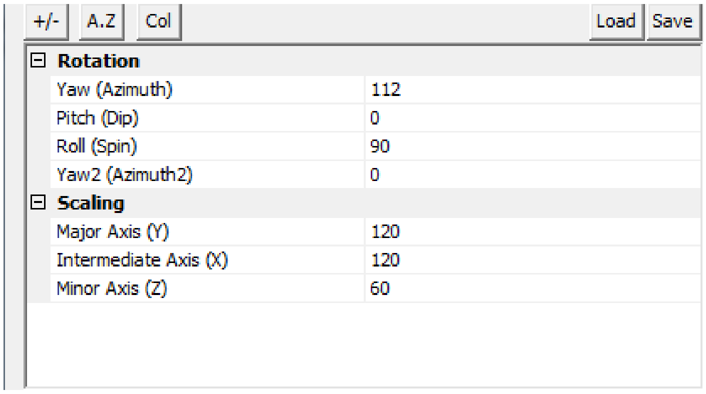
A search ellipse of 350 m, 150 m, 75 m and a maximum of ten (10) composites, minimum of two (2), with a maximum of four (4) composites from the same hole. The long axis is oriented north 112° and the dip is at 90°. See Figure 14.1.8.

14.1.2.4 Resource Categories

An assessment of the grade continuity was undertaken to establish the drill spacing necessary to attain a Measured, Indicated or inferred level of confidence.

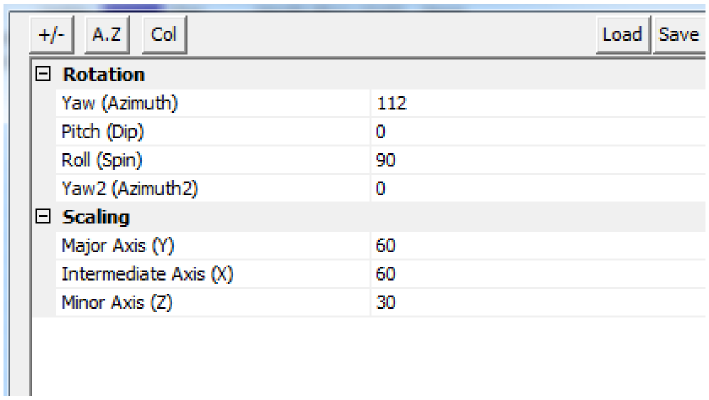
The Author observed that a range of 150 meters of % P_2O_5 provided some evidence that this drill spacing had meaningful grade information within this distance.

A first pass of automatic classification was done using an anisotropic search ellipsoid for the Measured category (60 m long axis) and then for the Indicated category (120 m long axis; the remaining within the envelope was classified as Inferred category). The Figures 14.1.9 and 14.1.10 below present the effective search ellipsoid orientation and size.



Rotation	
Yaw (Azimuth)	112
Pitch (Dip)	0
Roll (Spin)	90
Yaw2 (Azimuth2)	0
Scaling	
Major Axis (Y)	120
Intermediate Axis (X)	120
Minor Axis (Z)	60

Figure 14.1.9 Search ellipsoid parameters for the Indicated category for the Paul Zone



Rotation	
Yaw (Azimuth)	112
Pitch (Dip)	0
Roll (Spin)	90
Yaw2 (Azimuth2)	0
Scaling	
Major Axis (Y)	60
Intermediate Axis (X)	60
Minor Axis (Z)	30

Figure 14.1.10 Search ellipsoid parameters for Measured category for the Paul Zone

Figures 14.1.11 through to 14.1.13 present bench plans with blocks colour coded by class.

The block model was provided to Met-Chem to be used for the estimate of the Mineral Reserves. The results of the pit optimization showed that there were blocks of inferred resources within the pit shell. These blocks were a result of the automatic classification that required two holes in the ellipse, creating thin slices and small patches within the pit, due to the grid being not exactly rectangular. Since this material falls within the economic pit limits, the inferred blocks within the pit were reclassified as Indicated. Figure 14.1.11 presents the pit outline with the first classification. The black blocks proved to be inadequate and were reclassified. The red blocks were still classified as Measured in the resource model.

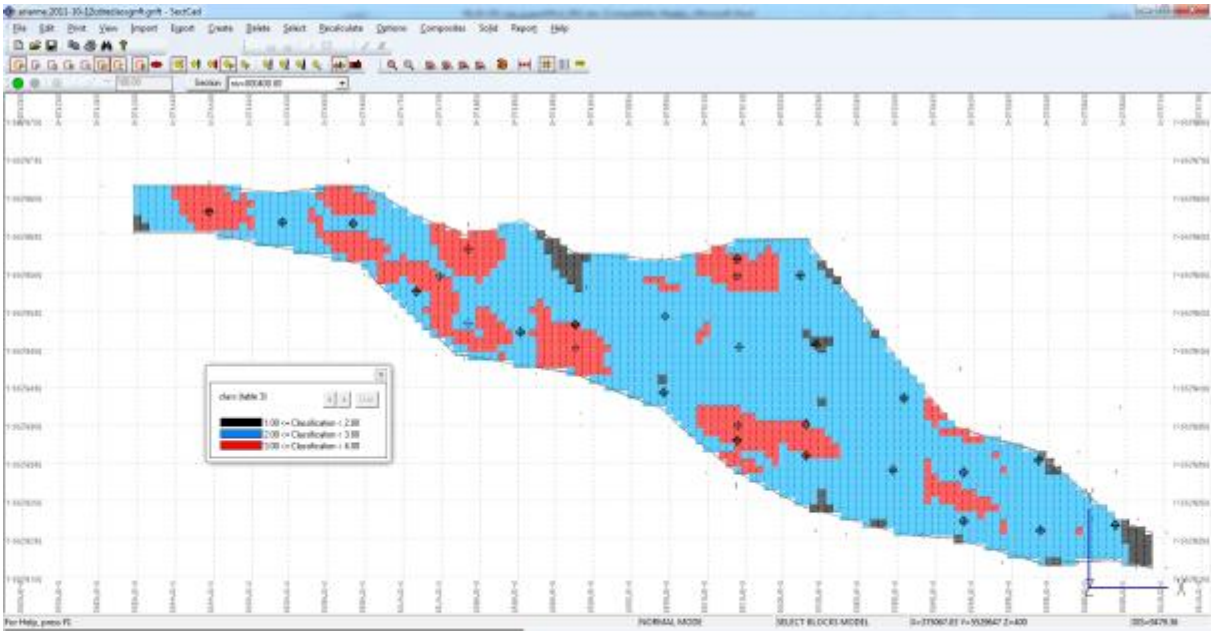


Figure 14.1.11 Bench 400 with colour coded classification (red Measured, blue Indicated)

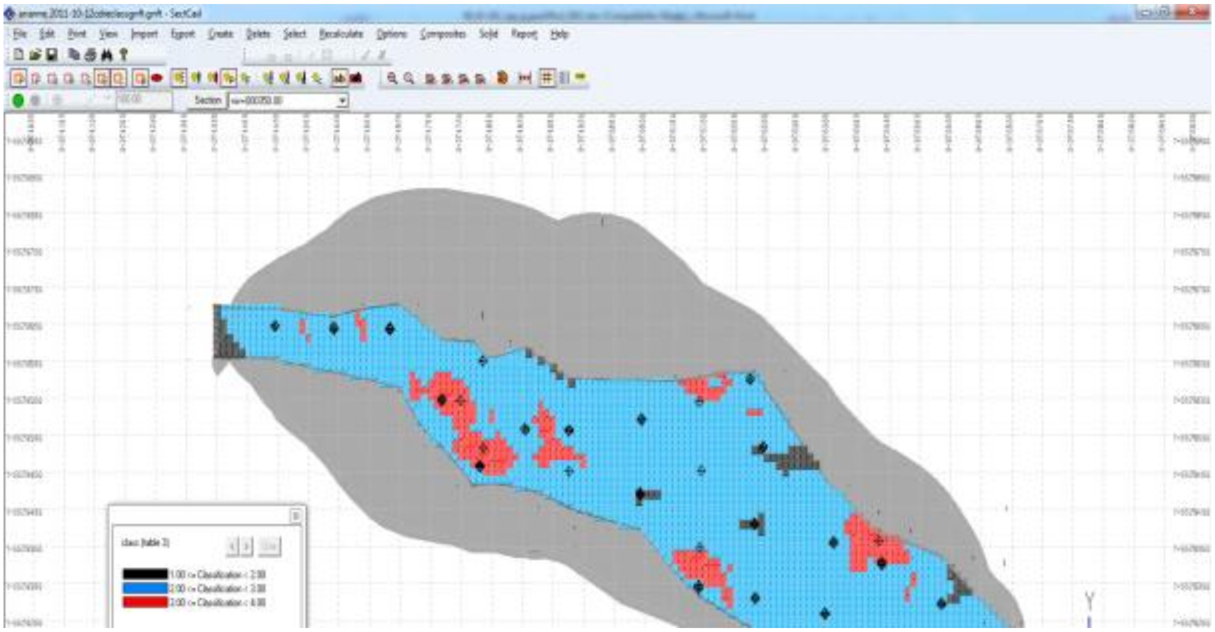


Figure 14.1.12 Bench 350 with colour coded classification (red Measured, blue Indicated)

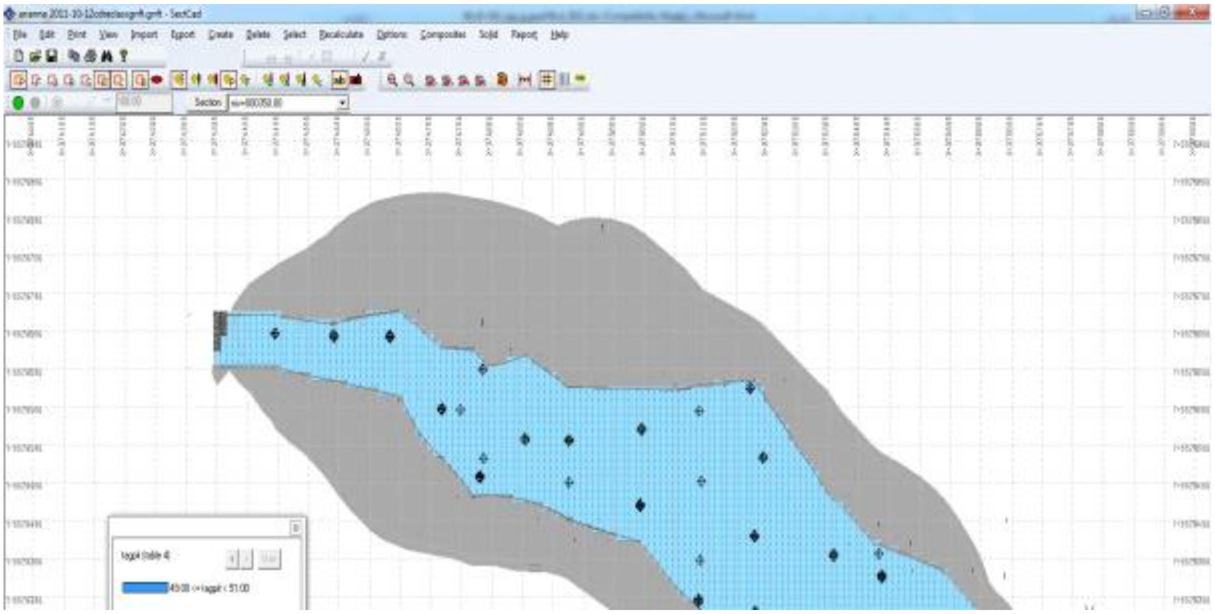


Figure 14.1.13 Bench 350 with blocks in blue classified as Measured and Indicated

14.1.2.5 Mineral Resource Statement

Mineral resources for the Lac a Paul, Paul Zone were estimated by using a 2.43% P_2O_5 cut-off grade. This is the economic cut-off grade calculated by Met-Chem. At this base case cut-off, the Paul Zone hosts a Measured Mineral Resource of 22.1 million tonnes grading 6.82% P_2O_5, an Indicated Mineral Resource of 161.8 million tonnes grading 7.10% P_2O_5 and an additional Inferred Mineral Resource of 50.3 million tonnes grading 6.61% P_2O_5. The mineral resource estimates are outlined in Table 14.1.2. Results are presented as in-situ. There are no known factors or issues related to permitting, legal, mineral title, taxation, socioeconomic or political relations that could materially affect the mineral resource estimate. Potential modifying factors regarding marketing are discussed in the market study section.

Ressources d'Arianne | **For Public disclosure**

cut-off grade ≥ 2.43% P2O5 | Rounded numbers

Lac à Paul Resources 7-Nov-11

OFFICIAL RESOURCES **PAUL**

	Fixed Density	% P2O5	% TiO2	Tonnes
Inferred	3.42	6.61	8.25	50,300,000
Indicated	3.42	7.10	8.21	161,800,000
Measured	3.42	6.82	7.89	22,100,000
Meas+Ind	3.42	7.06	8.17	183,900,000

Table 14.1.2 Mineral resource summary table for the Paul Zone using a 2.43% P_2O_5 cut-off grade

The resource block model with colour coded grades of P_2O_5 is presented in Figures 14.1.14 and 14.1.15 for bench 400 and 350, which are 50 and 100 meters below surface.

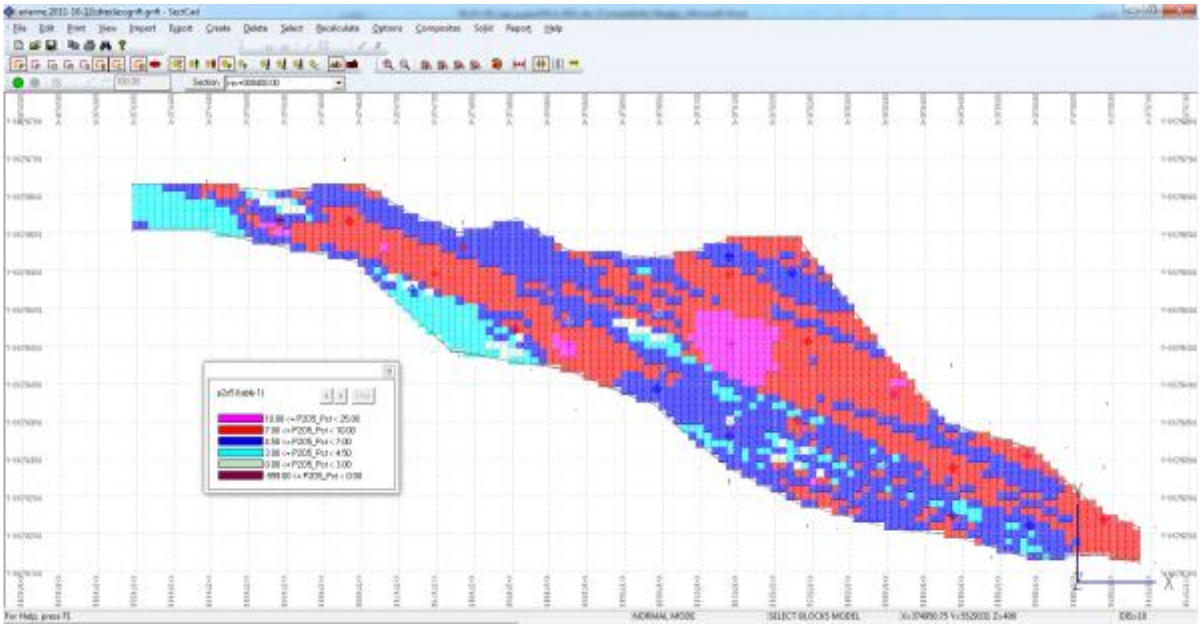


Figure 14.1.14 Bench 400 with colour coded blocks according to grades

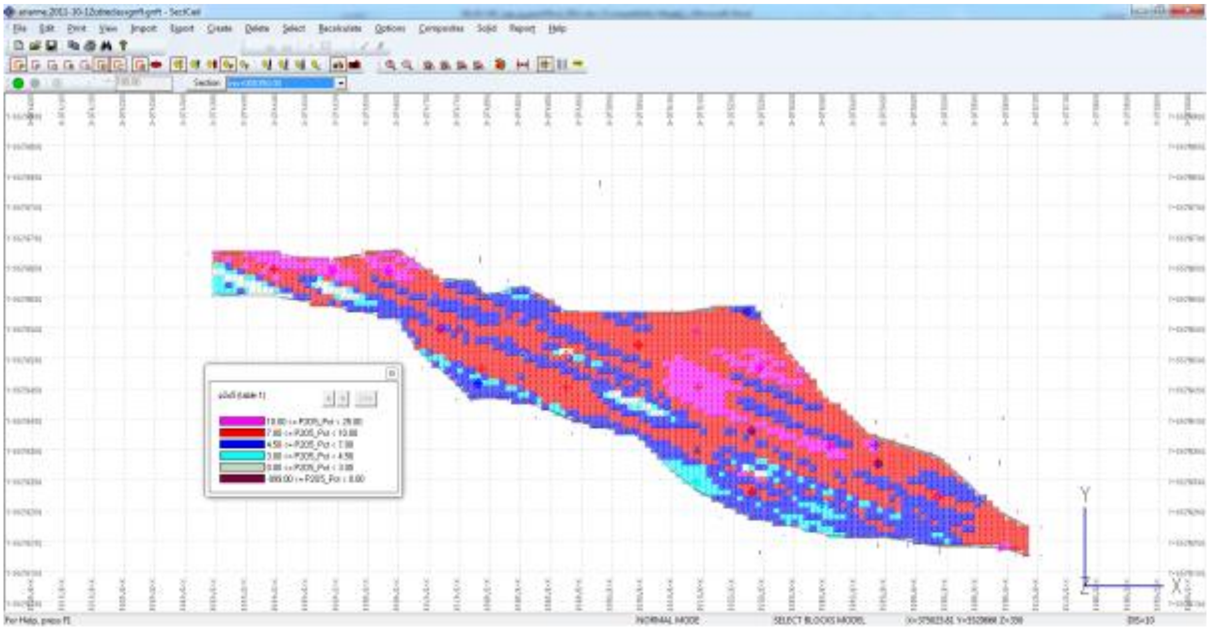


Figure 14.1.15 Bench 350 with colour coded blocks according to grades

14.1.3 Manouane Zone

A set of cross sections were developed with the new drilling information. Interpretation of the Nelsonite bodies was done on cross sections. Following a first interpretation on cross-sections, the interpretation was revised with control level plans. Once interpretation made sense, the prisms on sections were linked together to create a solid. Extremities of solids were completed with stumps prior to meshing. The North 25 West cross sections spacing ranged from 80 meters to 120 meters apart and was of 80 meters in general. The interpretation is limited to overburden-rock contact on each cross section. See Figures 14.1.16 through to 14.1.21 for visual details.

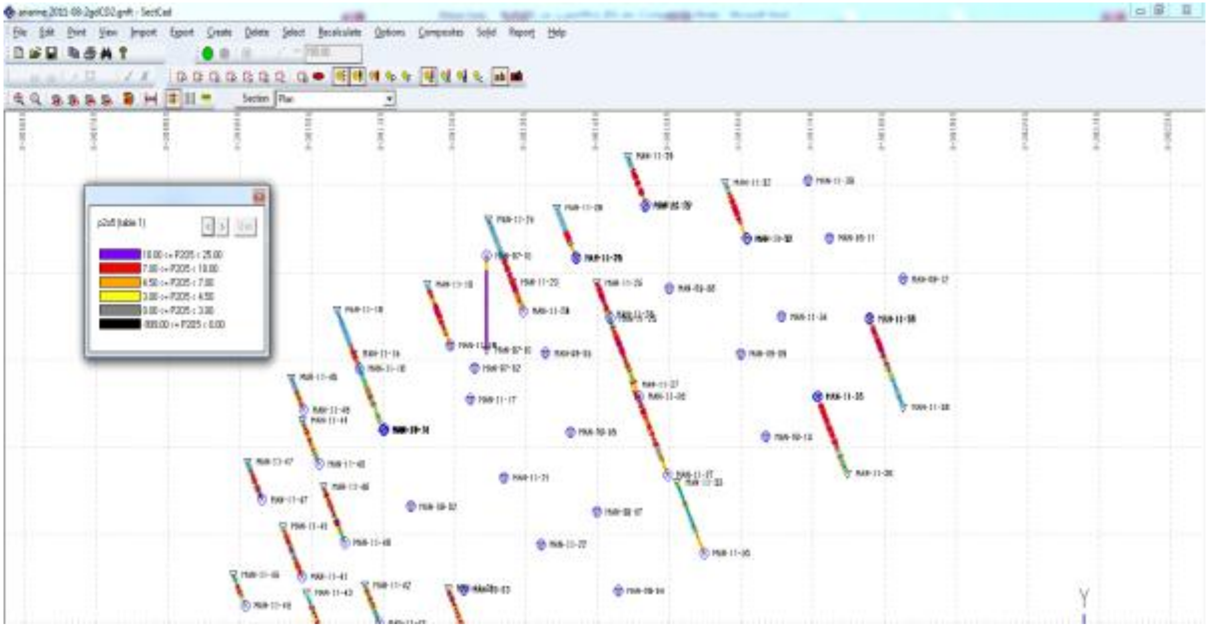


Figure 14.1.16 Drill hole layout in plan view UTM NAD 83 coordinates (Y is due north)

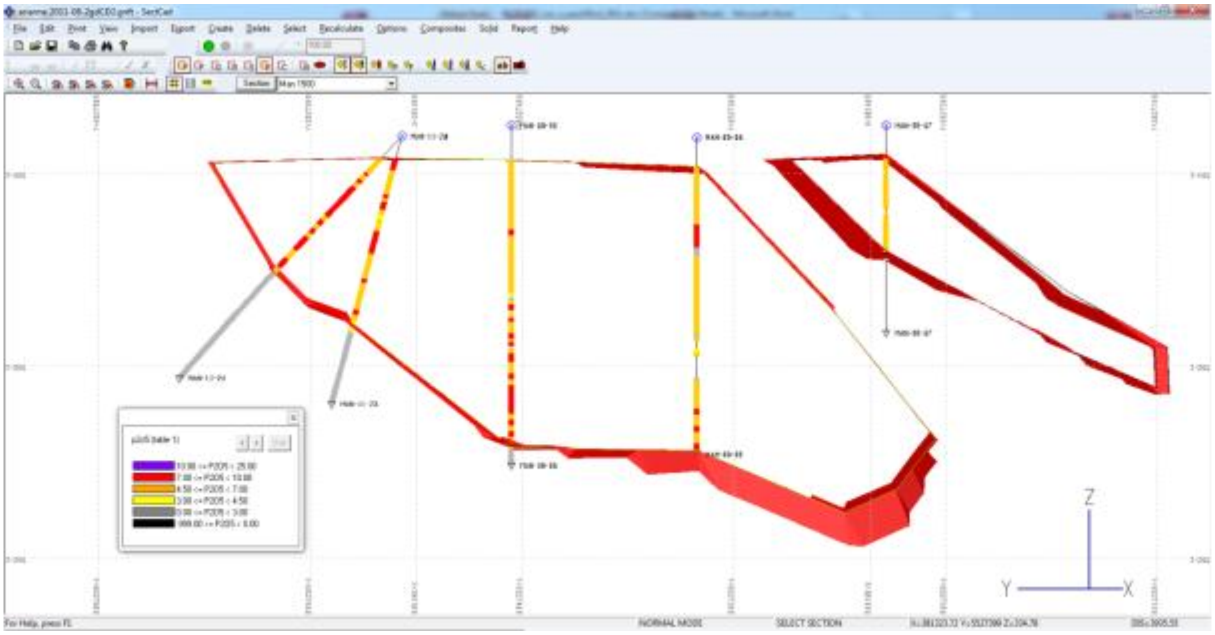


Figure 14.1.17 Cross sections looking 65 degrees (Man 1500) with % P_2O_5 and interpretation

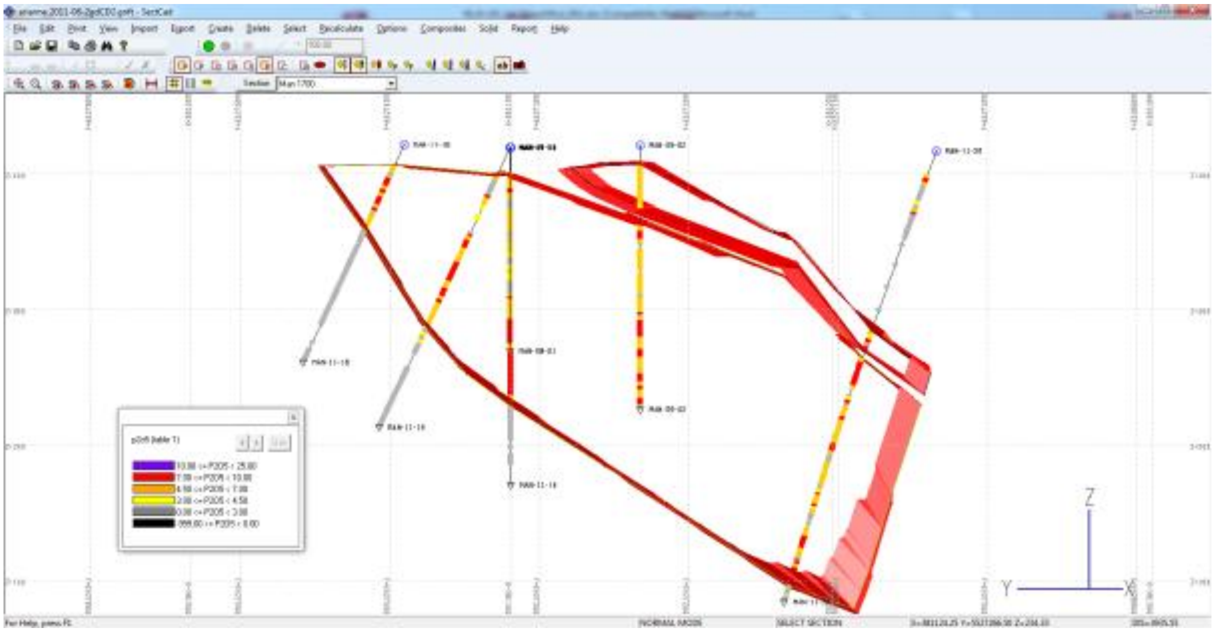


Figure 14.1.18 Cross sections looking 65 degrees (Man 1700) with % P_2O_5 and interpretation

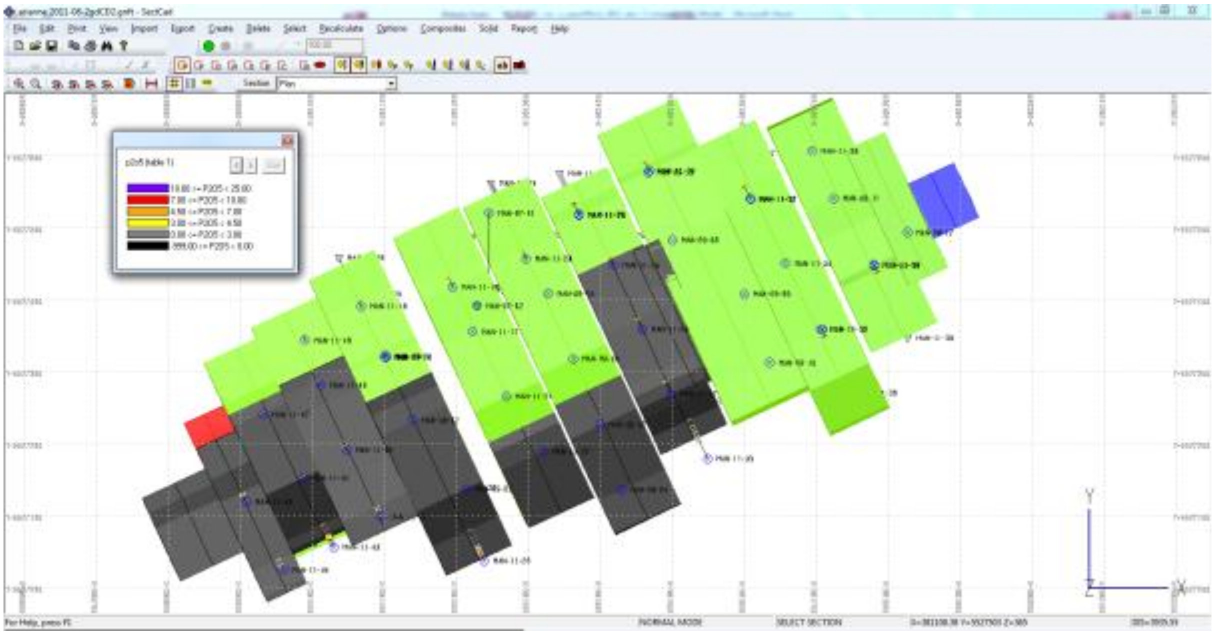


Figure 14.1.19 Plan view with trace of section interpretation

Drill holes from 1997 were not taken into account. The Manouane zone is made of two separate zones which merge together towards the North-East portion of the zone.

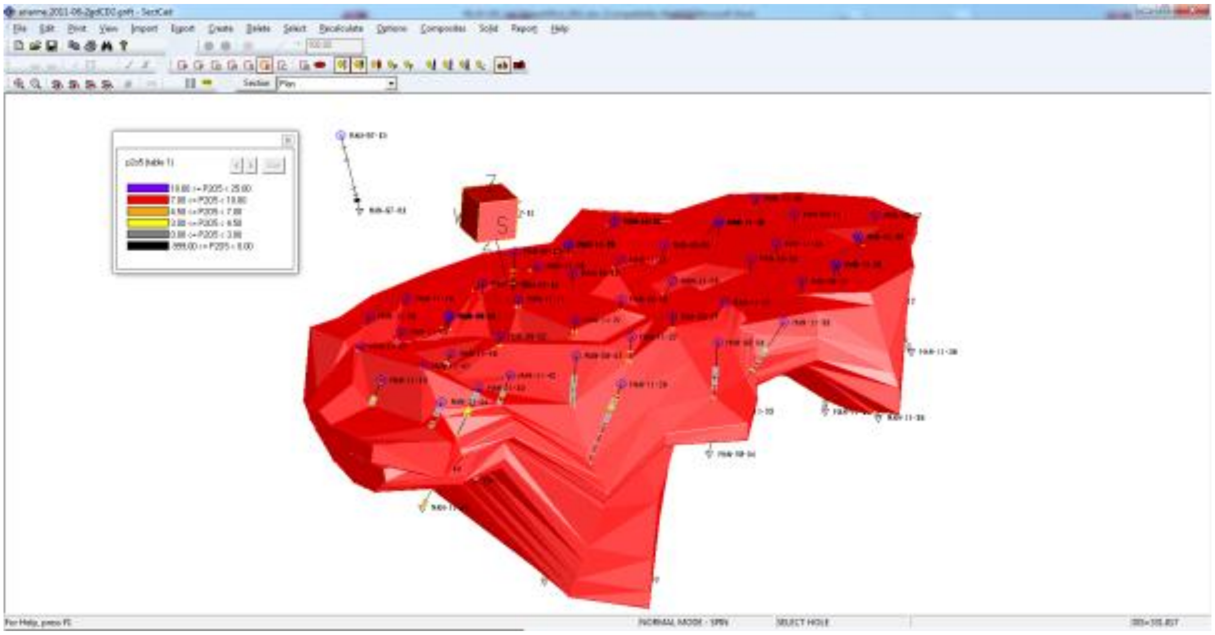


Figure 14.1.20 Oblique view of the solids looking down northeast

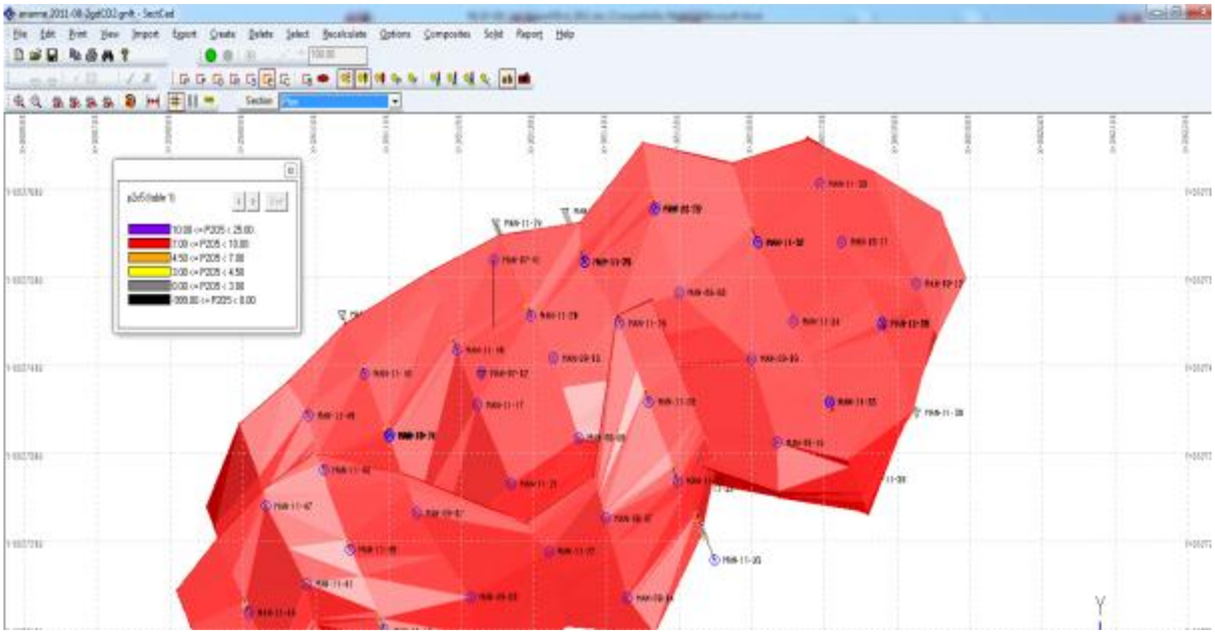


Figure 14.1.21 Plan view of the solids looking down northeast

14.1.3.1 Mineralized intersections

Mineralized intersections consist of drill hole samples within the interpreted limits of mineralized zones. Most intersections in drill holes are complete (start and end points at the zone limits).

A total of 41 intersections were defined from the holes, some holes having intersected more than one zone and some which were not crossing the zone. Holes not listed in the sequences did not cut the apatite zone.

Table 14.1.3 shows the list of the intersections (including dilution with gaps) used for the creation of standard length composites.

Hole Name	From (m)	To (m)	Length (m)	P_2O_5_Pct	TiO_2_Pct
MAN-09-01	18.00	150.00	132.00	5.35	8.27
MAN-09-02	12.00	46.50	34.50	5.70	9.02
MAN-09-02	55.00	195.00	140.00	5.97	9.73
MAN-09-03	73.30	91.70	18.40	4.37	7.05
MAN-09-03	100.00	150.00	50.00	6.92	8.24
MAN-09-04	81.20	111.00	29.80	5.84	8.17
MAN-09-05	18.00	168.00	150.00	6.53	9.85
MAN-09-06	15.00	163.00	148.00	6.10	9.72
MAN-09-07	15.00	65.60	50.60	5.22	10.23
MAN-09-08	18.00	123.40	105.40	6.31	10.16
MAN-09-09	18.00	137.50	119.50	7.15	9.92
MAN-09-10	20.00	117.00	97.00	6.49	10.22
MAN-09-11	12.00	55.50	43.50	7.76	10.94
MAN-09-11	55.50	81.00	25.5	2.14	4.48
MAN-09-11	81.00	154.20	73.20	6.62	9.23
MAN-09-12	12.00	87.70	75.70	6.02	8.78
MAN-09-13	10.00	78.30	68.30	6.50	9.65
MAN-11-14	150.00	191.10	41.10	6.96	9.74
MAN-11-15	21.00	147.00	126.00	5.61	8.59
MAN-11-16	16.00	69.00	53.00	5.86	8.87
MAN-11-17	12.00	200.20	188.20	5.91	9.67
MAN-11-18	16.90	150.00	133.10	6.79	10.06
MAN-11-19	19.60	104.90	85.30	6.50	9.80
MAN-11-20	141.00	157.40	16.40	5.72	4.43
MAN-11-20	161.70	338.40	176.70	5.68	8.26
MAN-11-21	15.00	277.50	262.50	5.25	8.43
MAN-11-22	36.00	47.00	11.00	5.08	7.79
MAN-11-22	124.90	350.00	225.10	5.18	8.57

Hole Name	From (m)	To (m)	Length (m)	P_2O_5_Pct	TiO_2_Pct
MAN-11-22	183.50	185.20	1.70	6.06	10.14
MAN-11-22	248.55	252.30	3.75	6.25	11.07
MAN-11-22	345.00	350.00	5.00	4.25	7.65
MAN-11-23	12.00	100.90	88.90	6.58	9.45
MAN-11-24	15.00	97.20	82.20	6.97	9.95
MAN-11-25	17.90	93.00	75.10	6.87	10.13
MAN-11-26	29.00	63.10	34.10	5.13	6.75
MAN-11-26	63.10	185.20	122.10	6.92	10.28
MAN-11-27	35.00	51.70	16.70	6.00	10.33
MAN-11-27	66.50	209.90	143.40	6.48	9.34
MAN-11-28	15.00	107.00	92.00	6.80	9.29
MAN-11-29	22.20	53.20	31.00	7.33	8.93
MAN-11-30	15.00	70.10	55.10	7.03	10.20
MAN-11-31	21.00	105.00	84.00	6.14	8.68
MAN-11-32	28.20	92.70	64.50	6.82	10.01
MAN-11-33	120.30	131.20	10.90	6.11	10.81
MAN-11-34	17.80	173.70	155.90	6.81	9.42
MAN-11-35	15.90	203.80	187.90	6.00	8.58
MAN-11-36	18.60	213.70	195.10	6.22	8.57
MAN-11-36	159.00	162.15	3.15	4.39	6.39
MAN-11-37	12.30	63.70	51.40	5.85	7.77
MAN-11-37	63.70	71.60	7.90	0.38	0.92
MAN-11-37	71.60	105.00	33.40	5.25	7.31
MAN-11-38	13.00	116.00	103.00	5.72	7.99
MAN-11-39	12.40	164.25	151.85	7.16	9.94
MAN-11-40	22.70	32.00	9.30	3.83	5.45
MAN-11-40	38.10	140.90	102.80	5.25	8.23
MAN-11-41	3.50	80.00	76.50	5.62	7.91
MAN-11-41	104.70	191.30	86.60	5.55	8.43
MAN-11-42	51.00	92.00	41.00	5.95	7.50
MAN-11-42	94.85	152.10	57.25	5.45	8.53
MAN-11-43	94.40	114.00	19.60	4.12	5.42
MAN-11-43	117.00	189.00	72.00	4.88	6.69
MAN-11-44	44.80	105.80	61.00	5.59	8.32
MAN-11-45	44.50	92.60	48.10	5.35	6.76

Hole Name	From (m)	To (m)	Length (m)	P_2O_5_Pct	TiO_2_Pct
MAN-11-46	31.50	87.00	55.50	5.89	7.54
MAN-11-46	88.50	207.50	119.00	5.42	7.91
MAN-11-47	7.30	15.00	7.70	6.18	8.38
MAN-11-47	28.50	103.80	75.30	6.23	8.99
MAN-11-48	19.00	71.50	52.50	5.44	8.71

Table 14.1.3 List of mineralized intersections for mineralized zone definition

14.1.3.2 Compositing of assay intervals within mineralized intercepts

Since original assay intervals did not have all the same length, it was necessary to standardize the length of the grade “support” through numerical compositing before assigning grades in 3D space to dimensionless “points” (the composite centers) for the block grade interpolation.

The majority of assay intervals have a length of 1.5 m and three (3) m. The selectivity of 1.5 m is not commonly achievable in bulk tonnage mining; therefore a three (3) m standard length was elected. This also allowed for internal smoothing and internal dilution, since it could be difficult and unrealistic in the Lac a Paul context to exclude dykes and barren inclusions of smaller dimension within a blast. The material not analyzed is considered barren with 0% P_2O_5 and 0% TiO_2.

In our professional opinion, capping on grade was not deemed necessary due to the nature of the mineralization.

Compositing was done down hole from the start of mineralized intercepts. Missing assays were assumed to be at zero grade. At the end of the mineralized intercepts, the last composite kept was the one with at least 1.5 m in length. It is important to mention that only composites within the envelope and its vicinity were used to estimate the mineralized zones. The composites were calculated from original uncapped samples.

14.1.3.3 Specific gravity data

Based on previous SG measurements of core, the specific gravity value used to convert volumes into tonnes was set to a conservative fixed value of 3.42 t/m^3 for the Manouane zone. Additional SG measurements should be done in the next phase of drilling in order to derive ideally a regression based on variable SG. The challenge is that SG is not 100% dependent of apatite content, iron and titanium but it is also affected by low SG minerals.

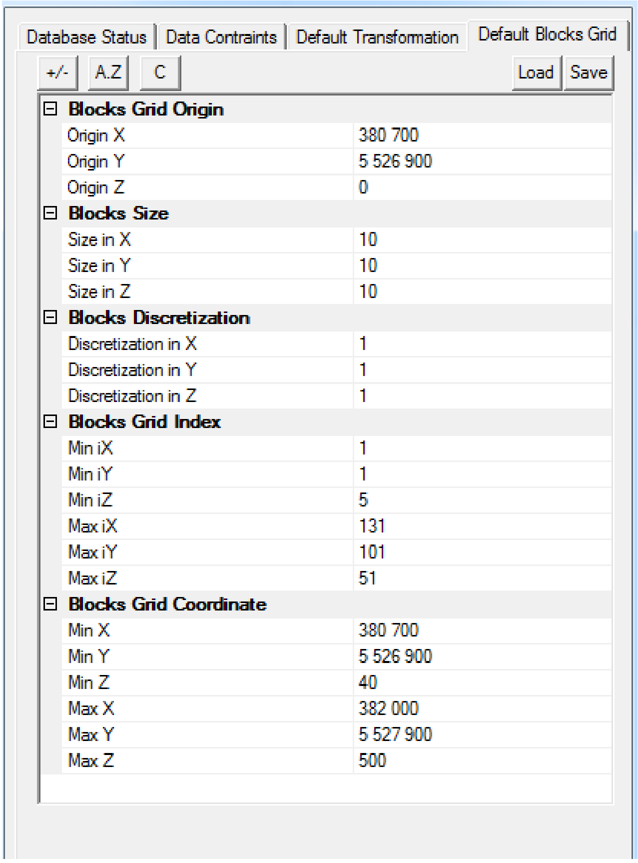
14.1.3.4 Resource block grade interpolation

Estimates were done with SGS Geostat SECTCAD plus which included SGS Geostat BLKCAD block modelling and resource estimation software.

The grades were estimated in each 10 m (EW) x 10 m (NS) x 10 m (Z) block of a regular matrix of 131 columns (EW), 101 rows (NS) and 51 benches (Z) with its center within the limits of the mineralized zones (see Figure 14.1.22). A total of 4,411 composites (data points representing 3 meters) were used to estimate the blocks. The block model was cut by overburden\rock surface. The Manouane zone did not outcrop.

The average % P_2O_5 and % TiO_2 grade of each block was interpolated by inverse of the distance from the grades of nearby three (3) meters composites.

The Author used interpolation parameters based on drill spacing, envelope extension and orientation.



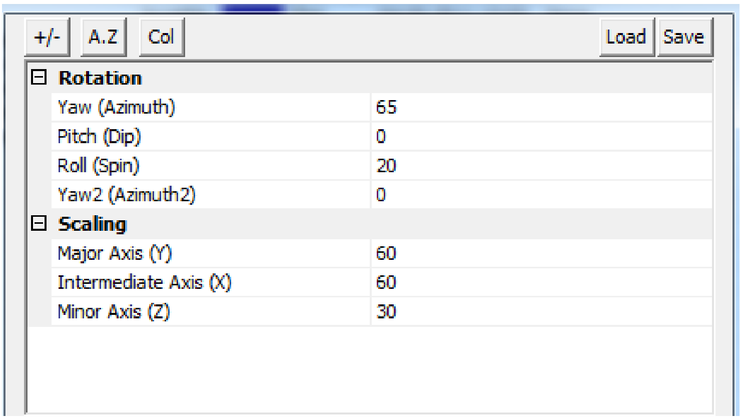
Blocks Grid Origin	
Origin X	380 700
Origin Y	5 526 900
Origin Z	0
Blocks Size	
Size in X	10
Size in Y	10
Size in Z	10
Blocks Discretization	
Discretization in X	1
Discretization in Y	1
Discretization in Z	1
Blocks Grid Index	
Min iX	1
Min iY	1
Min iZ	5
Max iX	131
Max iY	101
Max iZ	51
Blocks Grid Coordinate	
Min X	380 700
Min Y	5 526 900
Min Z	40
Max X	382 000
Max Y	5 527 900
Max Z	500

Figure 14.1.22 Block model origin and extent Manouane zone

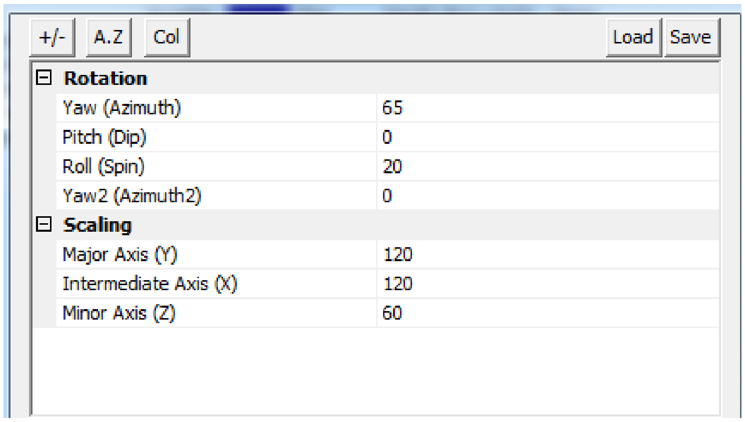
Grades of all P_2O_5 and TiO_2 were interpolated by the inverse distance squared method. Mineral resources were estimated using SectCad software. Results from the drilling program of winter 2011 were used for the resource estimation; even though sparse and shallow historic drilling was present in and around the Manouane Zone, these were not used in the estimation of resources. In the estimation process, the maximum number of composites to be used per hole was four (4); the maximum number per block was ten (10) whereas the minimum number was four (4).

Three successively larger search ellipses were used for the interpolation (see Figure 14.1.23).

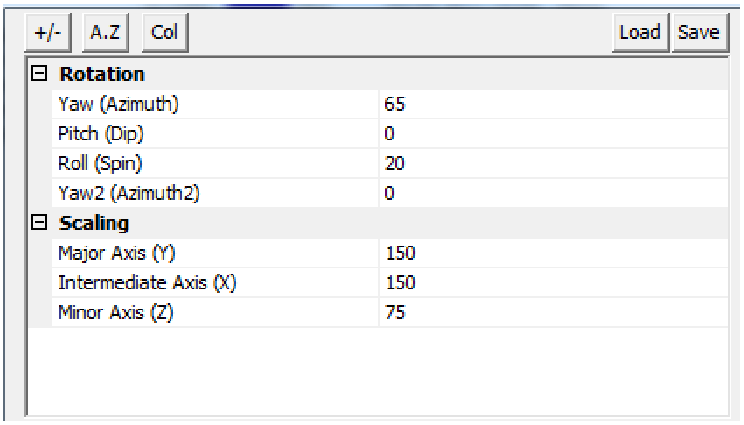
Blocks that were interpolated from an earlier pass were not re-interpolated. The inverse distance squared method was used to interpolate the grade within each block.



⊟ **Rotation**	
Yaw (Azimuth)	65
Pitch (Dip)	0
Roll (Spin)	20
Yaw2 (Azimuth2)	0
⊟ **Scaling**	
Major Axis (Y)	60
Intermediate Axis (X)	60
Minor Axis (Z)	30



⊟ **Rotation**	
Yaw (Azimuth)	65
Pitch (Dip)	0
Roll (Spin)	20
Yaw2 (Azimuth2)	0
⊟ **Scaling**	
Major Axis (Y)	120
Intermediate Axis (X)	120
Minor Axis (Z)	60



Rotation	
Yaw (Azimuth)	65
Pitch (Dip)	0
Roll (Spin)	20
Yaw2 (Azimuth2)	0
Scaling	
Major Axis (Y)	150
Intermediate Axis (X)	150
Minor Axis (Z)	75

Figure 14.1.23 Search ellipsoids and classification parameters for the Manouane Zone

14.1.3.5 Resource Categories

An assessment of the grade continuity was undertaken to establish the drill spacing necessary to reach a Measured, Indicated or Inferred level of confidence.

The Author observed that a range of 150 meters for % P_2O_5 provided some evidence that this drill spacing was meaningful information about the grade in the intervening distance.

The three ellipsoids used (Figure 14.1.23) for the estimation were also used for the automatic classification. Sixty (60) meters were used for the Measured category, 120 meters for the Indicated category, and 150 meters major axis were used for the Inferred category.

Figures 14.1.24 and 14.1.25 present a bench plan with blocks colour coded by class and a cross section.

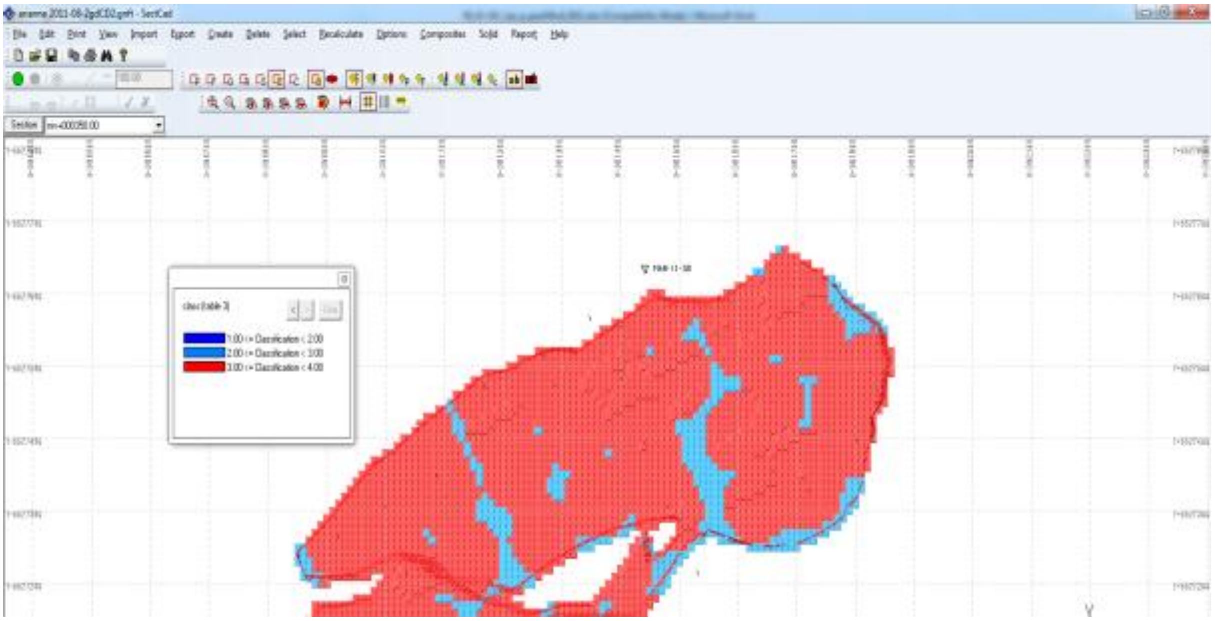


Figure 14.1.24 Bench 350 with colour coded classification (red Measured, cyan Indicated, blue Inferred)

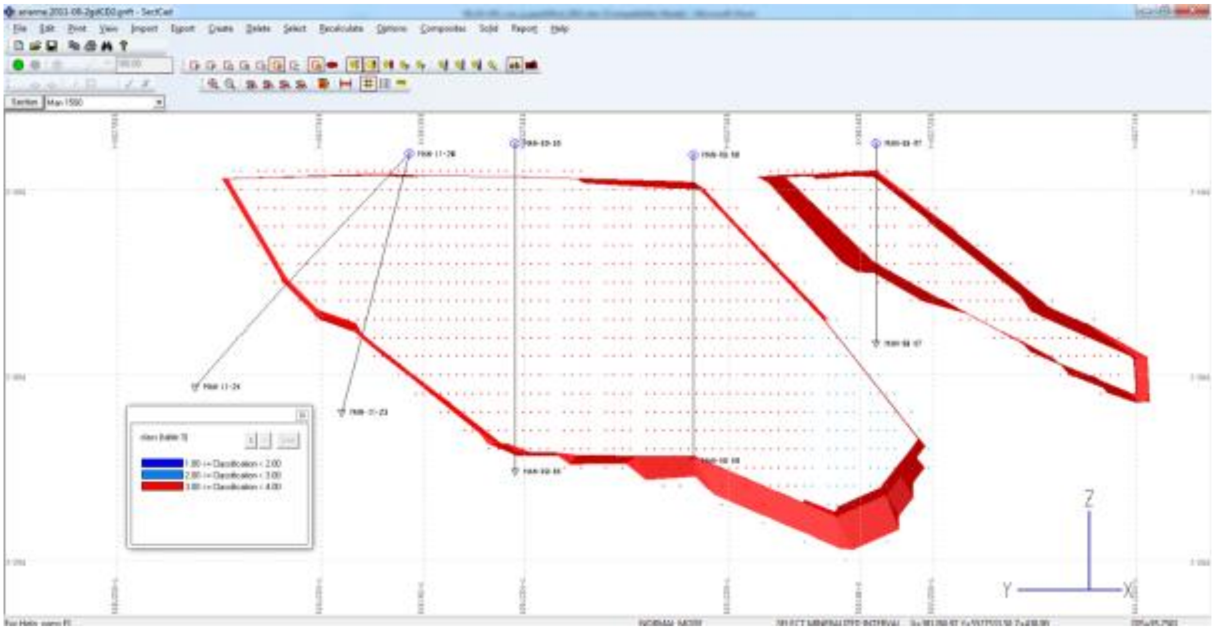
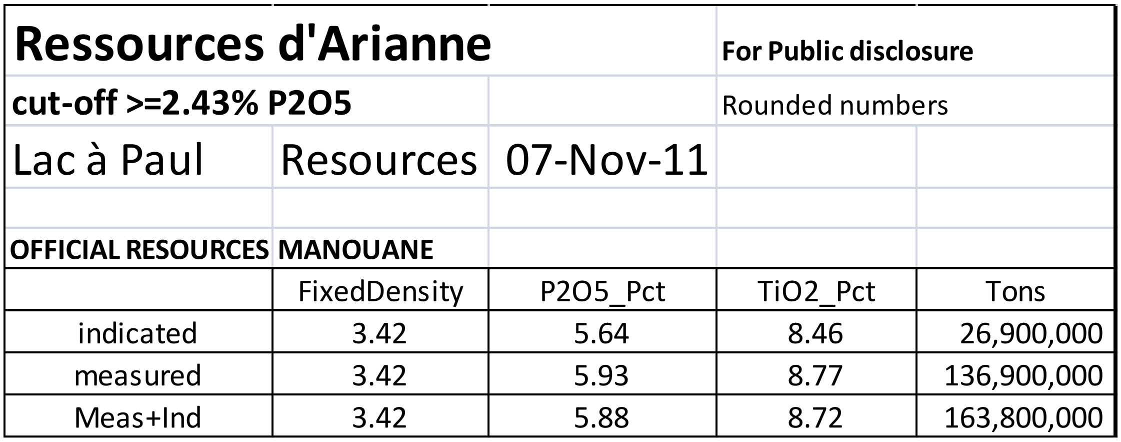


Figure 14.1.25 Section Man 1500 with colour coded classification (red Measured, cyan Indicated, blue Inferred)

It is important to mention that all blocks were classified within the Measured and Indicated categories in the Manouane zone.

14.1.3.6 Mineral Resource Statement

Mineral resources for the Lac a Paul Manouane Zone were estimated by using a 2.43% P_2O_5 cut-off grade. This is the economic cut-off grade calculated by Met-Chem. At this base case cut-off, the Manouane Zone hosts a Measured Mineral Resource of 136.9 million tonnes grading 5.93% P_2O_5 and an Indicated Mineral Resource of 26.9 million tonnes grading 5.64% P_2O_5. The mineral resource estimates are outlined in the Table 14.1.4. Results are presented as in-situ. There are no known factors or issues related to permitting, legal, mineral title, taxation, socioeconomic or political relations that could materially affect the mineral resource estimate. Potential modifying factors regarding marketing are discussed in the Market study section.



Ressources d'Arianne			**For Public disclosure**	
cut-off >=2.43% P2O5			Rounded numbers	
Lac à Paul	Resources	07-Nov-11		
OFFICIAL RESOURCES	**MANOUANE**			
	FixedDensity	P2O5_Pct	TiO2_Pct	Tons
indicated	3.42	5.64	8.46	26,900,000
measured	3.42	5.93	8.77	136,900,000
Meas+Ind	3.42	5.88	8.72	163,800,000

Table 14.1.4 Mineral resource summary table for Manouane using a 2.43% cut-off grade

The resource block model with colour coded grades of P_2O_5 is presented in Figures 14.1.26 and 14.1.27 for bench 360 and section Man 1500.

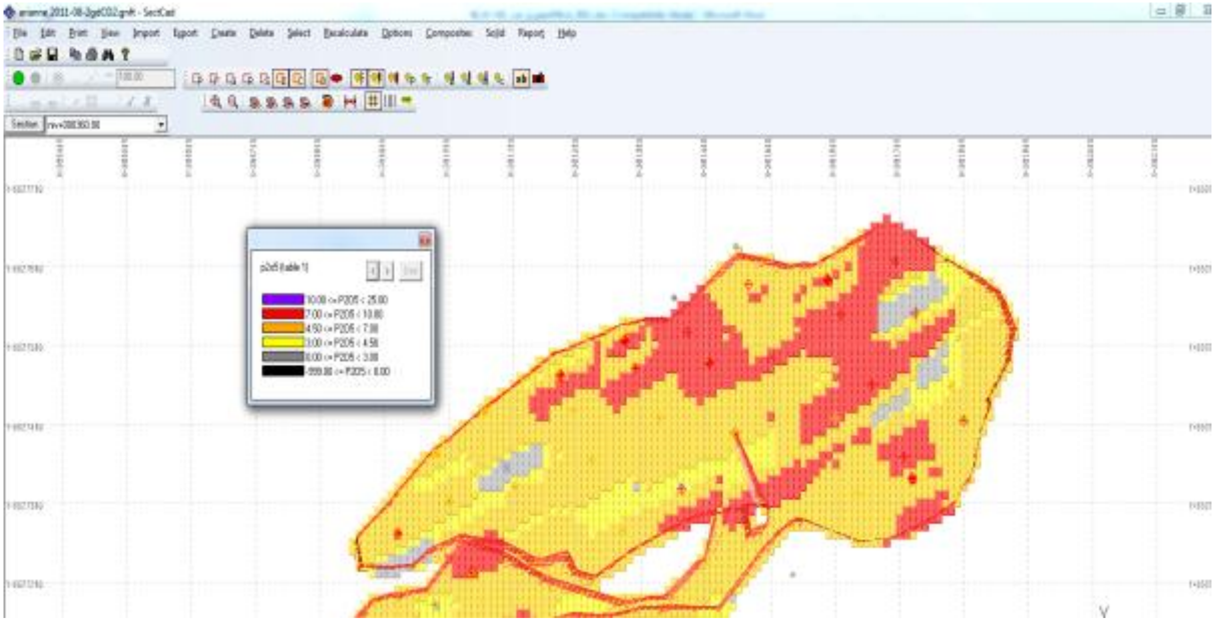


Figure 14.1.26 Bench 360 with colour coded blocks according to grades

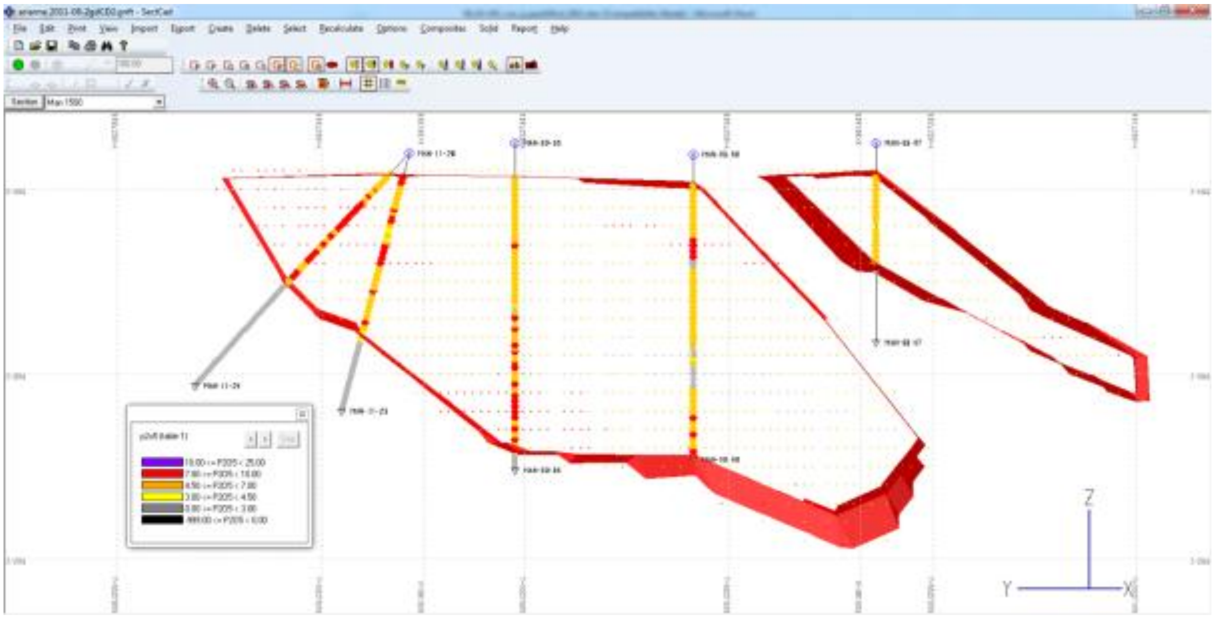


Figure 14.1.27 Section Man 1500 in the middle of the Manouane Zone with colour coded blocks according to grades

14.1.4 Zone No. 2

The mineral resources at Zone No. 2 have not changed since 2009 and this section reproduces the previous technical report that was prepared by the same Author, whom is also the Author of the current section.

The mineral resources of Zone No. 2 were not used in the Preliminary Feasibility Study because they were categorized as Inferred mineral resources. See Figures 14.1.28 through 14.1.30 for visual details.

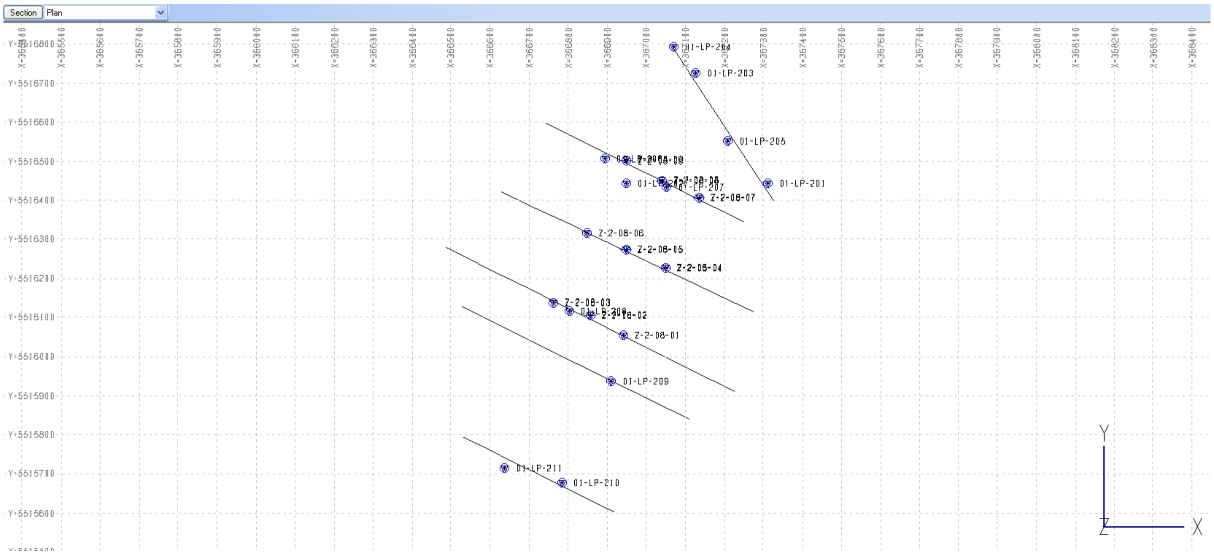


Figure 14.1.28 Drill hole layout in plan view UTM NAD 83 coordinates

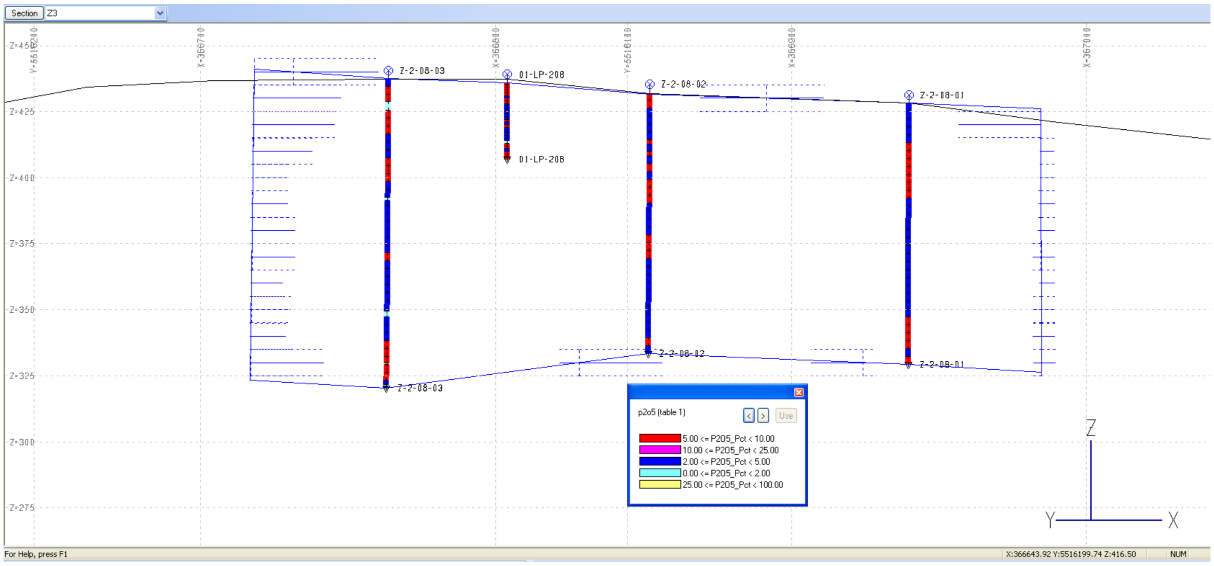


Figure 14.1.29 Typical cross section labelled Z3 in Zone No. 2

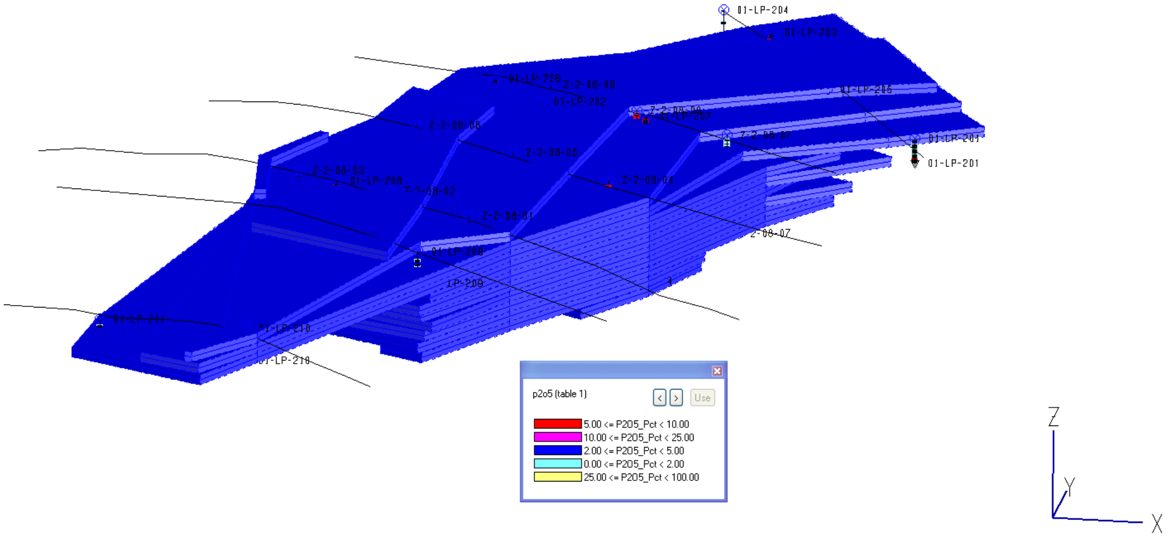
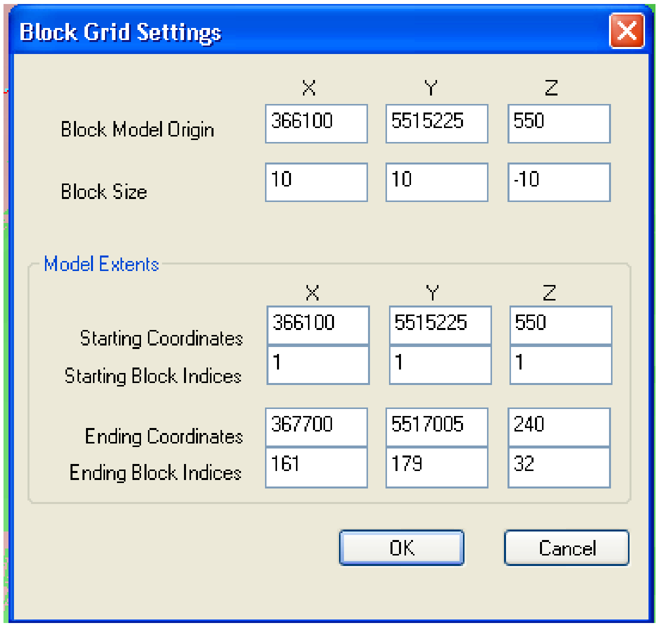


Figure 14.1.30 Oblique view of the interpretation on 10 m levels looking northwest

Grades were estimated in each 10 m (EW) x 10 m (NS) x 10 m (Z) block of a regular matrix of 161 columns (EW), 179 rows (NS) and 32 benches (Z) with its center within the limits of the mineralized zones. See Figure 14.1.31. Altogether, 20,272 blocks were estimated within the envelope from 383 composites (data points representing three (3) meters). The block model was cut by overburden/rock surface and topography.

The average % P_2O_5 and % TiO_2 grade of each block is interpolated by inverse of the distance from the grades of nearby three (3) meters composites.

The interpolation parameters were based on drill spacing, envelope extension and orientation.

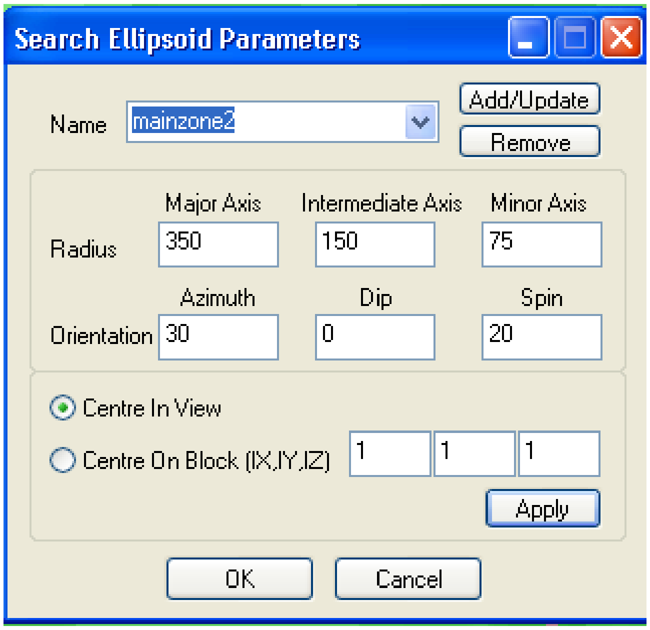


	X	Y	Z
Block Model Origin	366100	5515225	550
Block Size	10	10	-10

Model Extents

	X	Y	Z
Starting Coordinates	366100	5515225	550
Starting Block Indices	1	1	1
Ending Coordinates	367700	5517005	240
Ending Block Indices	161	179	32

Figure 14.1.31 Block model origin and extent Zone No. 2



Name: mainzone2

	Major Axis	Intermediate Axis	Minor Axis
Radius	350	150	75

	Azimuth	Dip	Spin
Orientation	30	0	20

● Centre In View

○ Centre On Block (IX,IY,IZ) 1 1 1

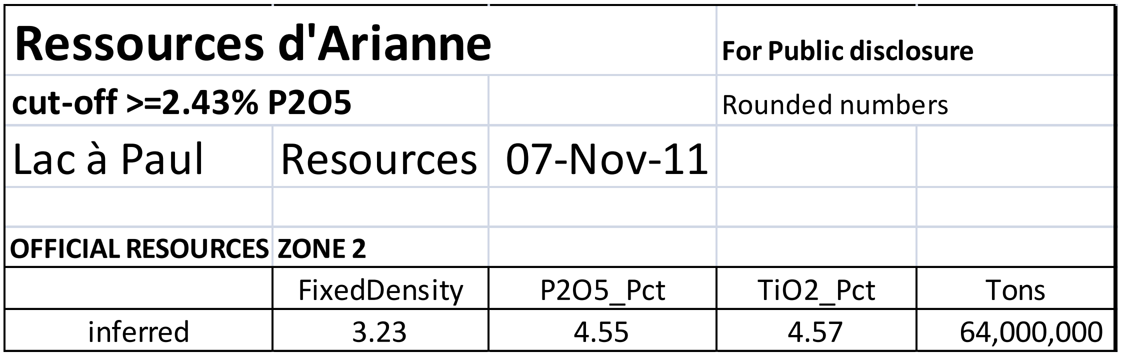
Figure 14.1.32 Search ellipsoid parameters Zone No. 2

For the interpolation process, estimation was made with one run:

- A search ellipse of 350 meters, 150 m and 75 m, with a maximum of ten (10) composites, minimum of two (2), and a maximum of four (4) from same hole. The long axis is oriented north 30° and dips 20° southeast (see Figure 14.1.32).

14.1.4.1 Mineral Resource Statement

Mineral resources for the Lac a Paul Zone No. 2 were estimated by using a 2.43% P_2O_5 cut-off grade provided by Met-Chem. At this base case cut-off, Zone No. 2 hosts an Inferred Mineral Resource of 64.0 million tonnes grading 4.55% P_2O_5. The mineral resource estimates are outlined in Table 14.1.5. Results are presented as in-situ. There are no known factors or issues related to permitting, legal, mineral title, taxation, socioeconomic or political relations that could materially affect the mineral resource estimate. Potential modifying factors regarding marketing are discussed in the market study section.

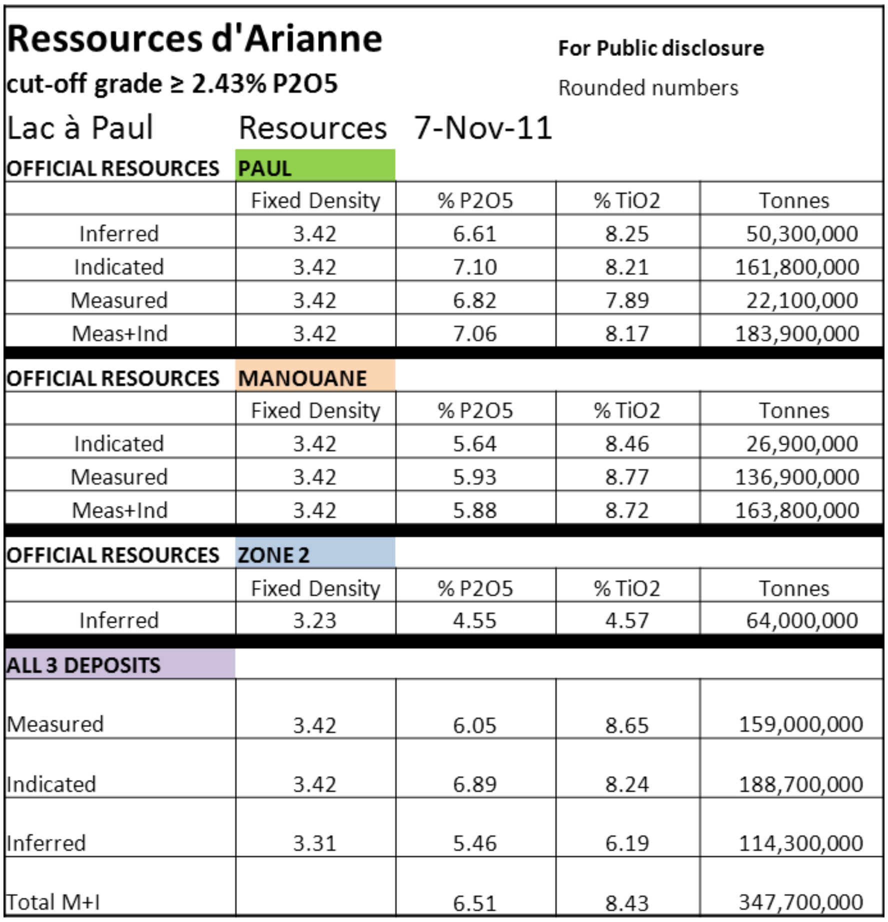


Ressources d'Arianne			**For Public disclosure**	
cut-off >=2.43% P2O5			Rounded numbers	
Lac à Paul	Resources	07-Nov-11		
OFFICIAL RESOURCES	**ZONE 2**			
	FixedDensity	P2O5_Pct	TiO2_Pct	Tons
inferred	3.23	4.55	4.57	64,000,000

Table 14.1.5 Mineral resource summary table for Zone No. 2 using a 2.43% cut-off grade

14.1.5 Mineral Resource Estimates Paul, Manouane, Zone No. 2 and Total 2011

The following mineral resources models are presented for each zone as well as the total for the three (3) zones as seen in Table 14.1.6.



Ressources d'Arianne **For Public disclosure**

cut-off grade ≥ 2.43% P2O5 Rounded numbers

Lac à Paul Resources 7-Nov-11

OFFICIAL RESOURCES	PAUL			
	Fixed Density	% P2O5	% TiO2	Tonnes
Inferred	3.42	6.61	8.25	50,300,000
Indicated	3.42	7.10	8.21	161,800,000
Measured	3.42	6.82	7.89	22,100,000
Meas+Ind	3.42	7.06	8.17	183,900,000

OFFICIAL RESOURCES	MANOUANE			
	Fixed Density	% P2O5	% TiO2	Tonnes
Indicated	3.42	5.64	8.46	26,900,000
Measured	3.42	5.93	8.77	136,900,000
Meas+Ind	3.42	5.88	8.72	163,800,000

OFFICIAL RESOURCES	ZONE 2			
	Fixed Density	% P2O5	% TiO2	Tonnes
Inferred	3.23	4.55	4.57	64,000,000

ALL 3 DEPOSITS				
Measured	3.42	6.05	8.65	159,000,000
Indicated	3.42	6.89	8.24	188,700,000
Inferred	3.31	5.46	6.19	114,300,000
Total M+I		6.51	8.43	347,700,000

Table 14.1.6 Mineral Resource model for 3 zones 43-101 compliant at 2.43% P_2O_5 cut-off

14.2 Paul 2013

14.2.1 Data

The final drill hole database used for the resource estimation of the Paul Zone is in file *Lac_Paul.mdb* dated January 22, 2013, at 15:47. The database holds information for 334 diamond drill holes.

A database in MS-ACCESS format (Geotic file) was transferred to GoldMinds Geoservices Inc. (GMG) from the client. GMG imported and validated the database into GENESIS and it was also cross checked with the laboratory certificates.

14.2.1.1 Computerized drill hole database used for resources

- The database has information for 334 drill holes from the entire Lac a Paul Property main block.

- The total drill holes length in the database is 64,072 meters.
- There are 19,006 assay records for % P_2O_5, % TiO_2, % SiO_2, % Fe_2O_3, % Al_2O_3, % CaO, % K_2O, % Na_2O, % MnO and % MgO.
- There are 4,723 deviation records.
- There are 2,201 lithology level 1 records.
- There are 1,807 RQD records.

The Paul Zone now has 153 diamond drill holes totaling 39,371 meters.

14.2.1.2 Topographic survey

The topography used is the new LIDAR survey. Arianne contracted an independent surveyor to survey topography with a differential GPS for the diamond drill hole collars. This information was coupled with LIDAR. The coordinate system is in UTM NAD 83.

The resource model used the UTM NAD 83 system and the LIDAR with surveyed collars.

The original supplied file was so large that it could not be handled by the modelling software in an efficient manner. GMG subcontracted SGS Geostat employee Mr. Ian Lafrance, Senior Technician, to clip the amount of data to only cover the north part of the Property with a reasonable amount of points, but it remains heavy to manipulate.

Figure 14.2.1 shows the LIDAR surface being used by GMG with the GENESIS software developed by SGS Geostat.

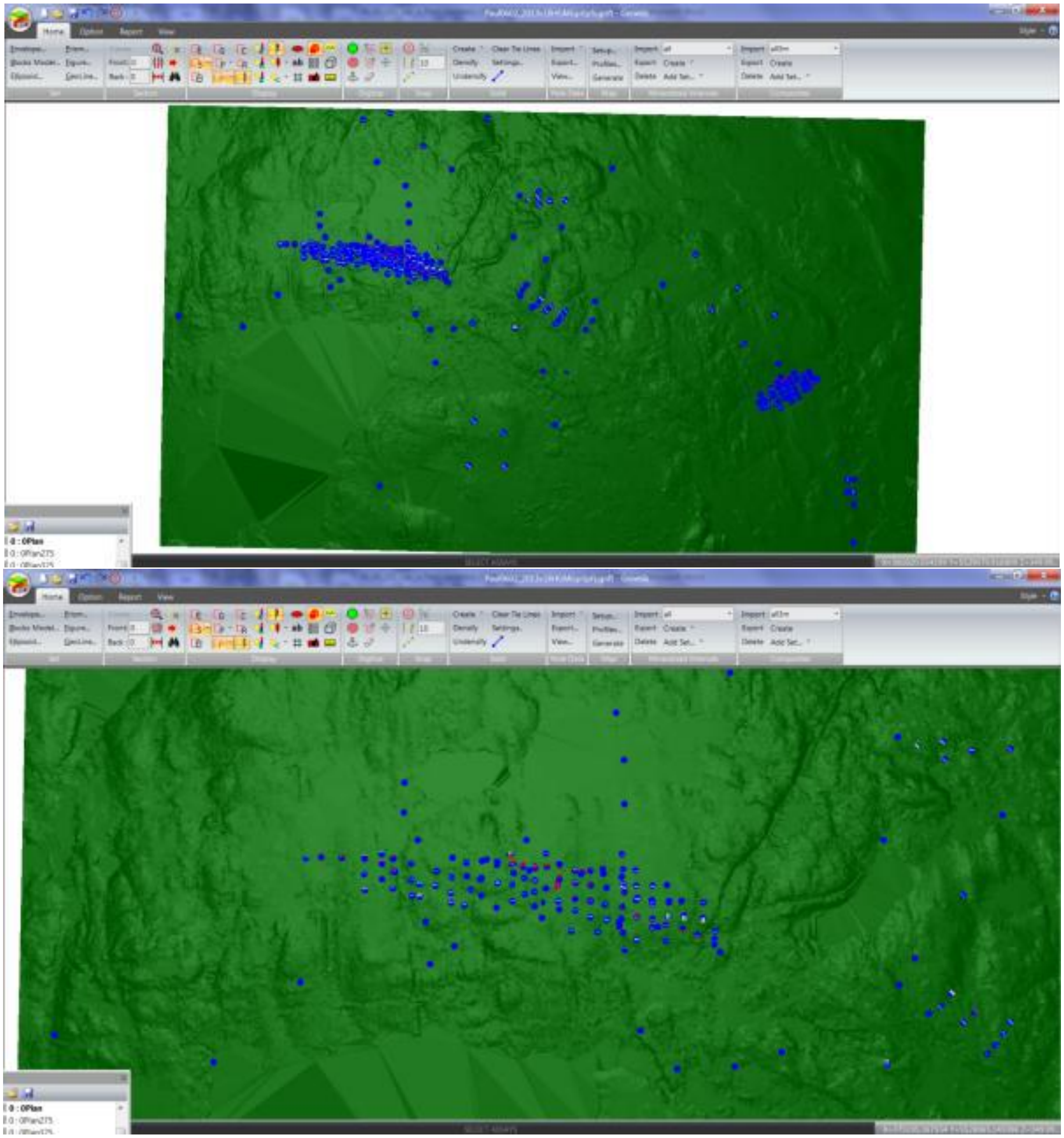


Figure 14.2.1 LIDAR surface within GENESIS; drill holes are blue dots

14.2.1.3 Mineralized envelope modelling approach

In order to adequately define the mineralized envelopes, a mineralized solid is defined using geological description and grade information along the drill hole core.

The mineralized envelopes are built on sections and are subsequently connected and sliced on levels.

For the 2013 Paul model resource update, interpretation of the mineralized structures on cross sections was provided by Arianne's geologists, Hugues Guérin Tremblay and Daniel Boulianne. The Nelsonite, Transition, Mixed zone and low grade zones with enriched apatite content were first interpreted by Arianne's technical team. Cross-sections were simplified by senior QP Claude Duplessis, geological engineer, who created envelopes which were integrated into GENESIS with 3D envelope modelling.

LIDAR topographic survey and overburden thickness are taken into account in the calculation of mineralized solids.

In Goldminds mineralized envelope simplified interpretation, the following zones were successively studied:

- High Grade Zone (Nelsonite and Transition) north body (HG).
- Medium Grade Zone (Mixed and a part of low grade) south body (MG).
- Intrusions (voids).

The following sections present the interpretation on sections, mineralized intersections, composites, estimation parameters and block models. This information is followed by classification and tabulation of mineral resource statements.

14.2.2 Paul Zone

A set of cross sections were developed by Arianne's technical team using the new drilling information. The interpretation of the bodies was a joint effort between GMG and Arianne. Following a first interpretation on cross-sections, the interpretation was verified with control level plans (see Figures 14.2.2 and 14.2.3).

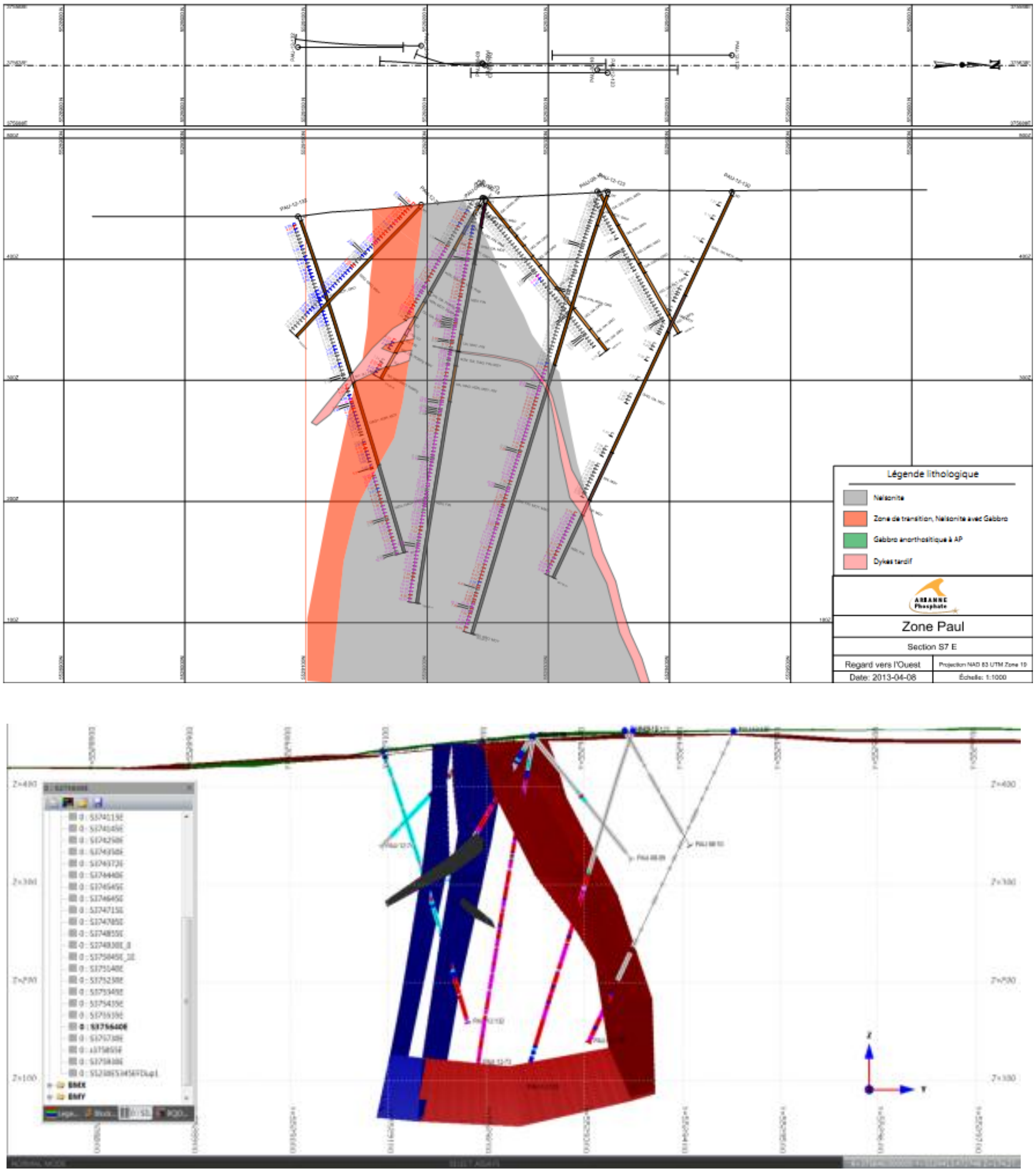


Figure 14.2.2 Cross section 7E – 375640E interpretation on PDF and integration in GENESIS

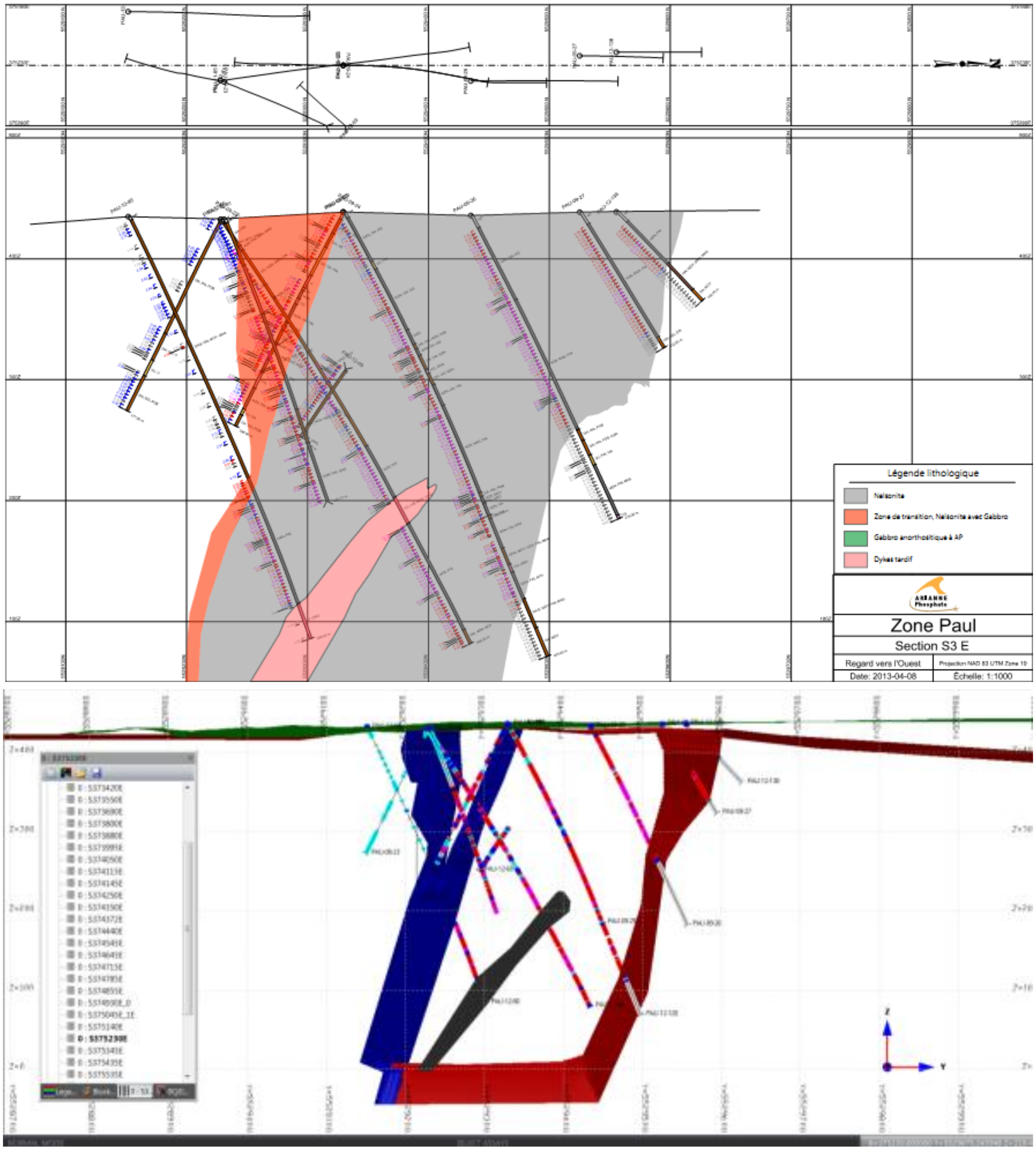


Figure 14.2.3 Cross section 3E – 375230E interpretation on PDF and integration in GENESIS

The relatively rich TiO_2 layer observed on the north side of the zone with very low P_2O_5 is still used to assist in the interpretation and extensions. Once interpretation generates a pattern, the prism on sections are linked together to create a solid. Extremities of solids are completed with caps on either end prior to meshing. The north south cross sections spacing ranges from sixty five (65) to one hundred fifteen (115) meters apart, and is on average ninety (90) meters. The overburden-bedrock contact was interpreted on each cross section. See Figures 14.2.4 through to 14.2.8 for visual details.

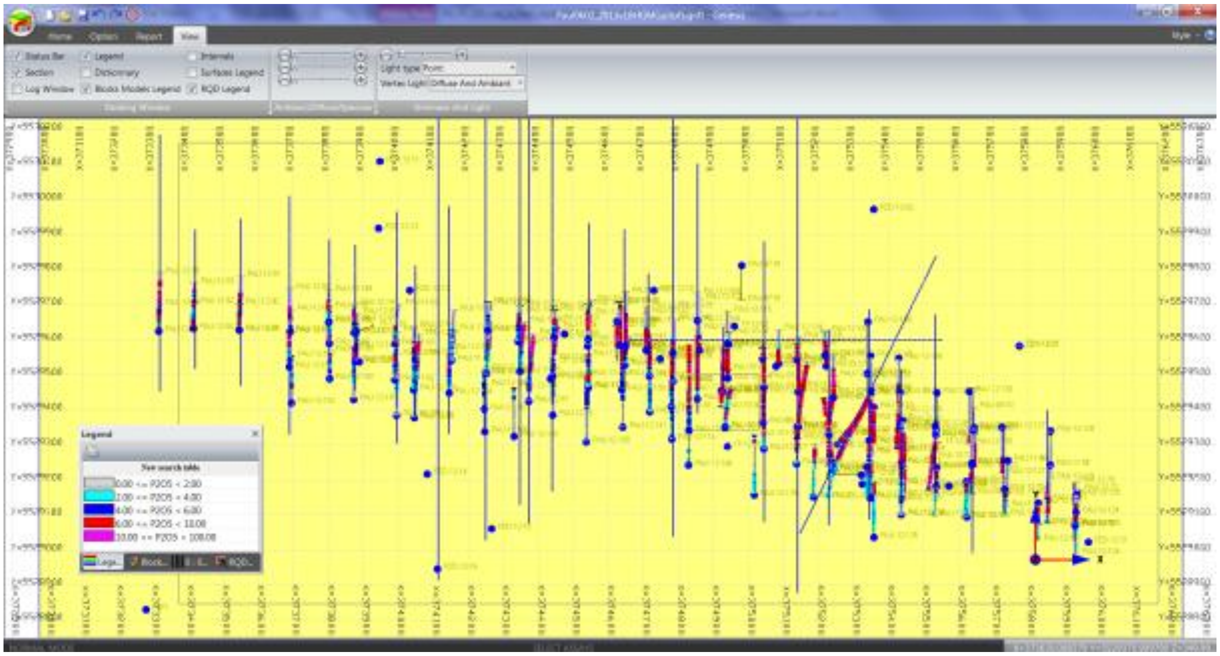


Figure 14.2.4 Drill hole layout in plan view UTM NAD 83 coordinates (Y is due north)

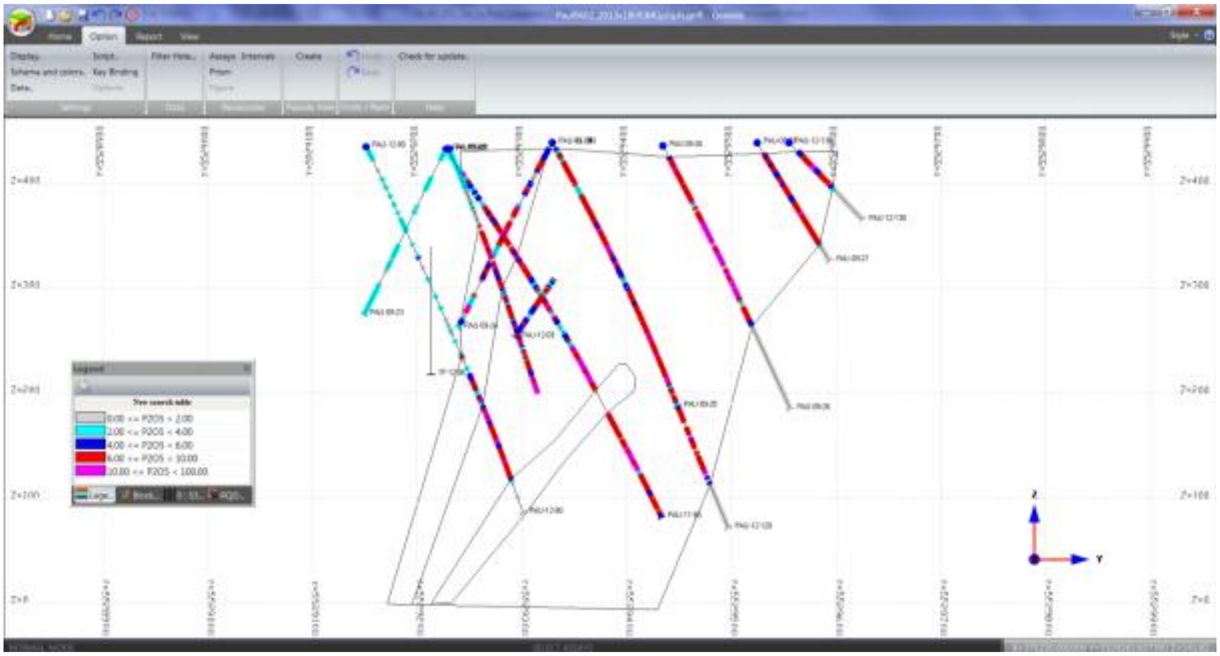


Figure 14.2.5 Cross sections looking West at 375230E with % P_2O_5 and interpretation

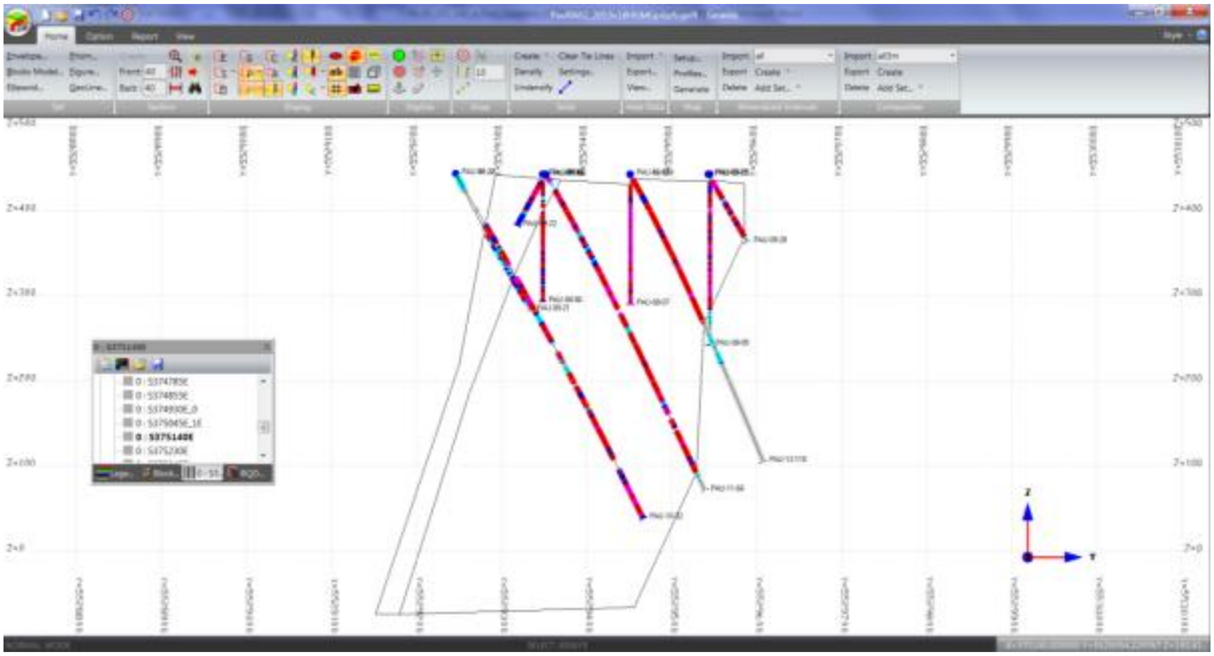


Figure 14.2.6 Cross sections looking West at 375140E with P_2O_5 % and interpretation

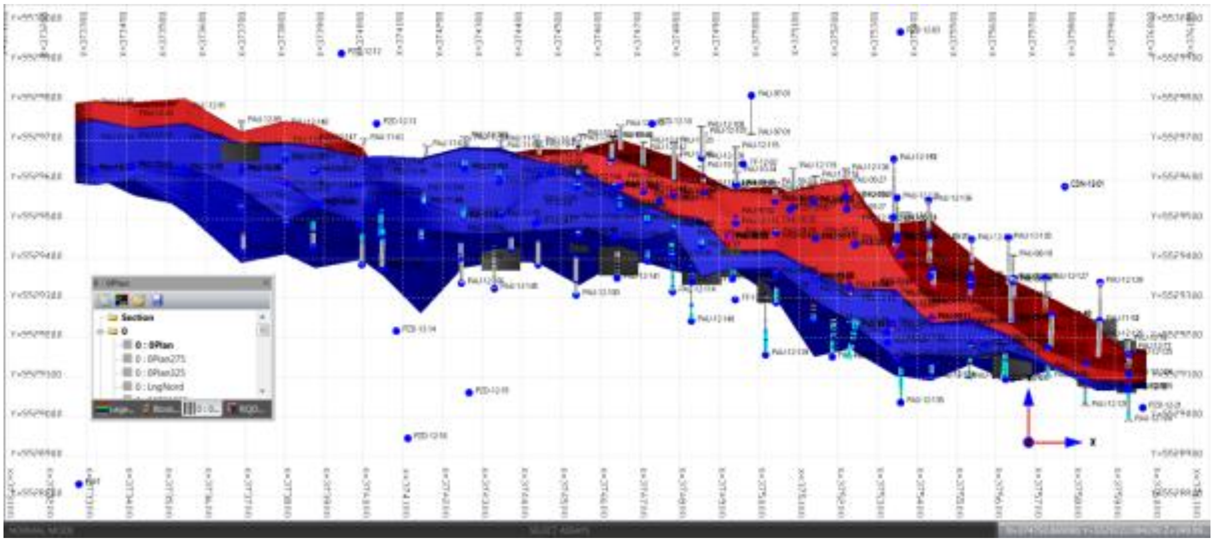


Figure 14.2.7 Plan view of envelopes; Red is High Grade, Blue is Medium Grade and black is Intrusions

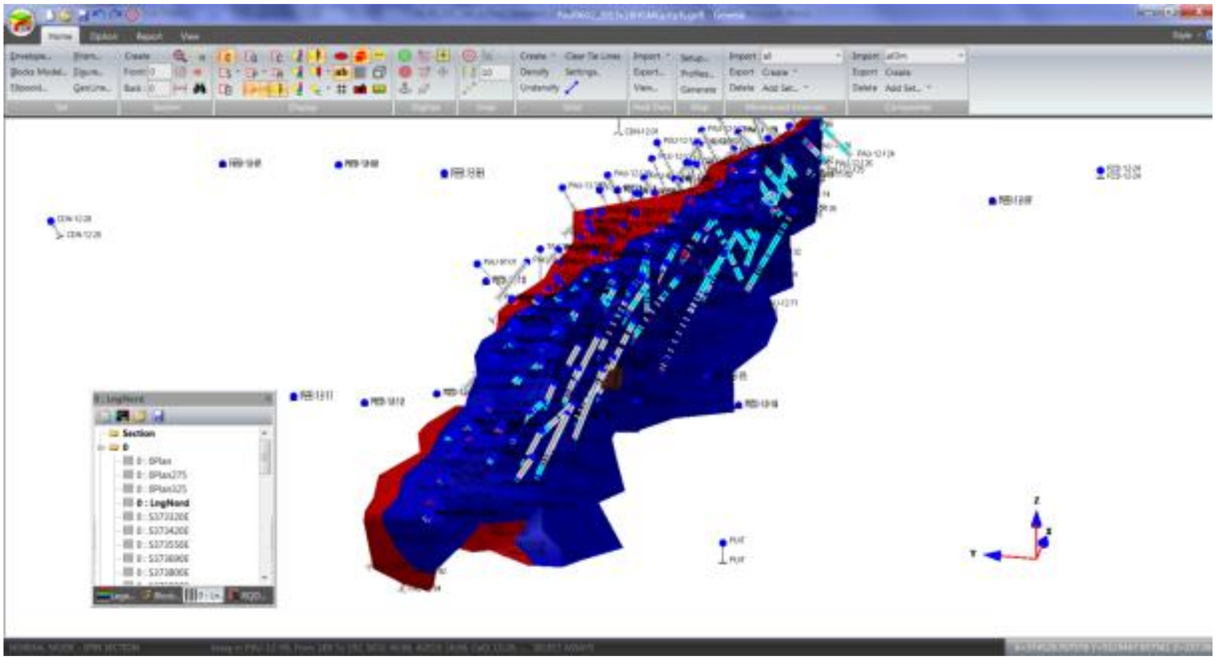


Figure 14.2.8 Oblique view of the High Grade & Medium Grade solids looking down east-northeast

14.2.2.1 Mineralized intersections

Mineralized intersections consist of drill holes samples within the interpreted limits of mineralized zones. Most intersections in drill holes are complete (start and end points at the zone limits).

14.2.2.2 Compositing of assay intervals within mineralized intercepts

Since original assay intervals are not all of the same length, it is necessary to standardize the length of the grade "support" through numerical compositing before assigning grades to dimensionless "points" in 3D space (the composite centers) in the block grade interpolation.

The majority of assay intervals are three (3) meters in length but there is the occasional 1.5 meter interval. The selectivity of 1.5 m is not commonly achievable in bulk tonnage mining; therefore a three (3) m standard length was elected. This also allowed for internal smoothing and internal dilution, since it could be difficult and unrealistic in the Lac a Paul context to exclude dykes and barren inclusions of smaller dimension within a blast. Any material that was not analysed is considered barren and ascribed 0% P_2O_5 and 0% TiO_2.

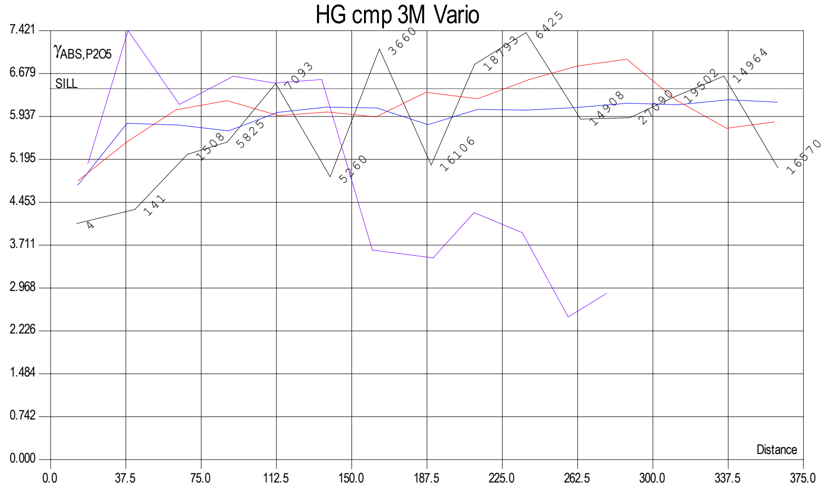
In our professional opinion, capping of the grade was not necessary due to the nature of the mineralization.

Compositing was done down hole from the start of mineralized intercepts. Missing assays were assumed to be of zero grade. At the end of the mineralized intercepts, the last composite kept was at least 1.5 meter in length. It is important to mention that only composites within the envelope and its vicinity were used to estimate the mineralized zones. The composites are calculated from original uncapped samples.

The three (3) m composites within the High Grade (HG) zone were used to estimate the HG material (see Figure 14.2.9, Figure 14.2.10 and Table 14.2.1 for HG estimate details) and the three (3) m composites of the Medium Grade (MG) zone were used to estimate the MG material (see Figures 14.2.11, Figure 14.2.12 and Table 14.2.2 for MG estimate details).

As a reminder, the Paul Zone is divided into two areas, the nelsonite (HG) area and the nelsonite combined with anorthositic gabbro area (MG), respectively located in the northern part and the southern part of the deposit.

The intrusions modelled as waste envelopes were subtracted from the HG and MG envelopes.



```
Variable  : P2O5                      Date     : 22-04-2013
Variogram : Absolute                  File     : statHGcmp3m.gsd

Directioneast-wes    moyen 180down8 360acros
Azimuth   : 90.00   360.00   180.00   360.00
Dip       :  0.00   -20.00   -80.00   -10.00
Tolerance : 20.00   180.00    20.00    20.00
Lag Dist  : 25.00    25.00    25.00    25.00
```

Figure 14.2.9 Variogram of HG 3 m composites

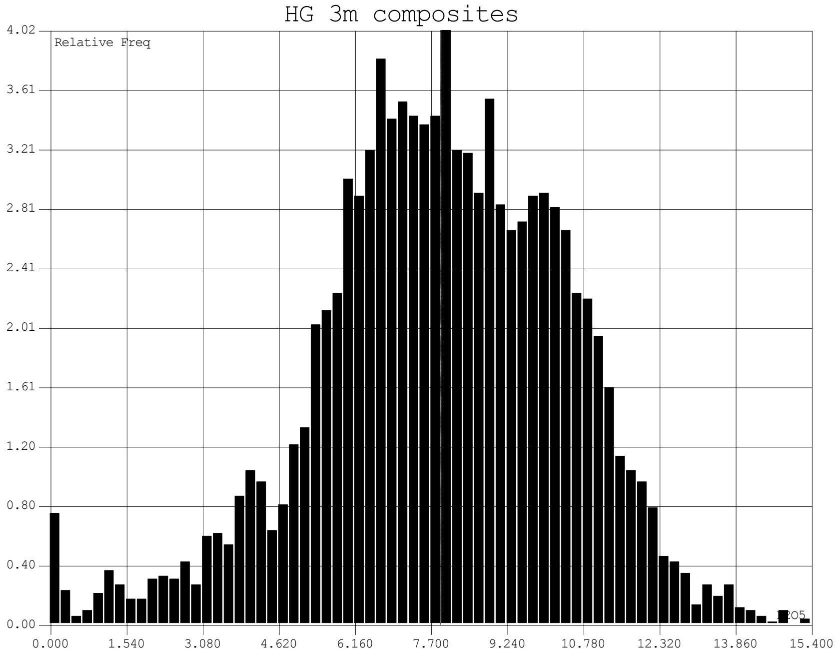
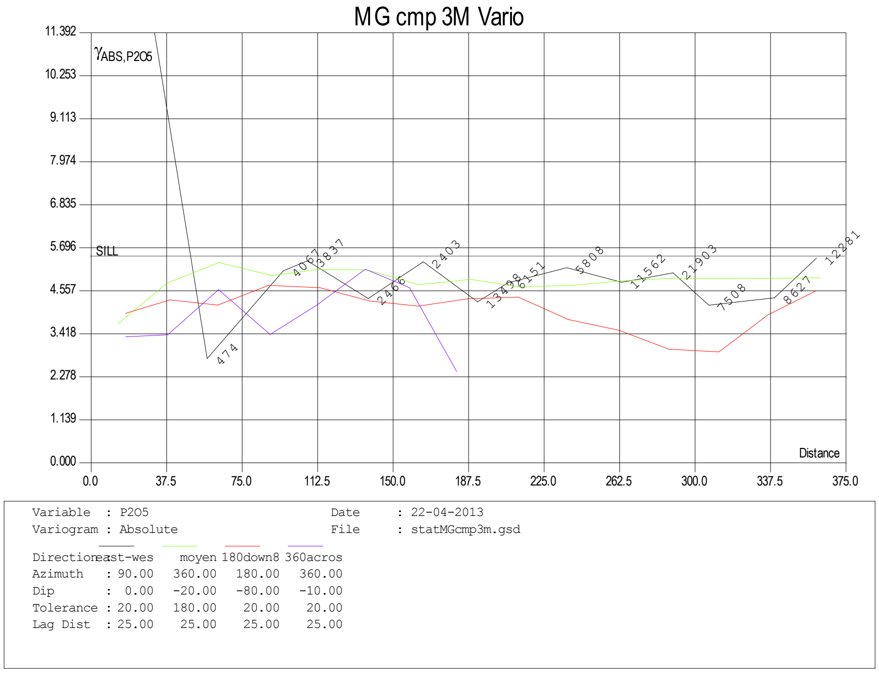


Figure 14.2.10 Histogram of HG 3 m composites

	Statistics for P_2O_5	
Statistical Data Definition	Regular	Log
Minimum Value	0.0000	-4.6052
Percentile 5%	3.4400	1.2865
Percentile 16%	5.6400	1.7370
Percentile 50%	7.9600	2.0769
Percentile 84%	10.4300	2.3456
Percentile 95%	11.6900	2.4596
Maximum Value	15.4000	2.7344
#Samples	5179	
Average	7.9002	
Variance	6.4014	
Std. Dev.	2.5301	
Coef of Var.	0.3203	
Skewness	-0.3977	
Kurtosis	3.3898	
#Log Samples	5154	
Log Average	1.9951	
Log Variance	0.2419	
Log Std. Dev.	0.4918	
Log Mean	8.2981	
Log Skewness	-4.5818	
Log Kurtosis	41.7475	

Table 14.2.1 Statistics of HG 3 m composites



```
Variable  : P2O5                       Date      : 22-04-2013
Variogram : Absolute                   File      : statMGcmp3m.gsd

Directioneast-wes    moyen 180down8 360acros
Azimuth   : 90.00   360.00   180.00   360.00
Dip       :  0.00   -20.00   -80.00   -10.00
Tolerance : 20.00   180.00    20.00    20.00
Lag Dist  : 25.00    25.00    25.00    25.00
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Figure 14.2.11 Variogram of MG 3 m composites

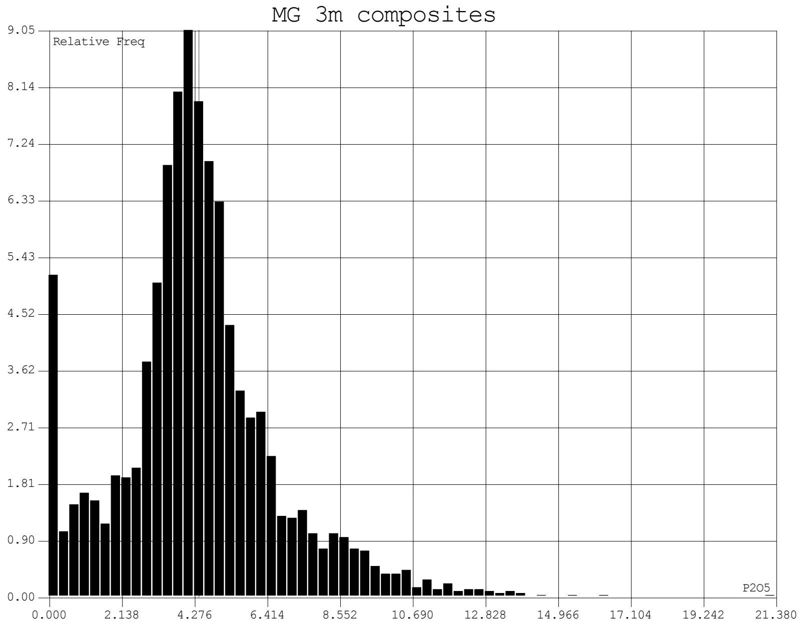


Figure 14.2.12 Histogram of MG 3 m composites

	Statistics for P_2O_5	
Statistical Data Definition	**Regular**	**Log**
Minimum Value	0.0000	-4.6052
Percentile 5%	0.2100	0.1398
Percentile 16%	2.4500	1.0578
Percentile 50%	4.2400	1.4656
Percentile 84%	6.2900	1.8485
Percentile 95%	8.7300	2.1759
Maximum Value	21.3800	3.0625
#Samples	3249	
Average	4.4151	
Variance	5.4521	
Std. Dev.	2.3350	
Coef of Var.	0.5289	
Skewness	0.7648	
Kurtosis	5.3336	

	Statistics for P_2O_5	
Statistical Data Definition	**Regular**	**Log**
#Log Samples	3116	
Log Average	1.3719	
Log Variance	0.4785	
Log Std. Dev.	0.6917	
Log Mean	5.0086	
Log Skewness	-3.0639	
Log Kurtosis	19.7408	

Table 14.2.2 Statistics of MG 3 m composites

14.2.2.3 Specific gravity data

Based on previous and new specific gravity (SG) measurements of core, and the weak relationship between density measurements on pulps vs witness core vs analytical results, the specific gravity value used to convert volumes into tonnes was set to a fixed value of 3.42 t/m^3 for the Paul Zone. Additional SG measurements on core were in progress at the moment of preparing the resource estimate and disclosure of April 2013. The resources disclosed and current from April 2013 used a fixed specific gravity of 3.42 t/m^3.

Additional measurements in 2013 have allowed the identification of a fixed specific gravity for each rock domains which are coherent with the average 3.42 t/m^3 value used.

For the reserves, a SG of 2.0 t/m^3 for overburden is used, 3.52 t/m^3 for the HG (Nelsonite domain), 3.12 t/m^3 for the MG (mixed domain) and within mineralized zones (voids - internal intrusions) are 2.80 t/m^3. Other SG numbers used for the FS resource model are:

- Waste North (out of resource block model): 3.21 t/m^3.
- Waste South (out of resource block model): 2.90 t/m^3.

Additional SG work is required to enable building a correlation between SG results and XRF analysis, since existing results are not conclusive enough to establish such a relationship.

14.2.2.4 Resource block grade interpolation

Estimates were done with the SGS Geostat GENESIS integrated 3D orebody modelling, block modelling and resource estimation software.

The block model was separated into four (4) block models, two (2) for the eastern part and two (2) for the western part.Table 14.2.3 shows the block model origin and extent for the Paul Zone.).

Grades were estimated in each 10 m (EW) x 5 m (NS) x 10 m (Z) block of a regular matrix of 311 columns (EW), 211 rows (NS) and 66 benches (Z) with its center within the limits of the mineralized zones. Composites from each domain were used to estimate the blocks within their domains.

The block model is cut by overburden\rock surface and the topography.

The average % P_2O_5 and % TiO_2 grade of each block was interpolated by inverse distance squared from the grades of nearby three (3) m composites.

The Author has used interpolation parameters based on drill spacing, envelope extension and orientation.

Grid	X	Y	Z
Origin:	373100	5528850	550
Size:	10	5	-10
Discretization:	1	1	1
Starting Coordinate:	374600	5528850	550
Starting Block Indice:	151	1	1
Ending Coordinate:	376200	5529900	-100
Ending Block Indice:	311	211	66

Table 14.2.3 Block model origin and extent for the Paul Zone

Grades were estimated using an inverse distance squared interpolation in three (3) passes with the following parameters: pass one (1) with the number of composites limited to twelve (12) and to a minimum of four (4), as well as a maximum of three (3) from the same drill hole; the estimate for passes two (2) and three (3) was carried out with the number of composites limited to twelve (12) and to a minimum of three (3), as well as a maximum of three (3) from the same drill hole; the search ellipses were identical for passes one (1) and two (2), while pass three (3) used a larger ellipse; the first ellipse in the eastern sector measured 250 x 150 x 50 meters with the long axis oriented 112° north and the intermediate axis dipping 80° southwest (subvertical); the second ellipse measured 350 x 150 x 75 meters and was oriented at 102° and dipped 70°. In the western sector, the same measurements were used for the first pass with the long axis oriented 90° north and the intermediate axis dipping 70° south. See Figures 14.2.13 and 14.2.14 for visual details.

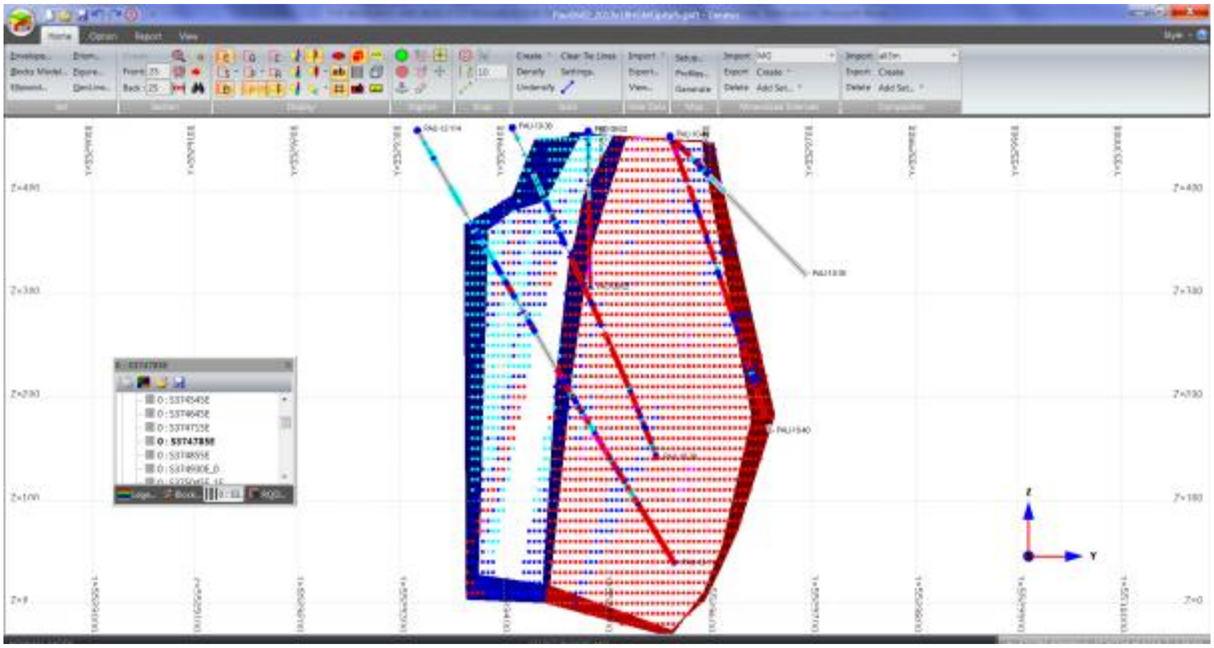


Figure 14.2.13 Typical section 374785E with blocks, envelope and drill holes

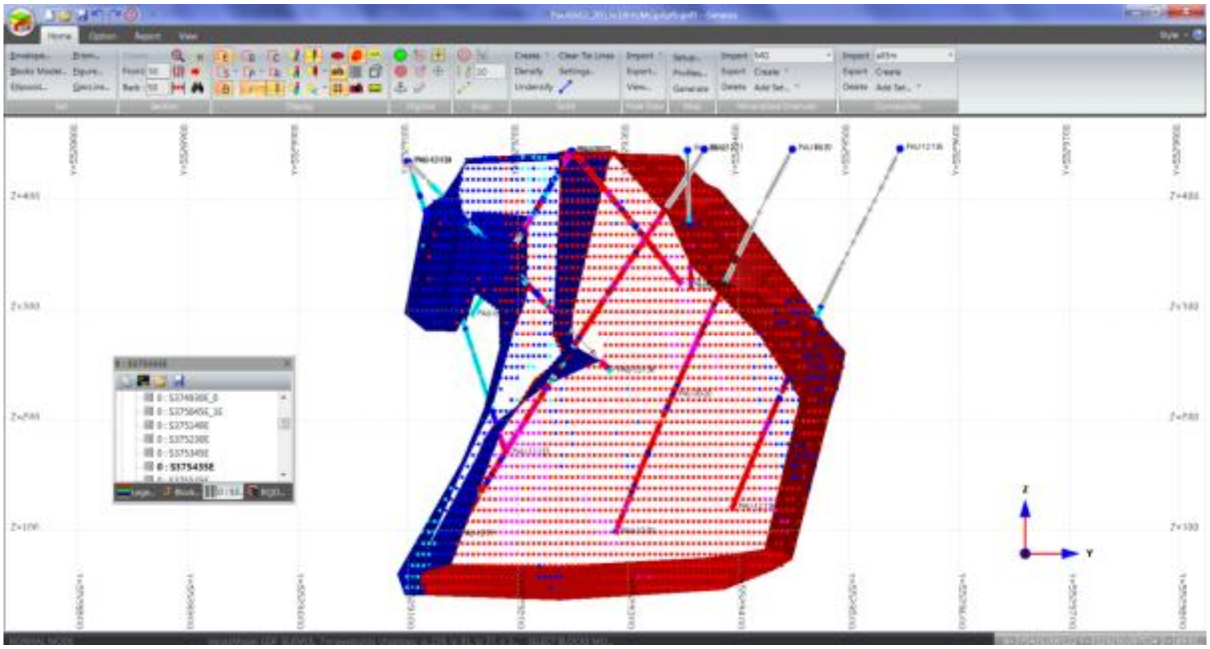


Figure 14.2.14 Typical section 375435E with blocks, envelope and drill holes

14.2.2.5 Resource Categories

An assessment of the grade continuity was undertaken to establish the drill spacing necessary to achieve a Measured, Indicated or Inferred level of confidence.

The Author observed that a range of 150 meters for % P_2O_5 provided some evidence that this drill spacing had meaningful information about the grade within this distance.

The classification parameters were:

- Measured with at least two (2) drill holes within a 70 x 70 x 35 m ellipse oriented (for all categories) at 102° north with the intermediate axis dipping 70° southwest (subvertical).
- Indicated with at least two (2) drill holes in a 140 x 140 x 70 m ellipse.
- Inferred with a drill hole with three (3) composites in 350 x 200 x 90 meters ellipse.

Figures 14.2.15 through to 14.2.19 present bench plans with colour coded blocks by % P_2O_5 grades.

The block model was provided to Cegertec WorleyParsons to be used for the estimate of the Mineral Reserves in the Feasibility Study.

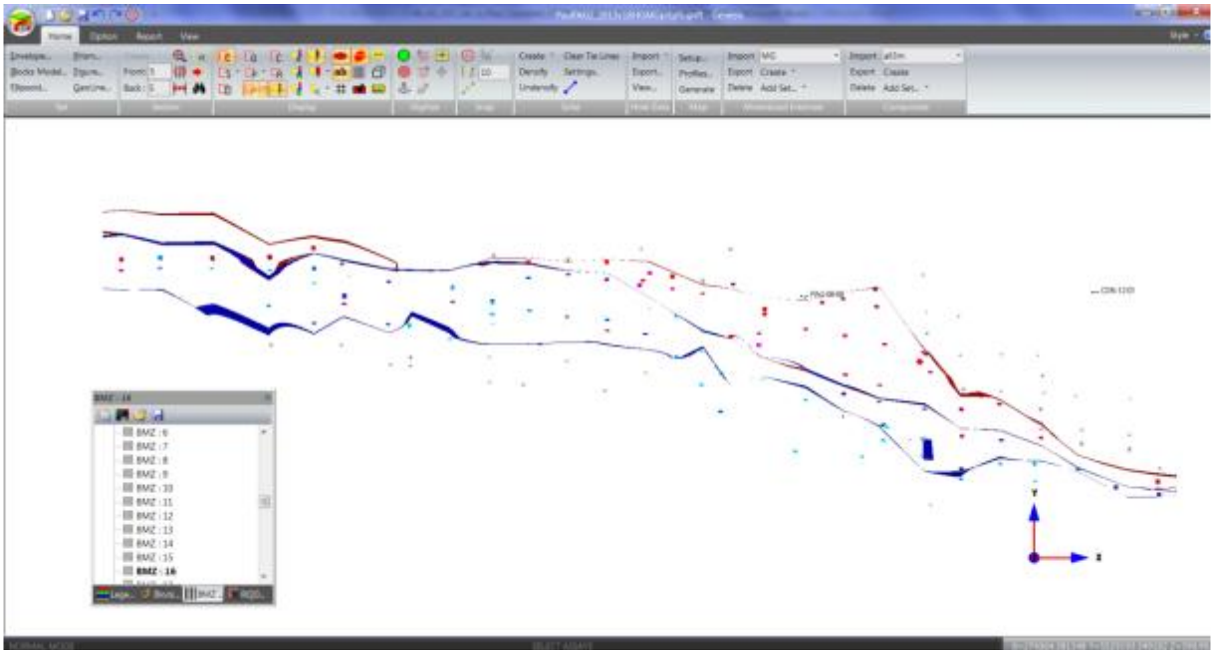


Figure 14.2.15 Bench 16 with trace of HG & MG envelope with assay data

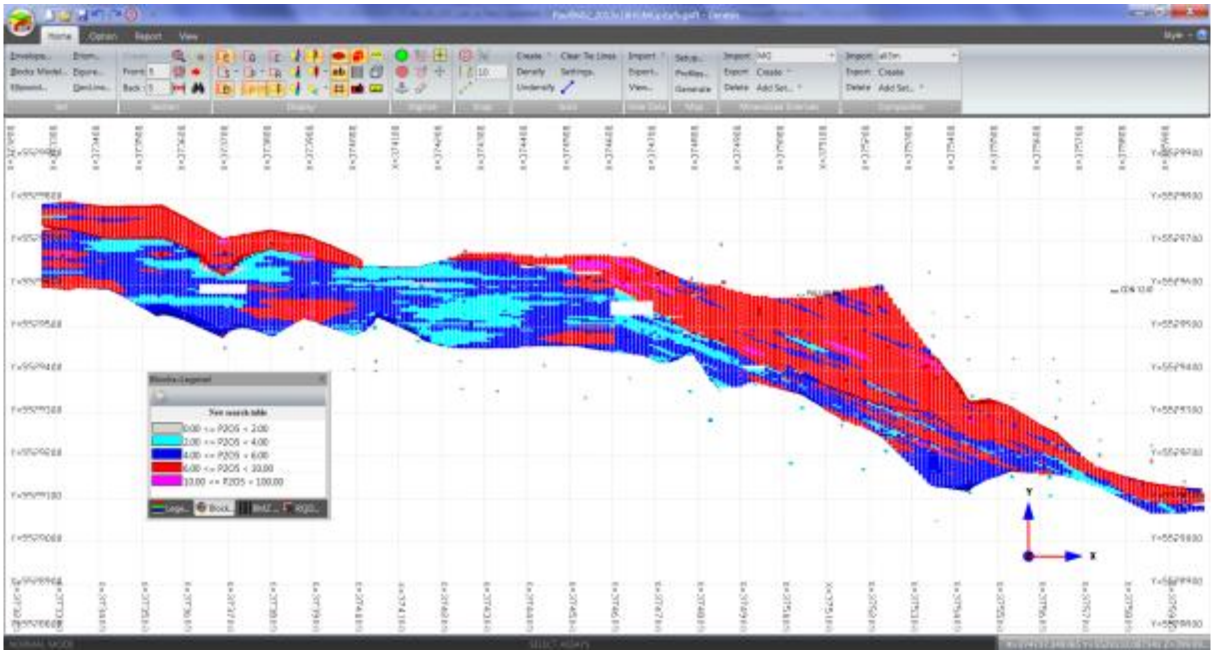


Figure 14.2.16 Bench 16 with colour coded blocks for P_2O_5 grade

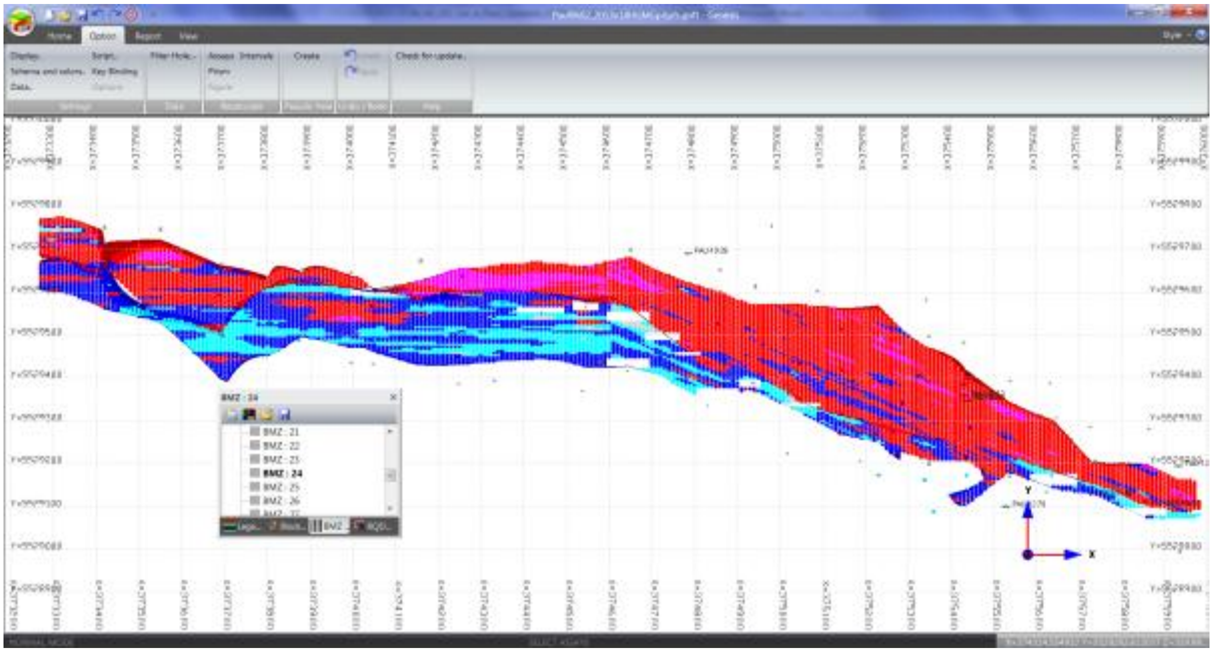


Figure 14.2.17 Bench 24 with colour coded blocks for P_2O_5 grade

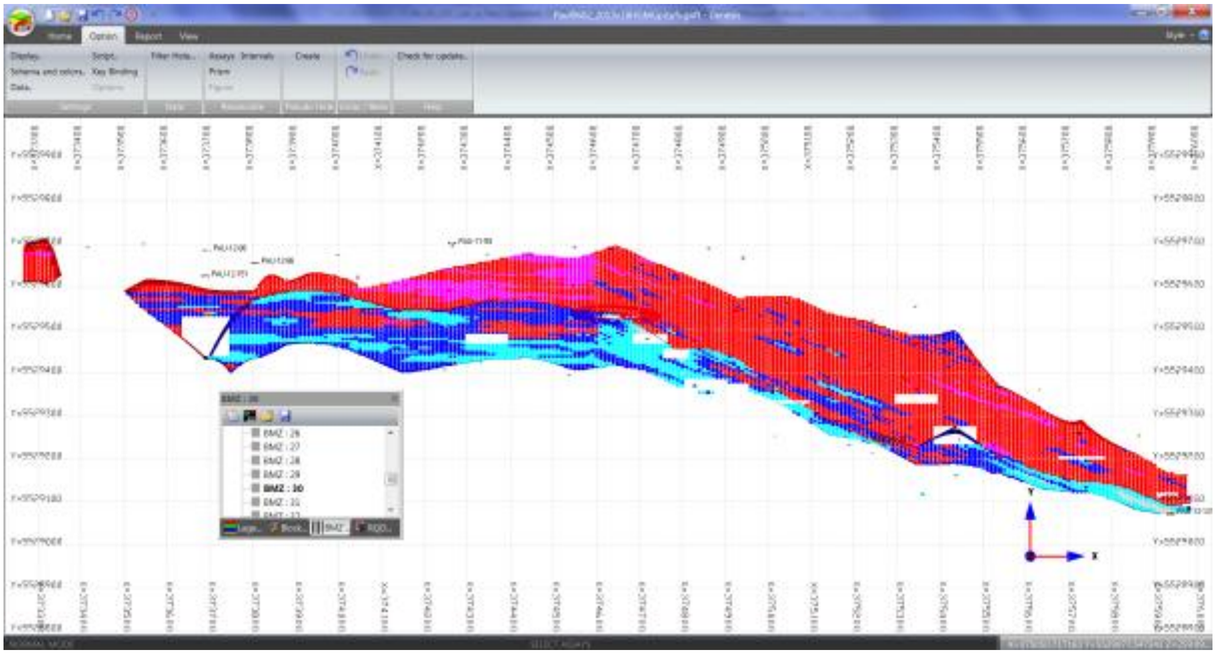


Figure 14.2.18 Bench 30 with colour coded blocks for P_2O_5 grade

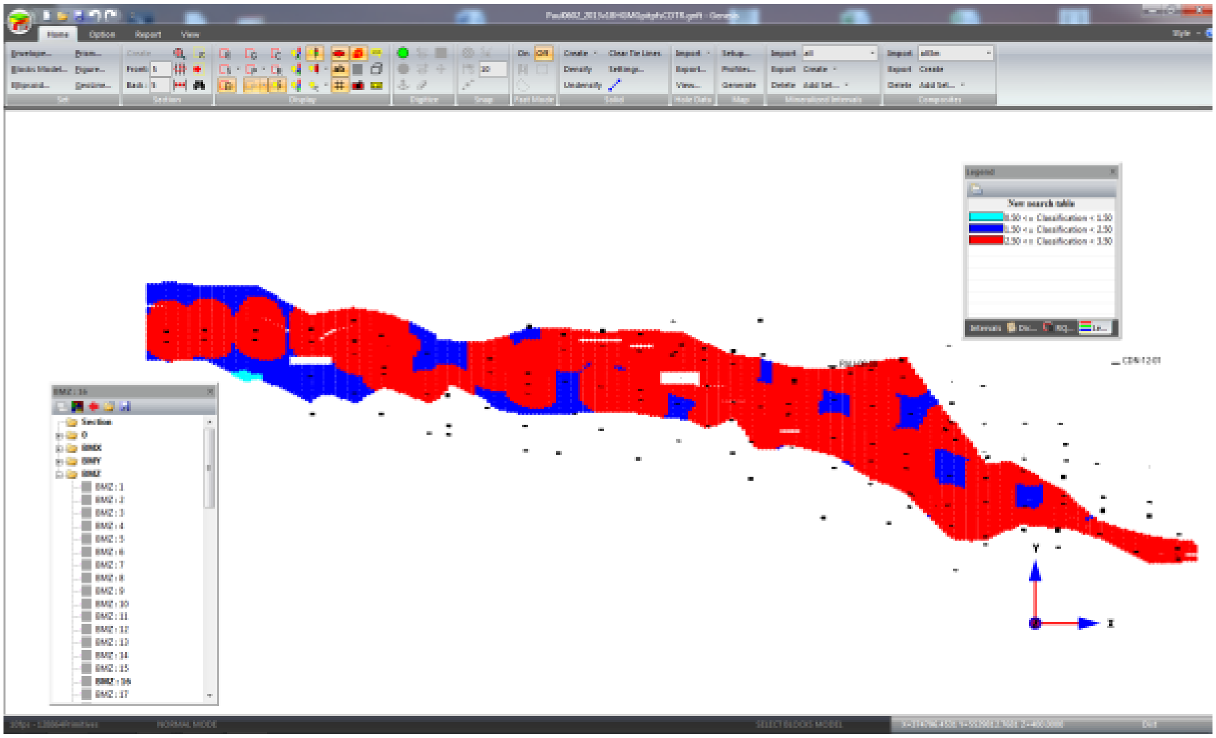


Figure 14.2.19 Bench 16, Z=400 with colour coded blocks by class

NOTE: Red is Measured (3), Blue is Indicated (2) and Cyan is Inferred (1).

The GENESIS file name is *Paul0602_2013v18HGMG.gnft* dated February 20, 2013.

14.2.2.6 Mineral Resource Statement

Mineral resources for the Paul Zone were estimated by using a 4.00% P_2O_5 cut-off grade (Table 14.2.4). This cut-off was applied by the Author to show the robustness of the resource; the cut-off grade during the current Feasibility Study was established at 3.5%.

- Although the cut-off grade is higher, the Measured and Indicated resources of the Paul Zone have increased by 221% compared to the last estimate released in 2011.
- The Measured and Indicated mineral resources (M+I) of the Paul Zone amount to 590.24 Mt at 7.13% P_2O_5.
- The mineral resource estimate was calculated according to NI 43-101.

**Comparison of the Paul Zone's Mineral Resources
(March 2013 versus November 2011 resources estimates)**

Resources	March 2013 (cut-off grade: 4.0% P_2O_5)		November 2011 (cut-off grade: 2.43% P_2O_5)	
	Tonnage (Mt)	Grade P_2O_5 %	Tonnage (Mt)	Grade P_2O_5 %
Measured (M)	336.76	7.22	22.10	6.82
Indicated (I)	253.48	7.02	161.80	7.10
Total (M+I)	**590.24**	**7.13**	**183.90**	**7.07**
Inferred	9.81	5.89	50.30	6.61

Paul update of mineral resources effective: March 7, 2013
Mineral resources which are not mineral reserves have not demonstrated economic viability.

Table 14.2.4 Paul Zone Updated Mineral Resources 2013

14.2.3 Other mineral resources of the Lac a Paul Property

In addition to the mineral resources identified in the Paul Zone, NI 43-101 compliant resources were estimated for Zone No. 2 and Manouane on the Lac a Paul Property. These resources, released by SGS Geostat in November 2011 in the NI 43-101 technical report, have not been updated because no additional drilling has been performed on these zones since 2011. They are summarized Table 14.2.5 below:

Resources	Manouane Zone (cut-off grade: 2.43% P_2O_5)		Zone No. 2 (cut-off grade: 2.43% P_2O_5)	
	Tonnage (Mt)	Grade P_2O_5 %	Tonnage (Mt)	Grade P_2O_5 %
Measured (M)	136.90	5.93	-	-
Indicated (I)	26.90	5.64	-	-
Total (M+I)	**163.80**	**5.88**	**-**	**-**
Inferred			64.00	4.55

Update of mineral resources effective: November 7, 2011
Mineral resources which are not mineral reserves have not demonstrated economic viability.

Table 14.2.5 Other mineral resources on the Lac a Paul Property

NOTE: Resources in the above tables are not additional to the Mineral Reserve statement in the Mineral Reserves section of this report.

In order to compare the 2.43% cut-off used in the Prefeasibility Study (PFS), a Whittle pit optimization was performed on the Paul Zone resources. The objective of the following exercise was to define the in-pit mineral resources using the PFS parameters. See Tables 14.2.6, 14.2.7 and Figure 14.2.20 for further details.

Pit Optimisation parameters		
Parameter	**Unit**	**Apr 2013 V4 (PFS)**
Slope angle	*deg*	50.0
OVB Mining Cost	*Cdn$/tonne*	1.54
Waste Mining Cost	*Cdn$/tonne*	1.76
Ore Mining Cost		1.83
Mining Recovery	*%*	100.00
Mining Dilution	*%*	-
Vertical Mining Cost Increment	*S/10m*	-
Concentrator	*Cdn$/t treated*	8.10
G&A cost	*Cdn$/t treated*	4.12*
Transport cost	*Cdn$/t treated*	10.42*
Ore Mining Increment	*Cdn$/t treated*	0.07
Rehab cost	*Cdn$/t treated*	0.07
Total Ore Based Cost	***Cdn$/t treated***	**8.24**
Processing recovery	*%*	Varia.**
Concentrate Grade	*%P_2O_5*	39.00
Weight Recovery	*%*	= (HG*10*Processing recovery)/(10*39.00)
Concentration ratio		= 1 / Weight Recovery
Apatite Concentrate Selling Price	*$/t con c*	175.00
Payable	*%*	100.00
Resulting Apatite Concentrate Selling Price	*$/t con c*	175.00
In-situ P_20_5 Value	*S/10kg*	NA
Exchange Rate	*Cdn$:US$*	1:1
Resulting cut-off grade	***%P_2O_5***	**2.43**

**Cost per tonne of concentrate (included in the generic grade of the Block Model)*

***HG (<4.50) = 82.5%*

***HG (4.50 – 6.49) = 87.5%*

***HG (6.50 – 8.50) = 90.0%*

***HG (>8.50) = 92.5%*

Table 14.2.6 Preliminary Pit Optimization Parameters for In-Pit Mineral Resources at Paul Zone

Preliminary Optimization Results					
ROCK GROUP	GRADE GROUP (P_2O_5 %)	Volume M**3	Density T per M**3	Tonnage T	P_2O_5 Grade
MEASURED	< 2.43	1 207 059	3.36	4 052 798	
	>= 2.43	111 897 063	3.42	382 687 963	6.77
INDICATED	< 2.43	1 023 747	3.28	3 359 260	
	>= 2.43	83 534 562	3.42	285 688 209	6.53
INFERRED	< 2.43	118 280	3.03	358 029	
	>= 2.43	2 146 331	3.42	7 340 452	5.61
OVERBURDEN	All	17 333 266	2.00	34 666 533	
WASTE	All	281 230 493	2.91	818 380 758	
Total		**498 490 800**	**3.08**	**1 536 534 001**	

Table 14.2.7 Preliminary Pit Optimization Result Direct Output

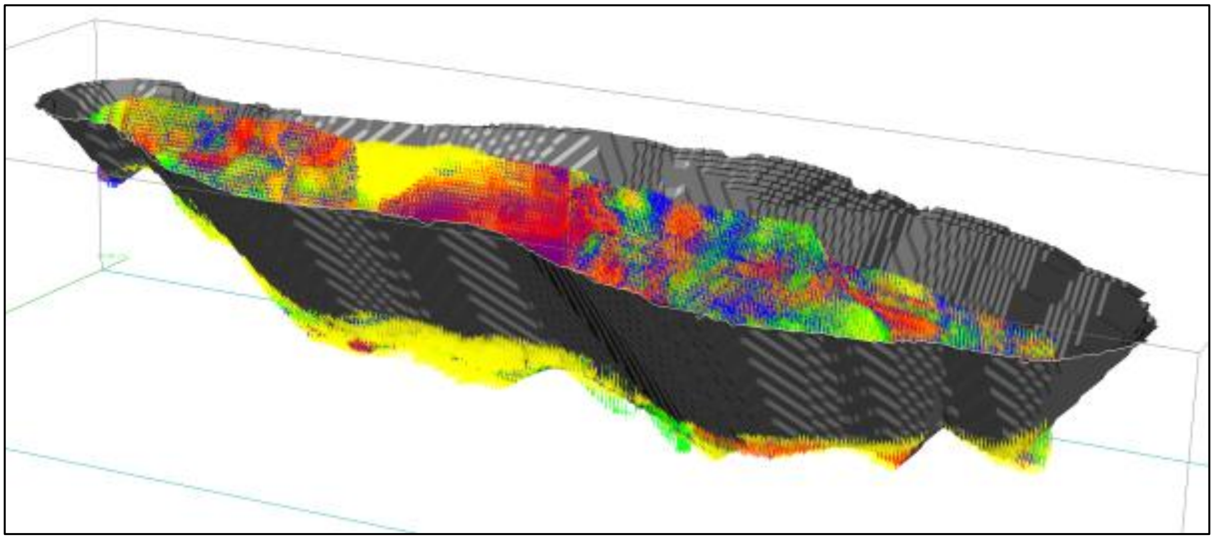


Figure 14.2.20 Isometric view of in-pit resources with colour coded blocks for P_2O_5 grade.

15. MINERAL RESERVE ESTIMATE

15.1 Resource Block Model

The resource block model for the Lac a Paul Feasibility Study (FS) was developed using conventional block modelling techniques. The block model was developed by Claude Duplessis of Goldminds Geoservices Inc. (GMG), and was provided to WP on February 6, 2013.

The Model was delivered in CSV file format under the name of: “Modelfinal1_06022013.csv”. The model was accompanied by the following documents, wireframe and point files:

- Doc1blkgrid.docx (document containing the Model parameters {e.g. Origin, Size of the blocks etc.}).
- HG_zone_Mesh.dxf (Wireframe representing High-Grade Mineralization, closed volume).
- MG_zone_Mesh.dxf (Wireframe representing Mixed-Grade Mineralization, closed volume).
- topolidarexportxyz.xyz (Topography File).
- topoOVBexportxyz.xyz (Overburden File).
- WasteprismEnvelope.dxf (Wireframe representing Waste Rock, closed volume).

The wireframes (DXF files) were imported into CAE Mining Studio 3 (3.21) (Datamine), and merged to form one model comprising all mineralized and non-mineralized blocks. The model was imported into Datamine with no modification. The model was checked in both the Datamine software and the MineSight 3-D software (7.60) (MineSight) for its validity and integrity.

The variables present in the model are shown in Table 15.1.1.

Variable Name	Description
Density	Density of Mineralized Rock (Defaulted)
Classification	Classification of Resource (1=Inferred, 2=Indicated, 3=Measured)
Type	Rock Type (Mineralized or Other)
SiO_2	Silica percent
Al_2O_3	Aluminium oxide percent
CaO	Calcium oxide percent
Fe_2O_3	Ferric oxide percent
K_2O	Potassium oxide percent
MgO	Magnesium oxide percent
MnO	Manganese oxide percent
Na_2O	Sodium oxide percent

Variable Name	Description
P_2O_5	(Phosphate percent) This is the percent grade item of special interest in the model;
TiO_2	Titanium dioxide percent
BaO	Barium oxide
SrO	Strontium oxide percent
Total	Total percent of all percent variables in model
Cr_2O_3	Chromium oxide percent
Percent_Env	Percent within wireframe
P_2O_5cut4pc	Test for whether grade ≥ 4% P_2O_5 (Yes=1, No=0)

Table 15.1.1 Block Model Variables and Descriptions

The most important variables for the purpose of the Study are Density variable, Classification, Rock Type and % P_2O_5 head grade. The Density, at the time of import, was defaulted as a constant of 3.42t/m^3 for mineralized blocks, and was later updated (See Section 15.1.2).

The Rock Type variable distinguishes the high grade material, the mixed grade material, inferred material, intrusion zones and waste rock.

The P_2O_5 head grades assigned to blocks of the model vary from 0% to 14.52%.

Certain variables were subsequently added to the model. They include:

- Topography Percent (% of block below topographical surface).
- Overburden Percent (% of block above bedrock surface).
- Weight Recovery (concentrate weight yield) (See Section 15.1.3).
- “CAT” item, which reorganized the classifications and added classifications for waste rock and for overburden (where 1=Measured, 2=Indicated, 3=Inferred, 4=Waste Rock, 5=Overburden).

15.1.1 Model Coordinate System

The model was provided in UTM NAD 83 ZONE 19 coordinate system. No model rotation was required by CWP. The model was provided with a specified origin of x=373,100m, y=5,528,850m, z=550m, which represents the top left corner of the model space. The centroid coordinates were used when importing into Datamine.

The block sizes of the model are 10m (x-coordinate) x 5m (y-coordinate) x 10m (z-coordinate). Figure 15.1.1 shows the exact block dimensions. In addition, Figure 15.1.2 shows a sample of elevations of the 3-D blocks (Measured and Indicated) in the model (above cut-off grade).

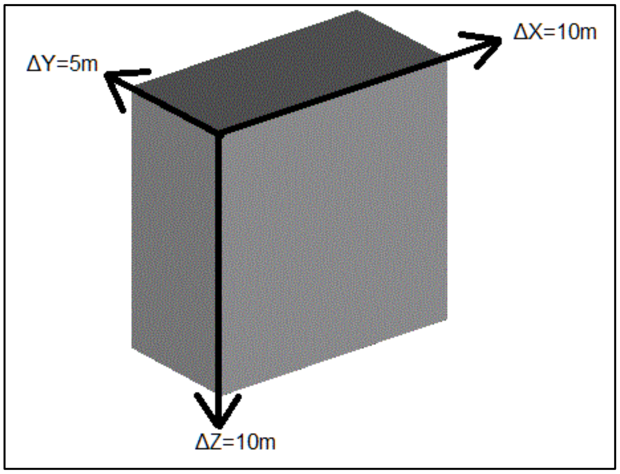


Figure 15.1.1 Block Dimensions

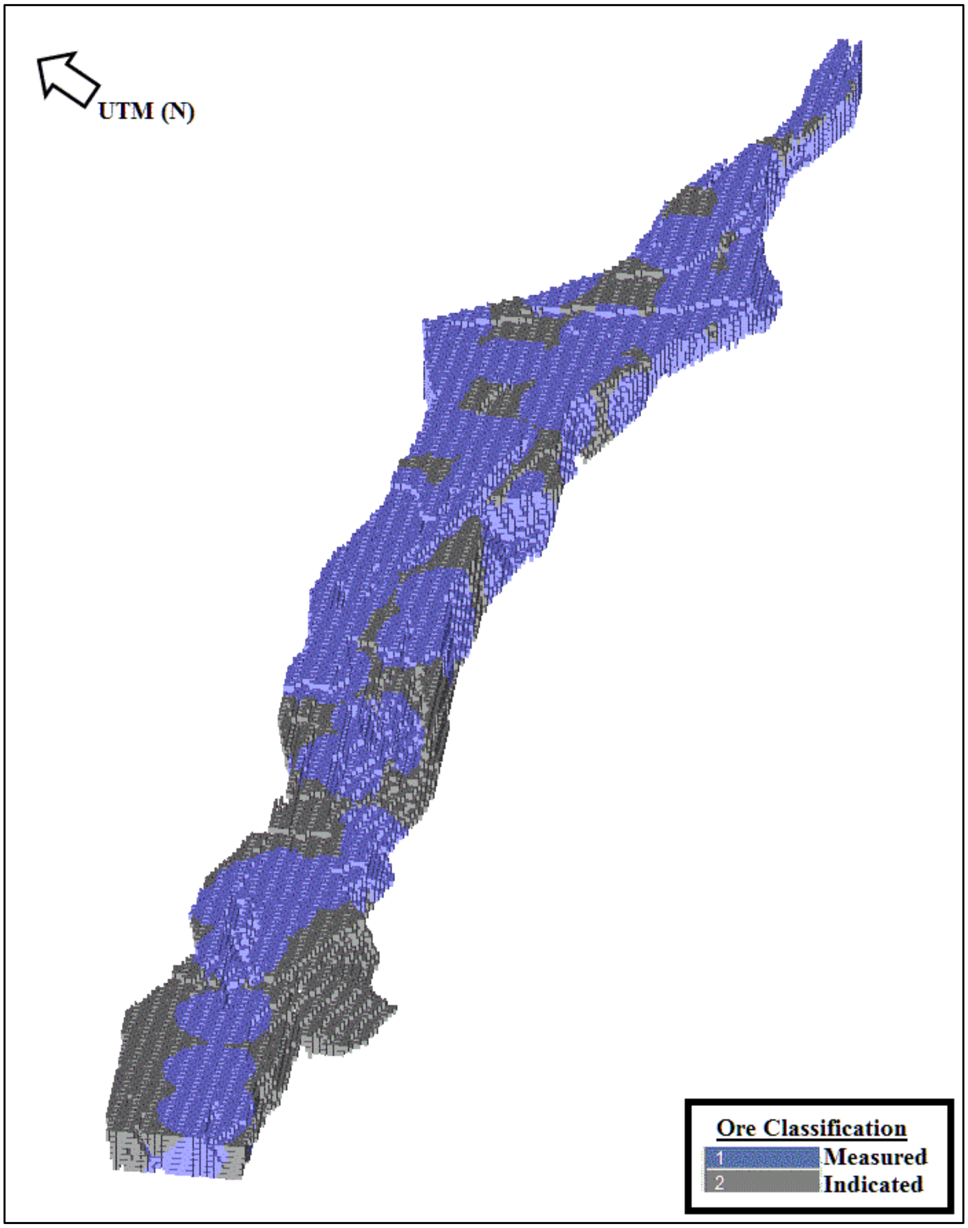


Figure 15.1.2 Sample 3D Block Model Shown ($P_2O_5 \geq 3.5\%$)

15.1.2 Model Densities

The original block model, provided to CWP, did not have a variable density relationship for the rock types present in the model. The original defaulted density for the mineralized blocks in the model was 3.42t/m^3, which corresponded with the original resource reported quantities. The non-mineralized blocks in the model did not have a defaulted density during the original import of the model.

The original resource report mentioned that there would be an updated variable density for the FS. Specific gravity measurements of the core by the geological team were used to update variable densities. The densities are divided by rock type, and are shown in Table 15.1.2.

Rock Type Description	Density (t/m^3)
Waste North (resource block model)	3.21
HG (Nelsonite domain)	3.52
MG (Mixed zone domain)	3.12
Waste South (resource block model)	2.90
The intrusion zones	2.80

Table 15.1.2 Densities by Rock Type

15.1.3 Model Recoveries

The model recoveries were determined from metallurgical test work presented in Section 13 of this report. The sampling campaign had variable recoveries, and the pilot plant testing was not completely stable. For this reason, the chosen recovery was downgraded to be conservative for the purpose of the Study.

The processing parameters for application in the FS mine plan are: 90% process recovery at 38.6% P_2O_5 grade in concentrate.

The process recovery and grade in concentrate are used to calculate the Weight Recovery (W.Rec) percent variable in the model. The formula for the calculation is also dependent on the head grade (% P_2O_5) in each block of the model, and is shown in the formula below:

$$Weight\ Recovery\ (W.Rec\ \%) = \frac{\text{\% P2O5 Head Grade (Variable) x 90\% Process Recovery}}{\text{38.6\% P2O5 Grade in Concentrate}}$$

The relevant definitions for the CIM Standards/NI 43-101 state a “Mineral Reserve is the economically mineable part of a Measured or Indicated Mineral Resource demonstrated by at least a Preliminary Feasibility Study”. For this reason, the Weight Recovery variable is only calculated for the blocks within the model with categorization as either Measured or Indicated. All other blocks in the model are considered “un-economic”.

15.1.4 Model Surfaces

Along with the model, the original wireframes provided by Claude Duplessis were:

- Topography (topolidarexportxyz.xyz).
- Overburden (topoOVBexportxyz.xyz).

Both of these files are 3-D point files, readable in Excel. The files were imported as point files into Datamine and MineSight, and then triangulated to form the required surface. The topography file was very detailed; however, the overburden file was not.

The overburden surface was subsequently re-modelled by Martin Bouchard from CWP and verified by Claude Duplessis (GMG). The new triangulated surface for the Overburden was then provided to CWP, Vancouver, BC. The average isopachs trend at 3m depths, with few outliers.

The additional variables coded by CWP (Mentioned in Section 15.1) “TOPO%” and “OB%” are coded from the provided surfaces. The “TOPO%” item is the proportion (in percent) of the block that is below the topography. Similarly, if a block is at least 50% in the overburden region (i.e. the region below the topography but above the bedrock), then it is coded as overburden.

15.2 Pit Optimization

The pit optimizations have been produced in Dassault Systèmes’ Geovia Whittle software (Whittle). In the software, the base case pit optimization was run using a CAD $200/tonne concentrate selling price, which is explained in Section 19: Market Studies and Contracts.

The base case Whittle 3-D algorithm uses a cut-off grade ore selection strategy. The algorithm runs on the standard Whittle block value calculation basis. Checks were completed using block value calculations defined by the mining engineer. In addition, MineSight was used to reproduce the generated pit shells as an additional validation method. The principles of the two software’ algorithms are essentially synonymous.

15.2.1 Pit Optimization Parameters

The pit optimization parameters were determined from a combination of evaluating numbers presented in the PFS Update, CWP expertise and experience and provided constraints particular to the FS.

The mining cost, processing cost, General and Administrative costs (G&A), and transport costs were obtained from the PFS Update report. The dilution of 5% and mining recovery of 10% were conservatively benchmarked from similar projects and using conventional recommendations.

The process recoveries are updated for the FS and are described in Section 15.1.3.

New pit optimization parameters for the FS include new geotechnical and environmental constraints.

The pit slope was downgraded by four degrees in order to allow space for operational design features such as geotechnical berms, security berms, overburden slopes, etc.

An environmental bounding constraint of 60m was applied from the lakes surrounding the pit to the North and from the creek to the West of the pit.

Incremental bench mining costs were applied starting at a depth of 5 benches, and augmented until the final depth of the pit was reached.

LAC À PAUL PIT OPTIMIZATION PARAMETERS- FS			
Parameters		**Unit**	**Values**
Operating Costs			
	Mining cost ore	($ / tonne mined)	1.83
	Mining cost waste	($ / tonne mined)	1.76
	Mining cost ob	($ / tonne mined)	1.56
	Mining Ore Loss	(%)	10.00
	Mining Dilution	(%)	5.00
	Unit mining cost per bench	($ / tonne / bench) (Starting at 5th bench)	0.02 incremental
	Processing cost	($ / tonne milled)	8.10
Indirect Costs			
	Rail Transport + Port cost + Ship Loading	($ / tonne concentrate)	10.42
	G&A cost	($ / tonne milled)	0.64
Sales Revenue			
	Average process recovery	(%)	90
	Grade in Concentrate	(P_2O_5 %)	38.6
	Weight Recovery	Wrec= P_2O_5% Head Grade x 90% Process Recovery/ 38.6% Grade in Con.	
Pit Characteristics			
	Overall Pit Slope	Degrees	50**
	Surface Limitations from Waterbodies	m	60

****Note that overall pit slope has been downgraded by a few degrees from final design IRA, to account for berms (regular, geotechnical and interface), ramps and operational parameters in final design.**

*****Note that reblocking has been used for pit optimization $(\Delta x, 2\Delta y, \Delta z)$**

Table 15.2.1 Lac a Paul Pit Optimization Parameters FS

15.2.2 Pit Optimization Results

The goal of the optimization was to generate an optimum economic pit shell that would:

- Maximize the net discounted cashflow as much as practical.
- Reduce the stripping ratio of the pit.
- Maximize grade and recovery.

The pit optimization results are shown in Figure 15.2.1. The figure represents the economic pit shell strings in dark blue. As well, the lakes are shown to the north, and the creek is shown to the west. The orange line shows the bounding constraint that was applied from the lakes and the creek in the Whittle software. The pit shell falls within this constraint.

Ramps, geotechnical berms, and overburden sloping, are neither shown nor produced in the economic pit shell strings. They are only incorporated during the engineered design.

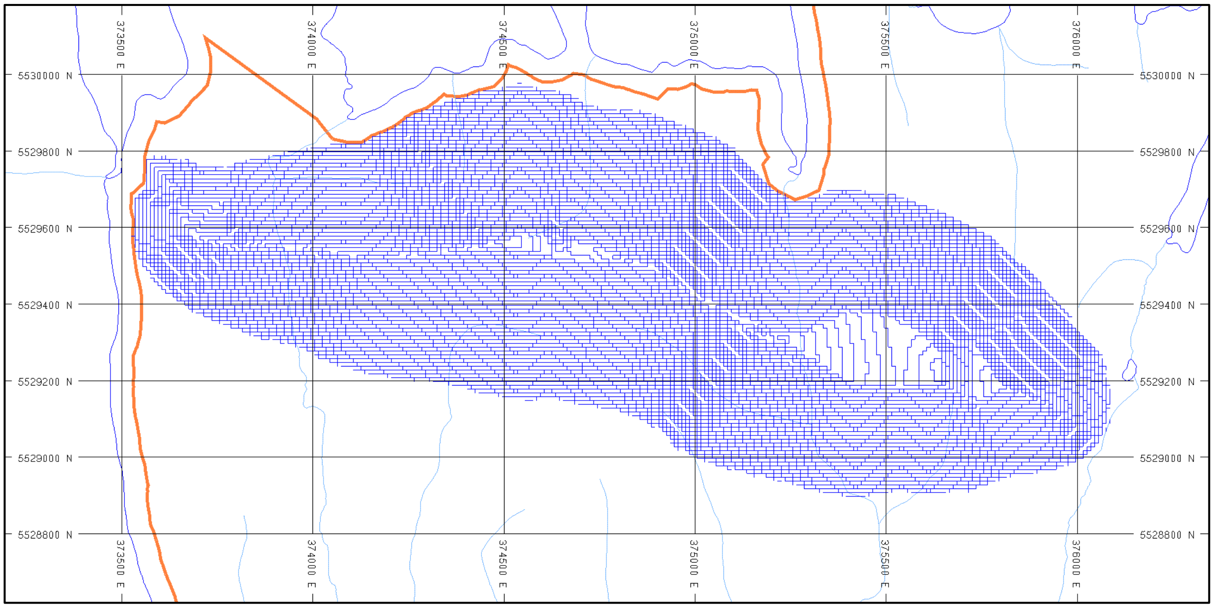


Figure 15.2.1 Pit Optimization Result

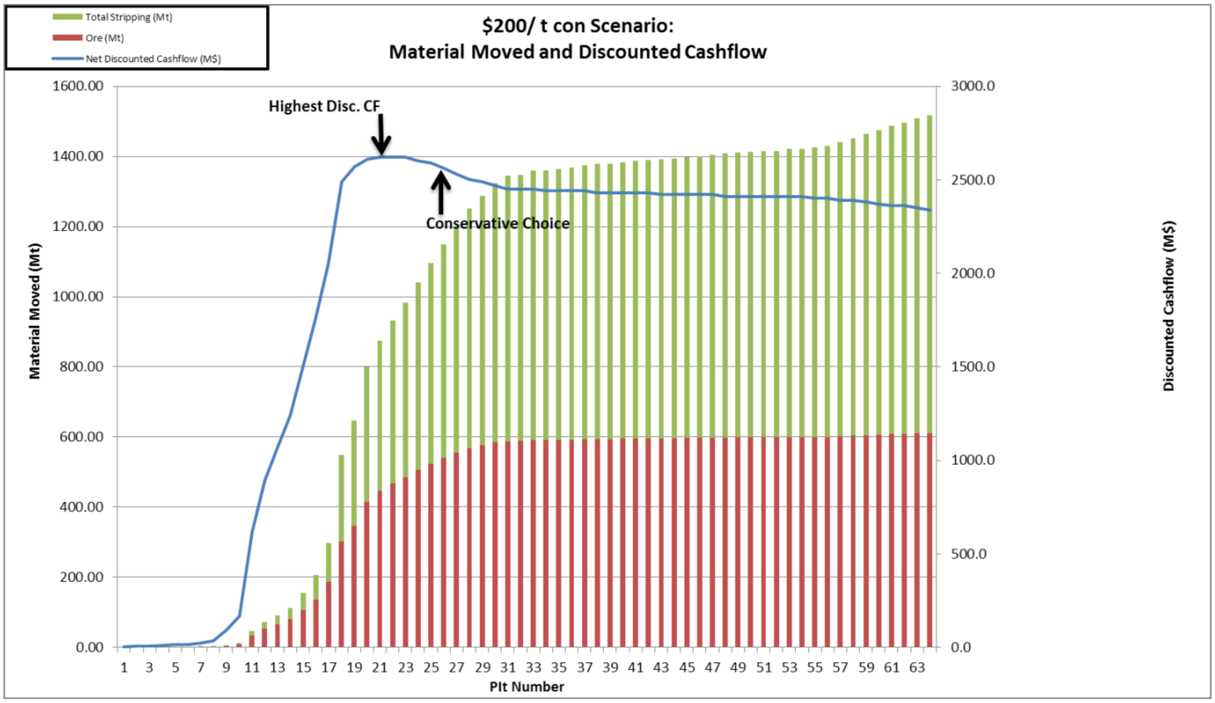


Figure 15.2.2 Graphical Representation of Pit Optimization Results (CAD)

The graphical representation showing the base case pit optimization results can be found in Figure 15.2.2. These results were attained using a commodity selling price of $200/ tonne concentrate (CAD). On the horizontal axis of the graph, the pit numbers are shown ranging from Pit 1 to Pit 64. These pits have been produced for a range of Revenue Factors (RF). The primary vertical axis shows the material moved (in million tonnes). This vertical axis relates to the bar graph. The red portion of the bar graph represents the ore being moved, and the green represents total stripping movement.

The secondary vertical axis presents the discounted cashflow (in million CAD$), and relates to the trendline (in blue). The highest discounted cashflow pit is shown with an arrow. The pit optimization that is used moving forward is shown with another arrow reading “Selected Economic pit”. This pit was selected as a conservative choice moving forward.

The selected pit for design basis for the FS is Pit 26 described previously. This pit has an approximate lifetime of 29 years (prior to engineered design), with an average stripping ratio of 1.13 (waste tonnes: ore tonnes), an average grade of 6.80% P_2O_5, and a net discounted cashflow of CAD $2,560 million. Once designed (with operational factors), this pit produces a 25-year lifetime.

This is due to the fact that once operational design factors such as the ramp, geotechnical berms, and recommended sloping are used, the pit resource will decrease due to a smaller pit. The 25-year lifetime pit has been chosen in order to be conservative.

15.2.3 Sensitivity Analysis

To examine the influence of the concentrate price on the output results, sensitivity tests were run to determine the possible impact on the Discounted Cash Flow by changing the concentrate sell price within the range ±$25 of the original value.

In order to assess these economic impacts, the following commodity prices (within ±$25) were used for the sensitivity analysis:

- CAD $175/ tonne phosphate rock concentrate;
- CAD $190/ tonne phosphate rock concentrate;
- CAD $200/ tonne phosphate rock concentrate;
- CAD $225/ tonne phosphate rock concentrate.

The results of the sensitivity tests are shown in Table 15.2.2.

Selling Price Scenario Comparison Results ($/tonne con)	Pit	Highest Discounted Cashflow (M$)	Ore (Mt)	Total Stripping (Mt)	Mine Life (years)	SR (t:t)	Grade P_20_5%
175	20	1947.24	406.23	369.16	22.57	0.91	6.95
190	22	2351.37	439.89	421.08	24.44	0.96	6.94
200	**21**	**2620.00**	**446.00**	**429.00**	**24.78**	**0.96**	**6.93**
225	19	3310.57	466.73	463.64	25.93	0.99	6.91

Table 15.2.2 Results of Commodity Selling Price Sensitivity Analysis (in CAD$)

For each run there is respective graph shown in Figure 15.2.3 through Figure 15.2.5.

The graph for base case scenario (CAD $200/t phosphate rock concentrate scenario) is shown in Figure 15.2.1 in Section 15.2.2.

Table 15.2.2 shows the result comparison from the four sensitivity analyses. These are the same results shown graphically. The sensitivity results show that selling price has a significant effect on overall discounted cashflow and on the size of the pit. For example, the CAD $200/t phosphate rock concentrate selling price is just over 10% difference from the CAD $225/t phosphate rock concentrate selling price, however, produces almost 20% less discounted cashflow.

The CAD $175/t phosphate rock concentrate selling price compared to the CAD $225/t phosphate rock concentrate selling price (which is an almost 20% decrease in selling price), shows that the overall discounted cashflow for the CAD $175/t phosphate rock concentrate scenario is nearly half that of the CAD $225/t phosphate rock concentrate scenario. This means that even though the life of mine difference (in between Pit 20 and 19) is only just over 3 years, the effect on the highest discounted cashflow is significant.

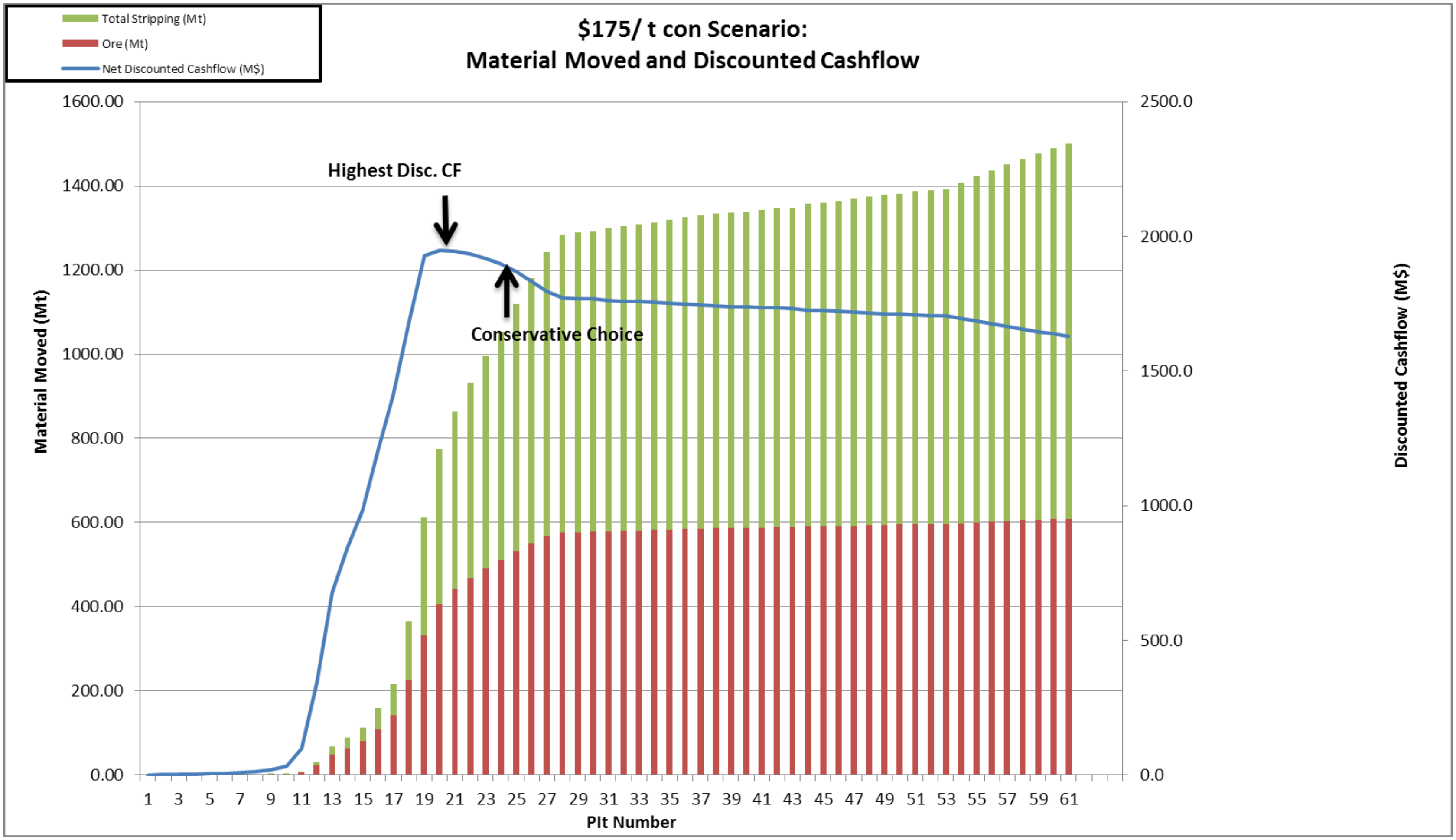


Figure 15.2.3 Sensitivity Analysis Results CAD $175/t phosphate rock concentrate

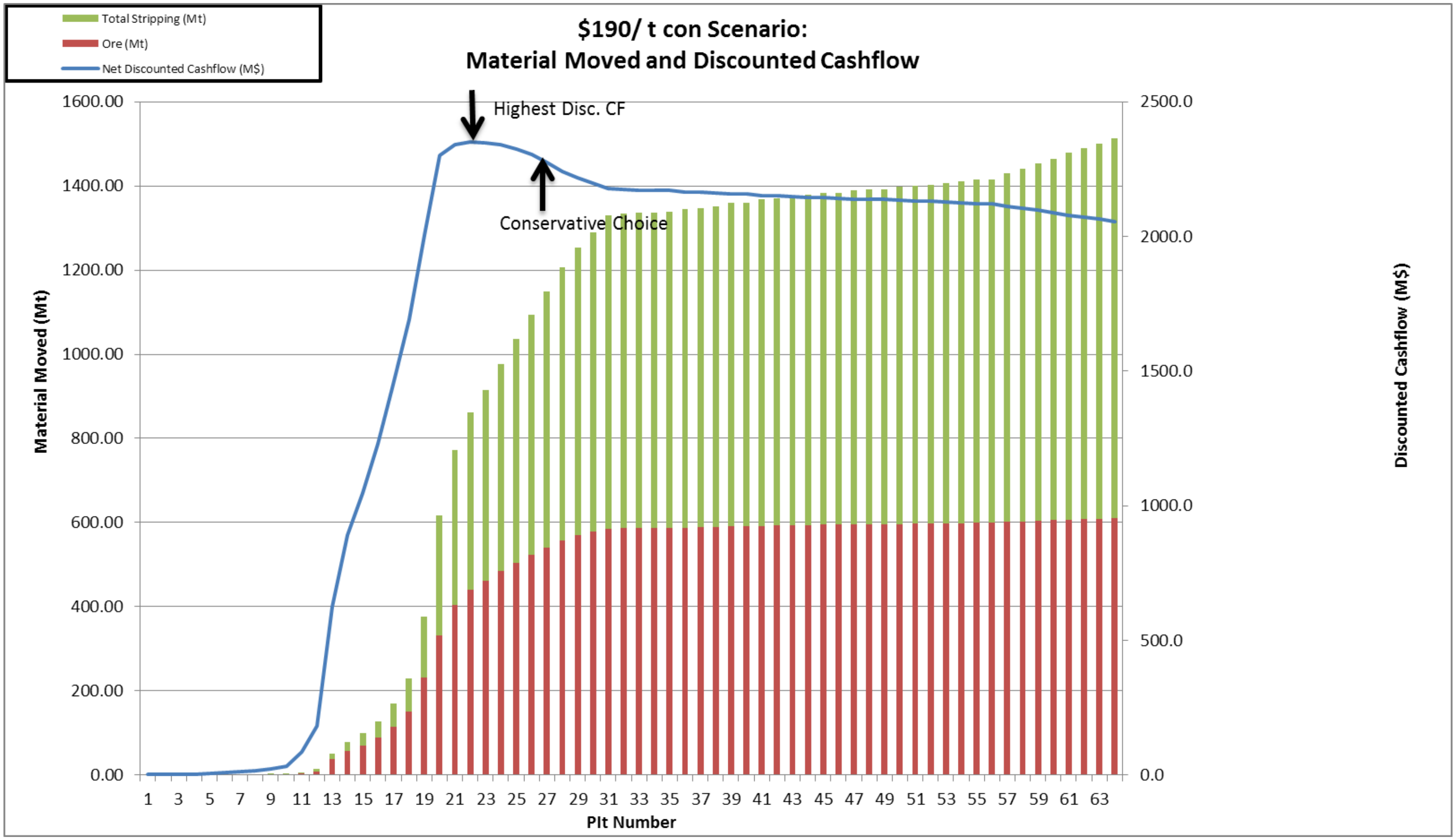


Figure 15.2.4 Sensitivity Analysis Results CAD $190/t phosphate rock concentrate

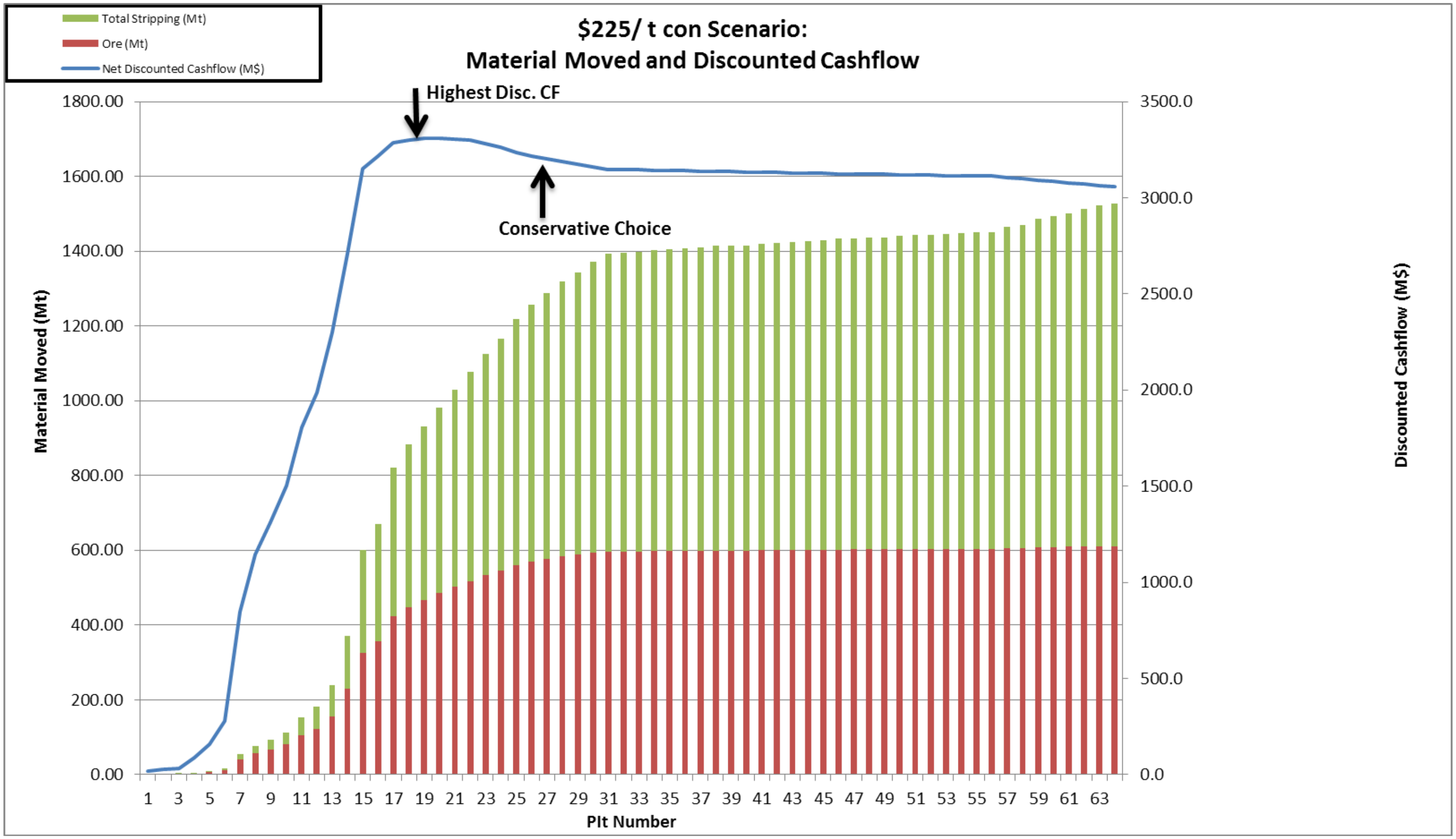


Figure 15.2.5 Sensitivity Analysis Results CAD $225/t phosphate rock concentrate

15.3 Cut-Off Grade Calculation

The pit optimization results were used to calculate the break-even cut-off grade. The break-even cut-off grade determines the economic limit for the excavation of mineralized/non-mineralized blocks within the model.

For the selected pit (See Section 15.2.2), the calculated break-even cut-off grade is 3.51% P_2O_5. A rounded cut-off grade of 3.5% P_2O_5 is used for reporting purposes for the FS.

15.4 Engineering Pit Design

The engineered pit is designed within the economic pit optimization presented in Section 15.2.2. The pit shell strings were exported from the Whittle software as a DXF file, to be imported and used in MineSight.

The pit design is produced using the Pit Expansion Tool in the MineSight. The tool takes into account benching configuration, sloping arrangement (as described in Section 15.4.1), berms, ramp width and grade, and ramp curvature.

15.4.1 Geotechnical Pit Slope Parameters

The slope specifications and benching arrangements were provided by Journeaux in their report entitled “Report on Pit Slope Design (Report No.L-12-1558)”. The slopes were provided as constant values for the entire pit (i.e. there were no sector divisions).

The slopes and the definition of each technical term relating to benching configuration are shown in Figure 15.4.1.

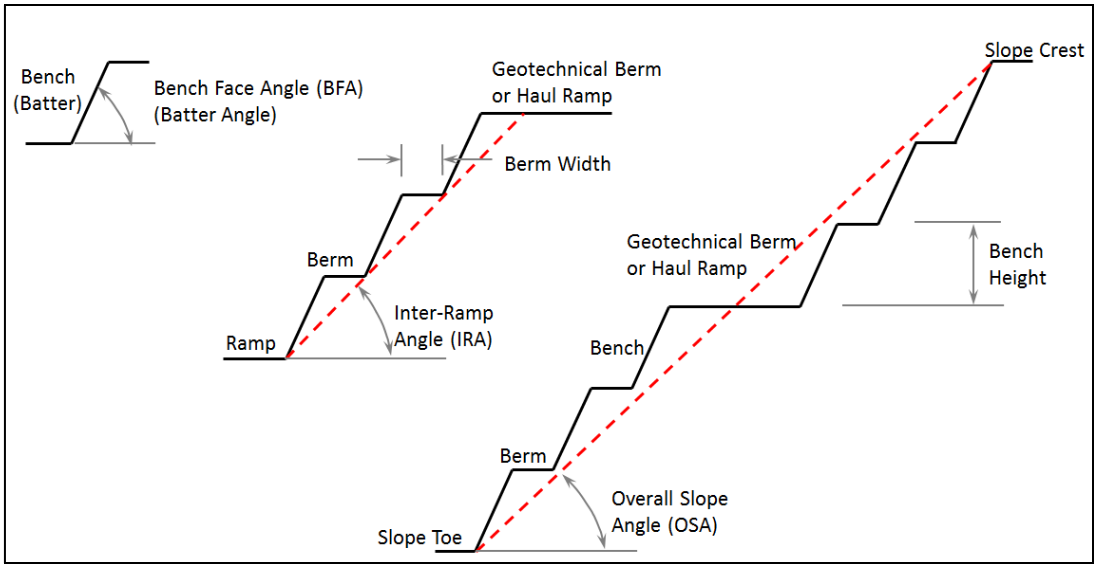


Figure 15.4.1 Definition of Slopes and Benching Configurations

Journeaux provided recommendations for a bench face angle of 70°, inter-ramp angle of 54°, and a double-benching configuration. The block height in the model is 10m; therefore the design assumption is that berms will appear at intervals of two block heights (20m bench height).

The Journeaux report is entitled “Report on Pit Slope Design (Report No.L-12-1558)”, in which the slopes are recommended assuming dry conditions. Particular attention should be made to the dewatering of the pit, for each phase of excavation.

15.4.2 Pit Design Parameters

The engineering pit design parameters are shown in Table 15.4.1.

LAC A PAUL PIT DESIGN PARAMETERS - FS		
Pit Design Characteristics	**Unit**	**Values**
Inter-Ramp Angle	Degrees	54
Bench Face Angle	Degrees	70
Berm Width	m	7.25
Bench Height (Berm to Berm)	m	20.00
Benching Configuration		Double (10m x 2)
Double-Lane Haulage Road Width	m	30.00
Single-Lane Haulage Ramp Width*	m	20.00
Ramp gradient	%	10.00
Surface Limitations from Creek and Lakes	m	60

Table 15.4.1 Engineered Pit Design Parameters

Additional concepts taken into account in the pit design include:

- Applying a minimum mining width of 50m.
- Aligning the ramp of the pit wall of greater geotechnical concern (North wall) in order to provide more stability during the design. (As recommended by Journeaux).
- Placing the pit ramp exit in a strategic manner for shorter access to the crusher and waste rock piles.

15.4.3 Dilution and Ore Loss

CWP conducted calculations using the Polygon Method in order to estimate the contact-dilution and ore loss for the engineered pit design. For the Polygon Method, four relatively equally spaced benches were analyzed as a means of attaining the necessary data.

Both the Measured and Indicated classifications are to be accounted for when creating the dilution polygons. The model used contains blocks with the dimensions 10m x 5m x 10m that represent the mineralization present above a cut-off grade of 3.5% P_2O_5.

The Polygon Method follows a set of criteria that are listed below:

- For a mining width of 10 meters or greater, 0.5m of ore width is assumed to be “lost” around the perimeter when mining blocks of these dimensions (i.e. 0.5m of ore is left behind along that edge in order to simulate ore loss. This translates to an ore loss in the calculations).
- For a mining width of less than 10m, 1.0m of width is added for the perimeter of this width.(i.e. waste-ore contact dilution will occur in order to extract these blocks of lesser width).
- The polygons should then be extruded to the height of the bench (i.e. 10m).
- The extrusion is then transformed into a solid region, and a volume is calculated for the tonnages and grades of the rock types present.
- A similar exercise is done for the voids (i.e the intrusion zones). There are a few voids that are sparse within the model. These voids should be deducted from the total solid volumes in order to avoid false “internal dilution” readings.
- In circumstances where only one block is present, the block shall be ignored due to the high dilution that would take place in order to mine that area to the necessary mining width.

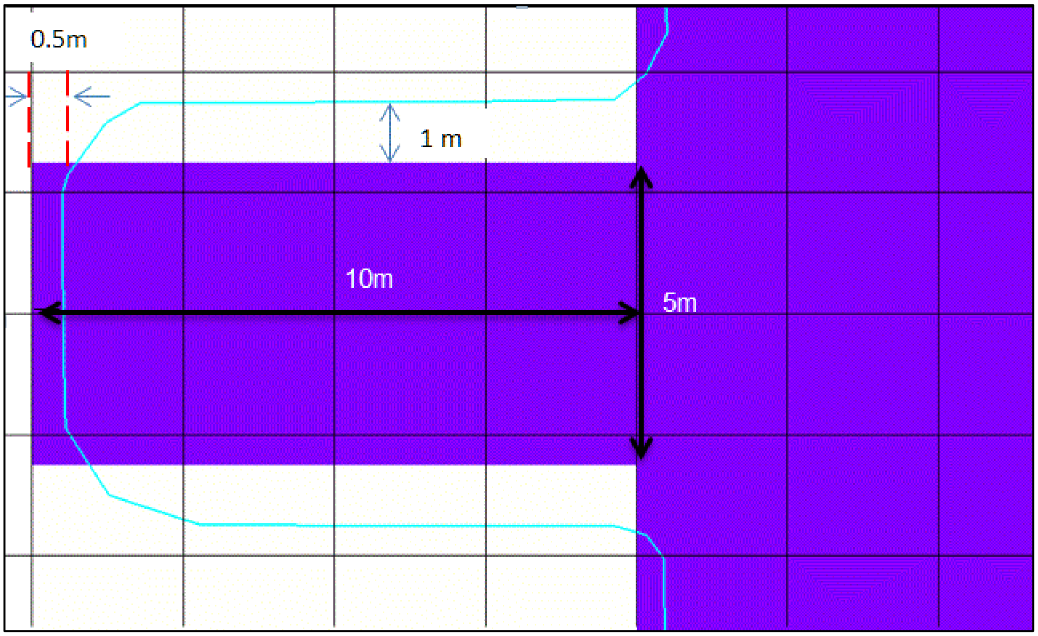


Figure 15.4.2 Polygon Method Contact Dilution and Ore Loss

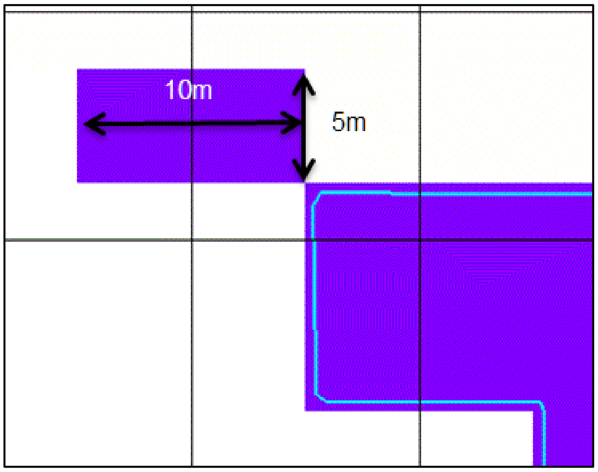


Figure 15.4.3 Example of Block Excluded from Calculation

The dilution and ore loss calculations take each bench into account. The results are tabulated, and weighted averages are taken from the four benches. The results are shown in Table 15.4.2.

Bench Elv. (m)	Mine Dilution %	Ore Loss %
125	0.71	2.41
185	1.00	2.16
265	1.25	1.61
355	1.01	2.04

Table 15.4.2 Dilution and Ore Loss Results

Given the variations shown above, the dilution of 2% and an ore loss of 3% are estimated. These values are rounded up from the calculations shown in order to be conservative.

15.4.4 Engineered Pit Design Results

Three dimensional and two dimensional views of the Pit are shown in Figure 15.4.4 and Figure 15.4.5, respectively. Figures 15.4.6 through to 15.4.12 demonstrate various section views. The section views shown include: elevations, northings and eastings.

Both the elevation and easting section views are chosen at equidistant intervals throughout the depth and length of the pit, respectively. In the section views, only the Measured and Indicated blocks of the model are shown. These blocks are the economic blocks that have a concentrate tonnage associated to each block. As well, only the mineralized blocks with a head grade of at least 3.5% P_2O_5 are shown; which is the calculated break-even cut-off grade.

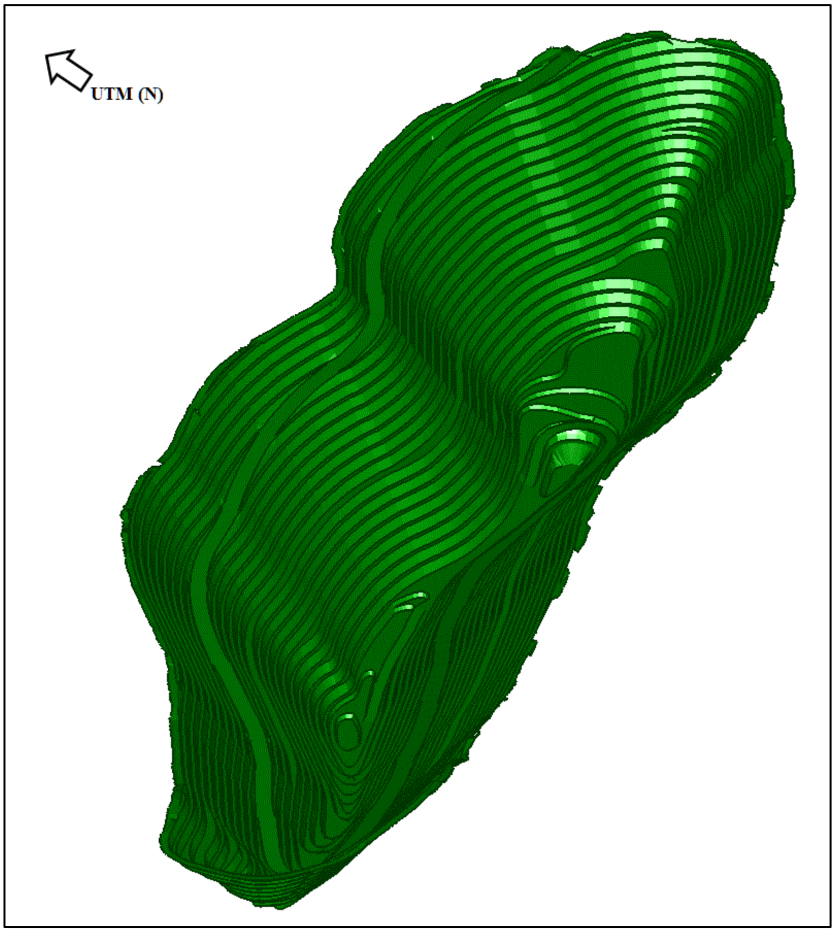


Figure 15.4.4 Engineered Pit Design 3D View

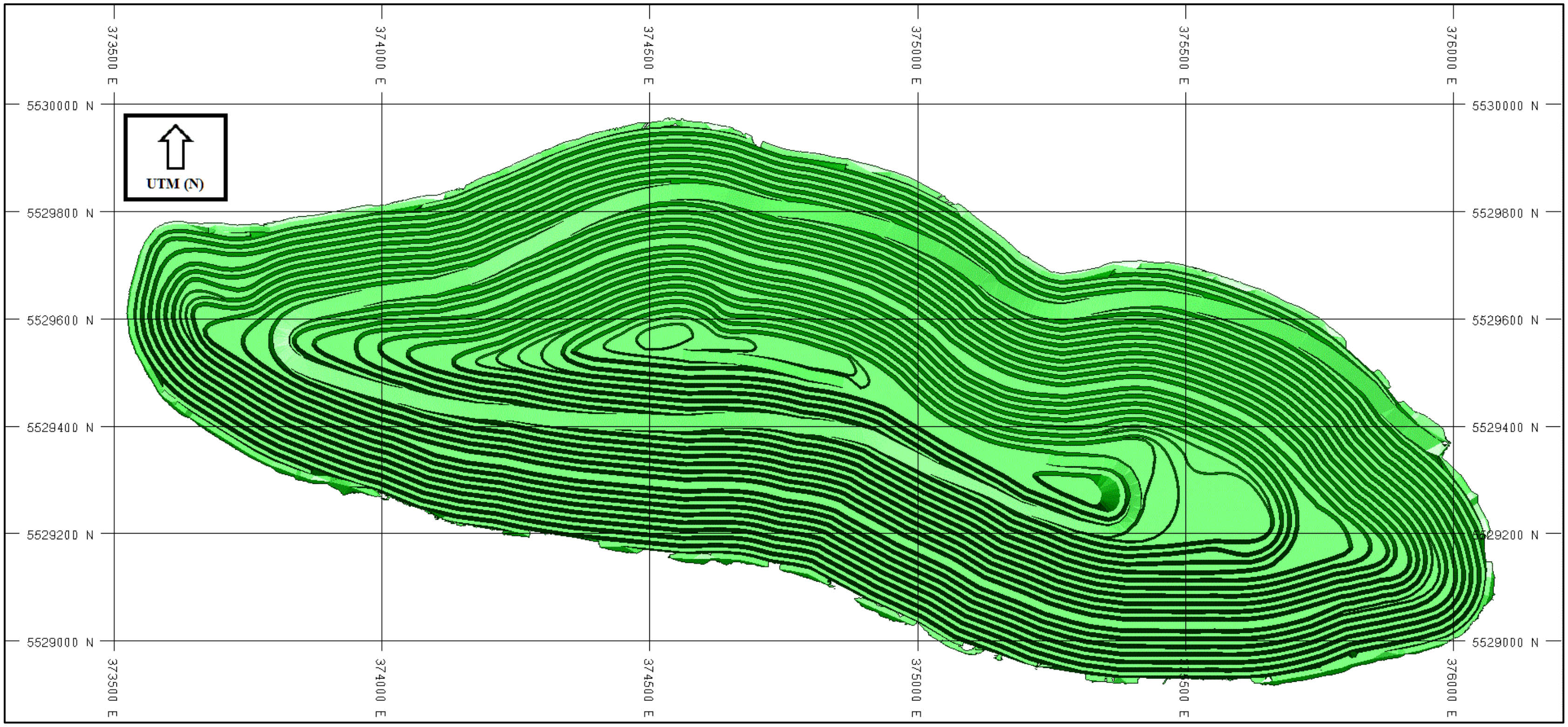


Figure 15.4.5 Lac a Paul FS Engineered Pit Design Plan View

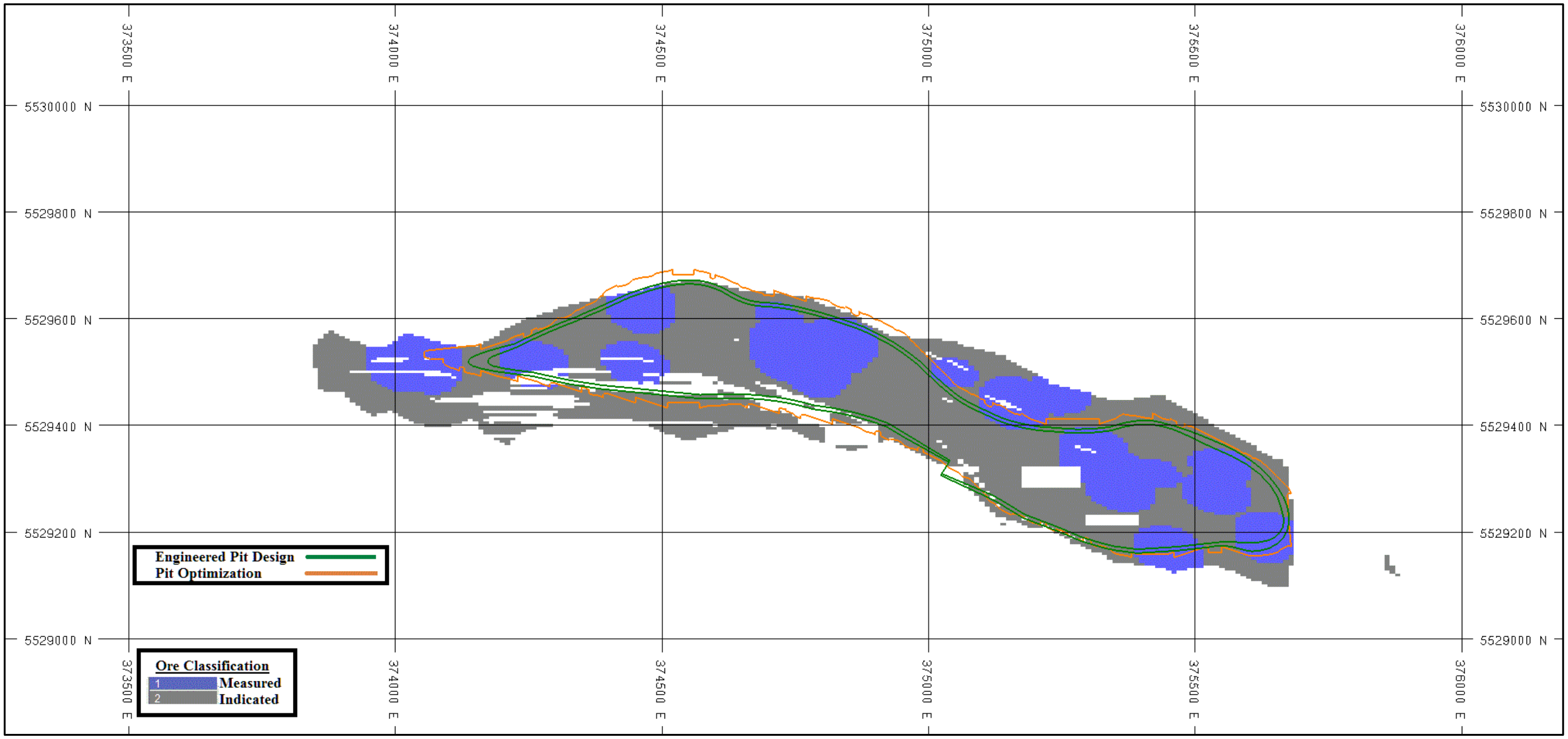


Figure 15.4.6 Engineered Pit Design z=105m Elevation ($P_2O_5 \geq 3.5\%$)

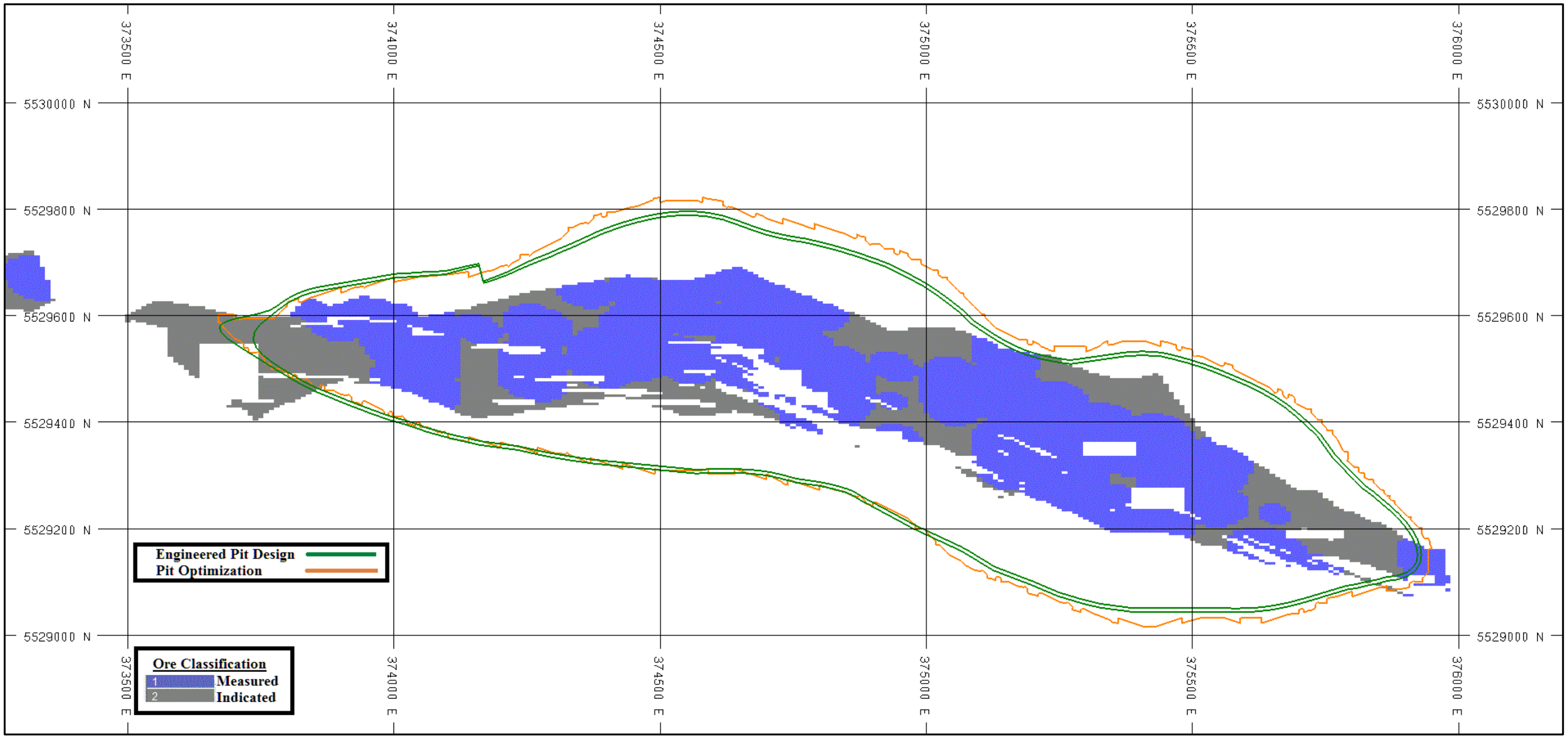


Figure 15.4.7 Engineered Pit Design z=265m Elevation ($P_2O_5 \geq 3.5\%$)

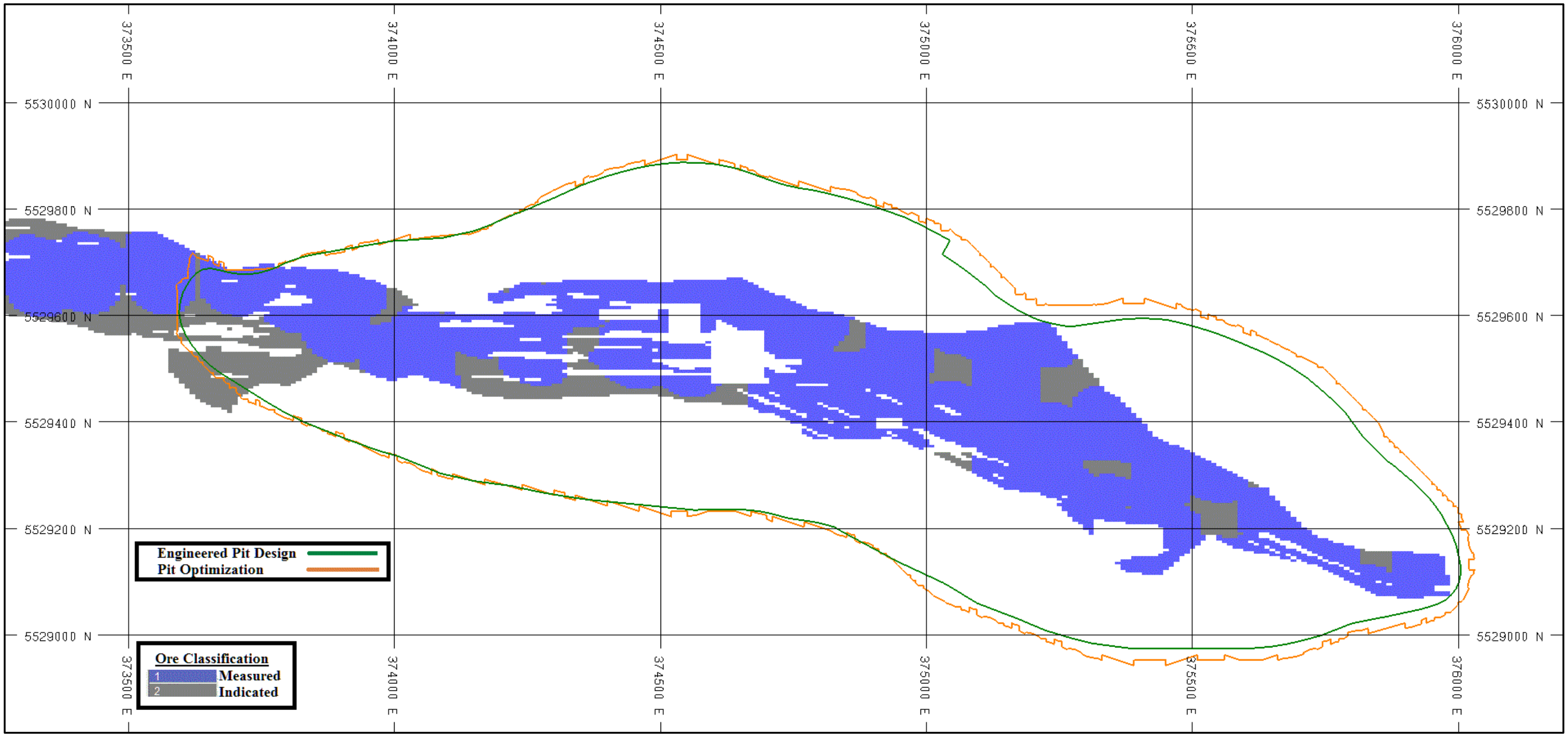


Figure 15.4.8 Engineered Pit Design z=355m Elevation ($P_2O_5 \geq 3.5\%$)

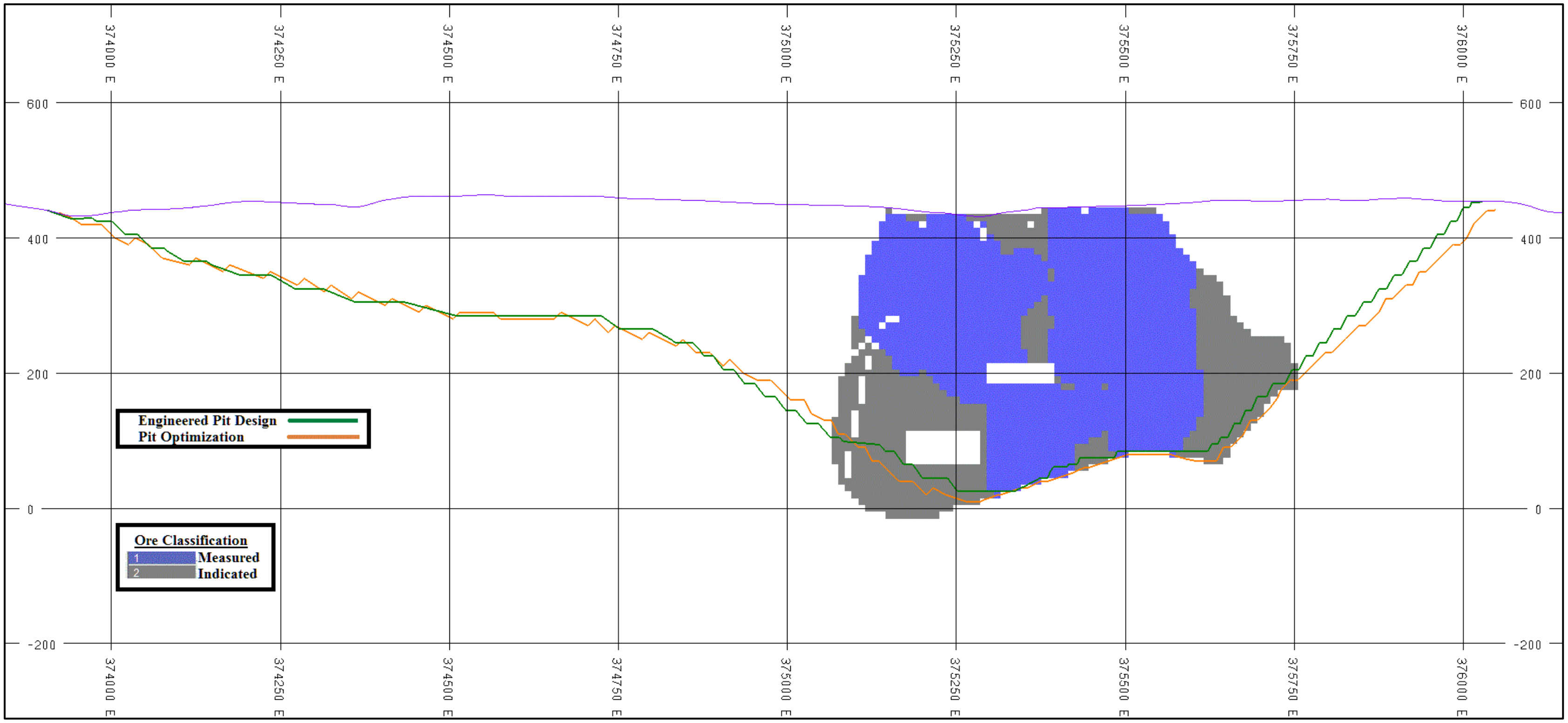


Figure 15.4.9 Engineered Pit Design North 5,529,287.50m ($P_2O_5 \geq 3.5\%$)

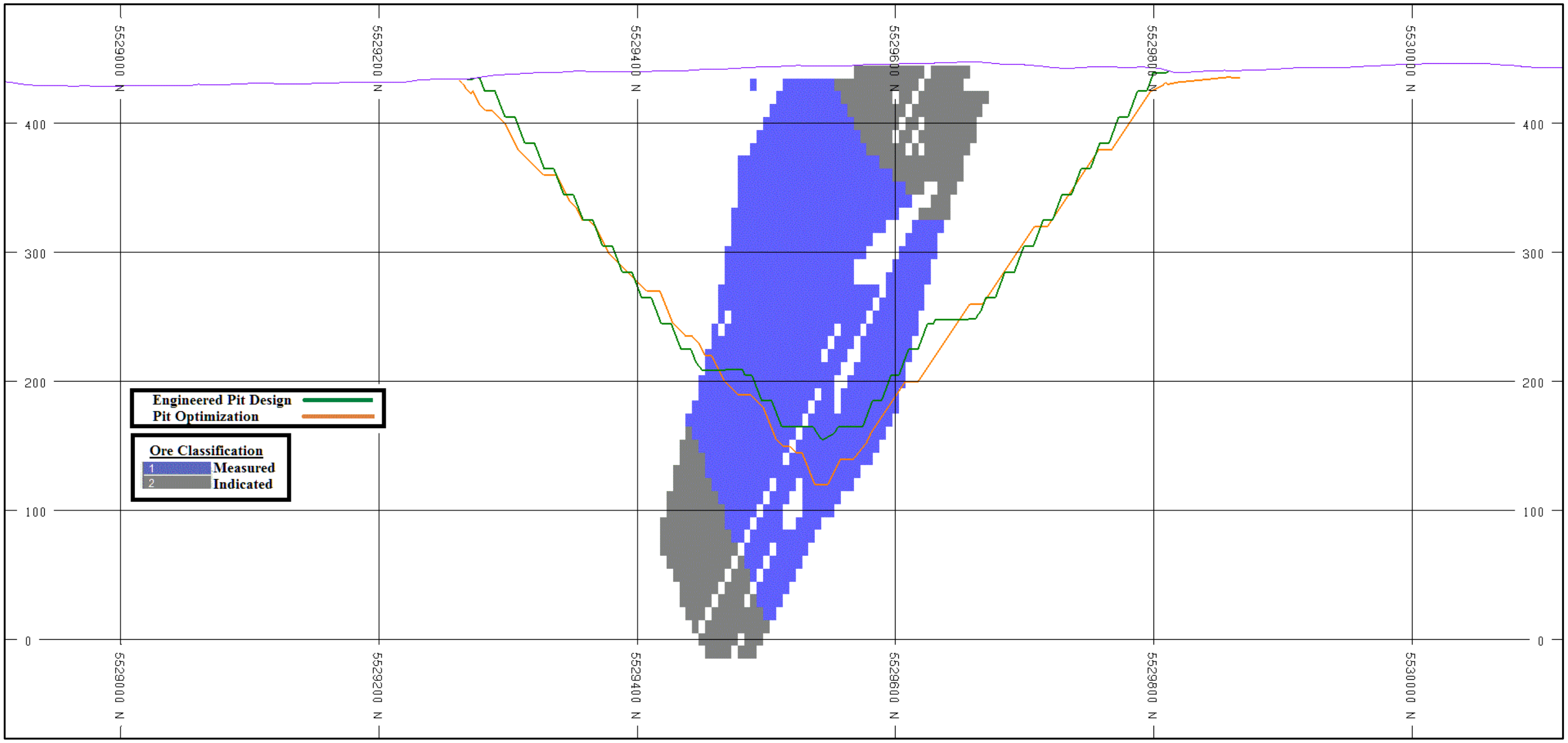


Figure 15.4.10 Engineered Pit Design East 373,995m ($P_2O_5 \geq 3.5\%$)

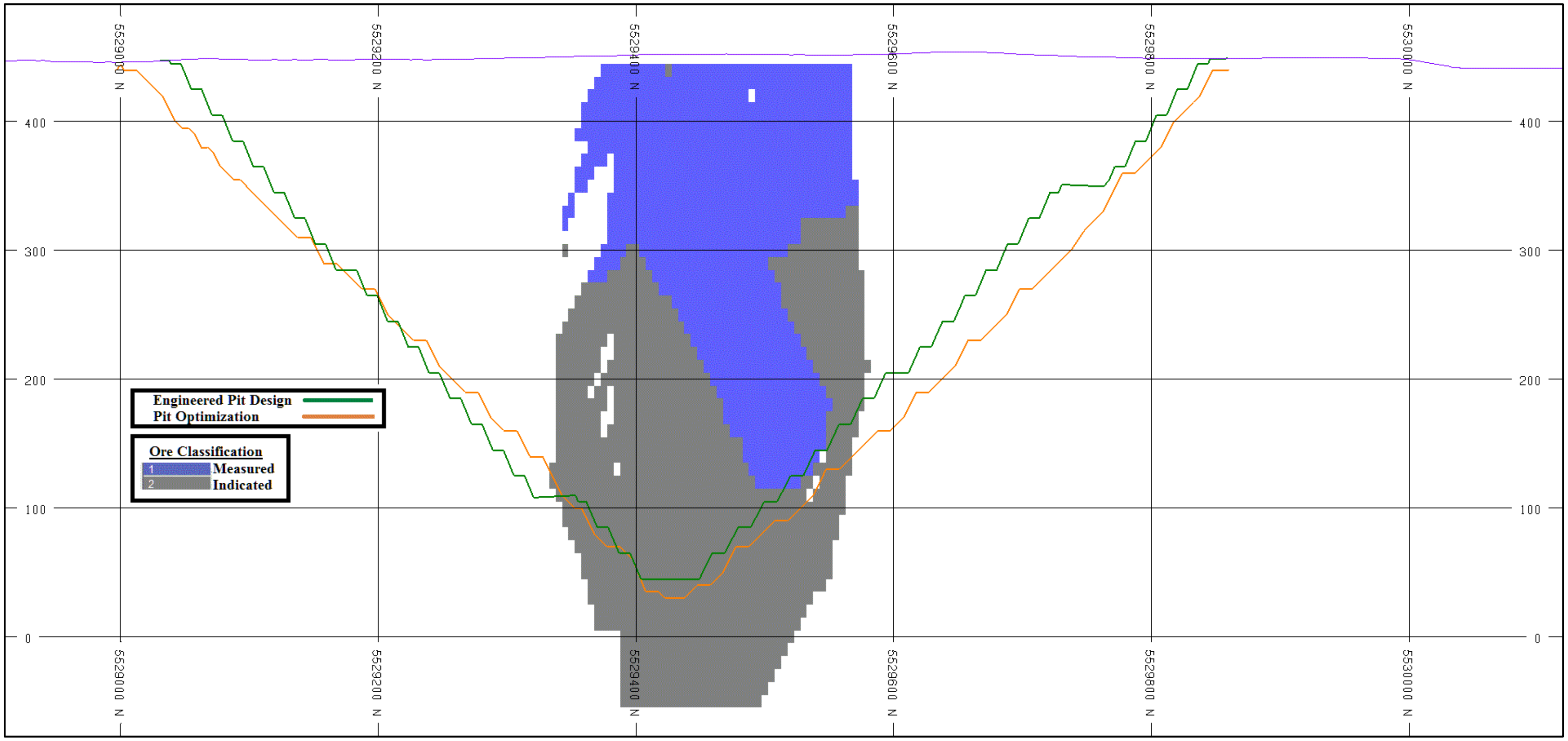


Figure 15.4.11 Engineered Pit Design East 374,995m ($P_2O_5 \geq 3.5\%$)

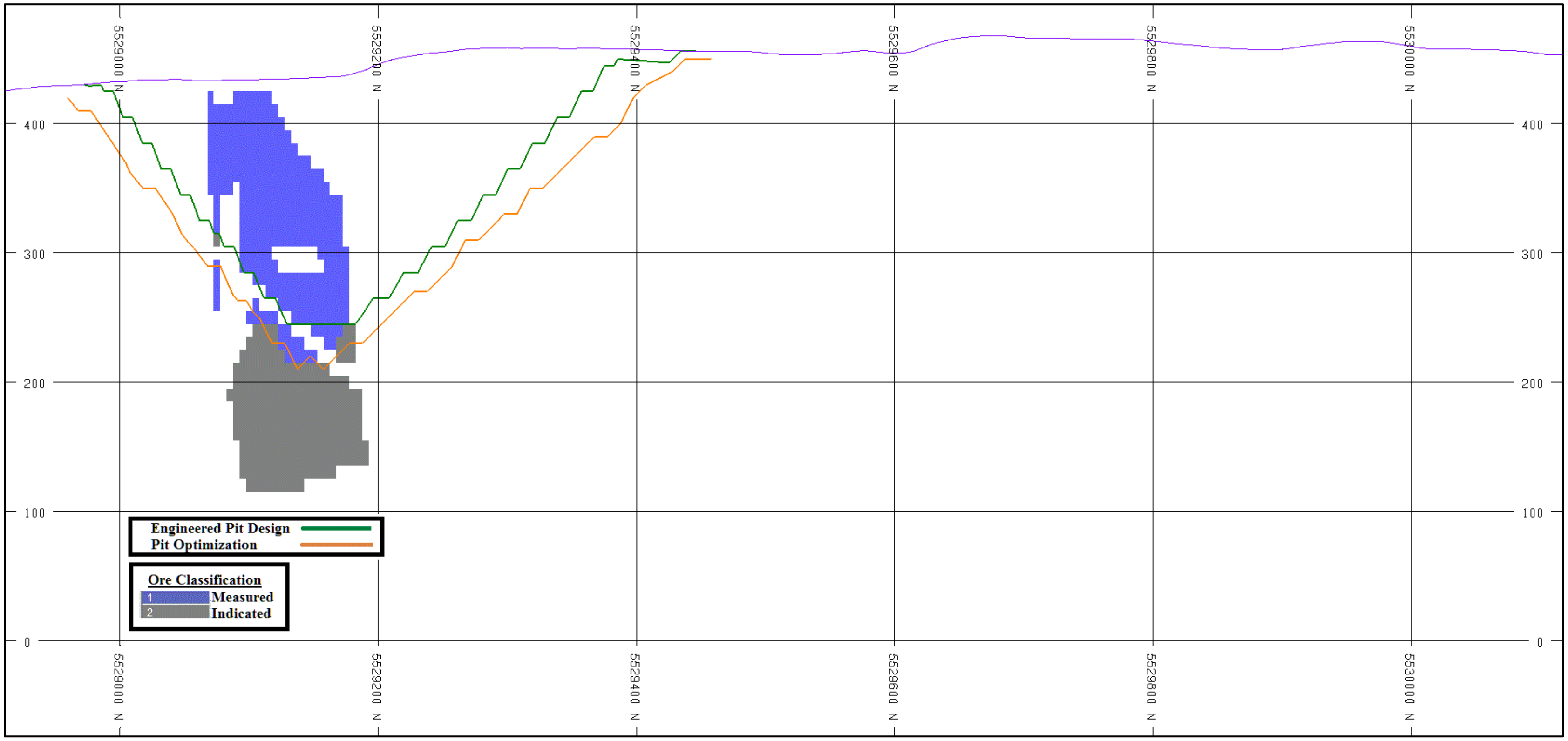


Figure 15.4.12 Engineered Pit Design East 375,905m ($P_2O_5 \geq 3.5\%$)

15.5 Mineral Reserve Estimate

The CIM guidelines for a FS govern that all resources classified as either Measured or Indicated shall be considered in the determination of the Reserve. Specifically, the standards state:

“A ‘Probable Mineral Reserve’ is the economically mineable part of an Indicated and, in some circumstances, a Measured Mineral Resource demonstrated by at least a Preliminary Feasibility Study.”

As well as,

“A ‘Proven Mineral Reserve’ is the economically mineable part of a Measured Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic, and other relevant factors that demonstrate, at the time of reporting, that economic extraction is justified.”

Table 15.5.1 shows the Mineable Reserve for the Lac a Paul FS, effective October 15, 2013, and approved by Alex Topalovic, MAusIMM (CP). The total mineable reserve amounts to 472.09Mt at 6.88% P_2O_5, reported at a cut-off grade of 3.5% P_2O_5, after an applied dilution of 2% and ore loss of 3%.

The total stripping amounts to 536.36Mt, including overburden tonnages. This contributes to an overall stripping ratio (waste tonnage: ore tonnage) of 1.14.

Final Engineered Pit Design
Mineral Reserve Estimate
COG $P_2O_5 \geq 3.5\%$
(Dilution=2%. Ore Loss=3%)

Classification	Tonnage (Mt)	P_2O_5 (%)
Proven	313.71	6.92
Probable	158.38	6.80
Total Reserve	**472.09**	**6.88**
Inferred	--	
Waste Rock	527.31	
Overburden	9.06	
Total Stripping	**536.36**	
SR	1.14	

Table 15.5.1 Lac a Paul Feasibility Study Reserves (Effective October 15, 2013)

16. MINING METHODS

This section presents the phase design and methodology, the scheduling, the mining methods, equipment, personnel and operating assumptions.

16.1 Mining Production Schedule and Methodology

The annual mine plan for the Lac a Paul FS is scheduled based on the production of 472.09 million tonnes Run-of-Mine (ROM), 527.31 million tonnes of waste rock and 9.06 million tonnes of overburden material. The average P_2O_5 grade is 6.88% Life-of-Mine (LOM), reported at a Cut-off Grade of 3.5% P_2O_5, after an applied dilution of 2% and an ore loss of 3%.

Four phases were designed based on the optimized pit shells. These phases were sequenced in order to maintain low stripping ratios (SRs) and high P_2O_5 grades during the early phases.

16.1.1 Optimized Mine Phases

Mine Phase optimizations were conducted using Dassault Systèmes' Geovia Whittle software (Whittle). The software was used to run the selected pit optimization (Section 15) at various revenue factors (RF). Each RF pit produced a different LOM optimized pit. The optimizations for the phases are refinements to those conducted in Section 15.

The optimized Whittle pits were selected based on the following:

- Incremental lifetimes.
- Proportionally dispersed incremental SRs between the phases.
- Realistic pushback scenarios between phases.

The lifetimes of each of the final phase designs are presented in Section 16.1.2.

16.1.2 Mine Phase Design

The mine phases were designed based on four selected optimized pit shells output from Whittle (Section 16.1.1). The four separate phases are shown in Figure 16.1.1 through to Figure 16.1.5. These four figures show the phases in 3-D.

Figure 16.1.1 shows the four phases mapped onto the site and infrastructure layout to provide orientation. The phases are geo-referenced and are projected using UTM NAD 83 ZONE 19 coordinates.

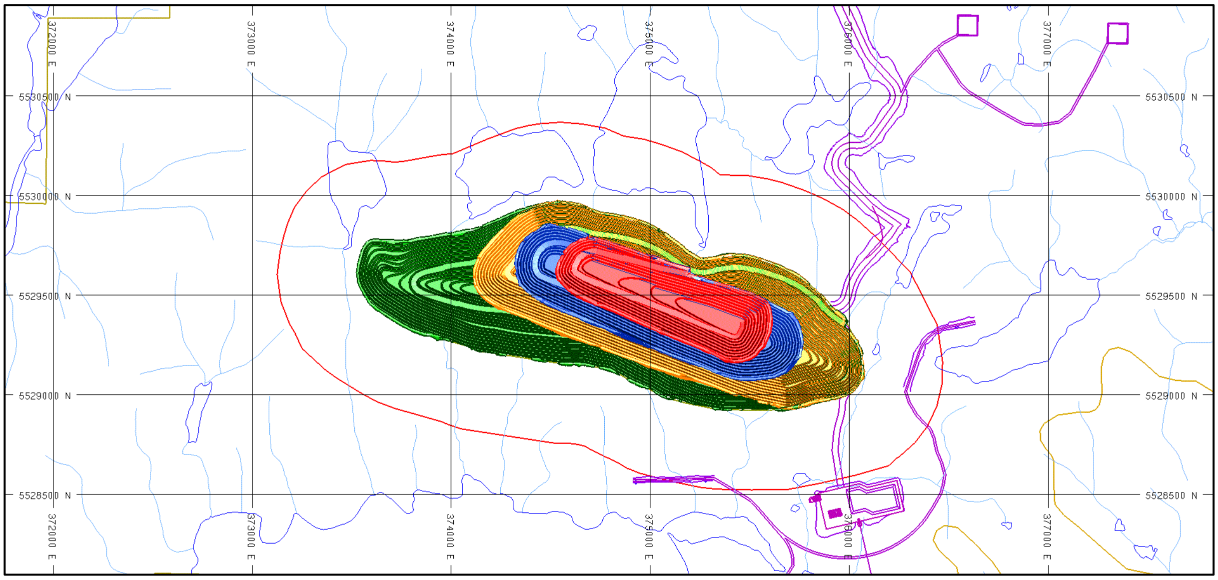


Figure 16.1.1 Four phases in Plan View with Site Layout

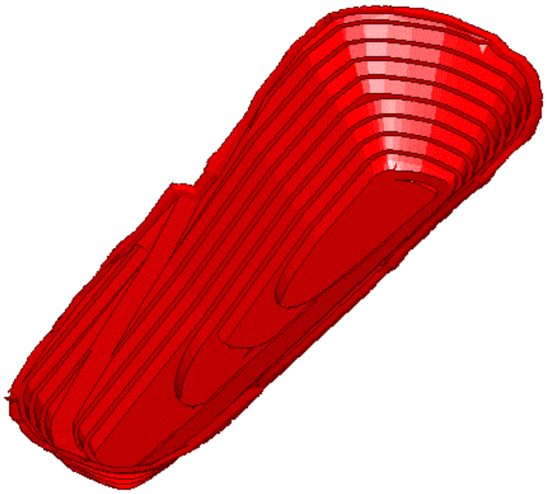


Figure 16.1.2 3-D Phase Design 1

The first phase, shown in Figure 16.1.2, was designed with the objective to produce high grade ore while reducing the stripping ratio during the first three years of the mine life.

The design parameters for all phase designs are the same as those used for the final engineered pit design (Phase 4). The haul ramp is positioned in the middle of the phase design to provide an equidistant haul to either the crusher or the north-western access to the Waste Rock Pile.

The dimensions of this smaller phase design are approximately 1100m long, 350m wide and approximately 157m deep. The ramp exit is at an elevation of z=442m.

The Phase 1 ore tonnes are 61.36 million tonnes. Phase 1 yields approximately 3 years of mining, and the strip ratio is 0.44 (including overburden).

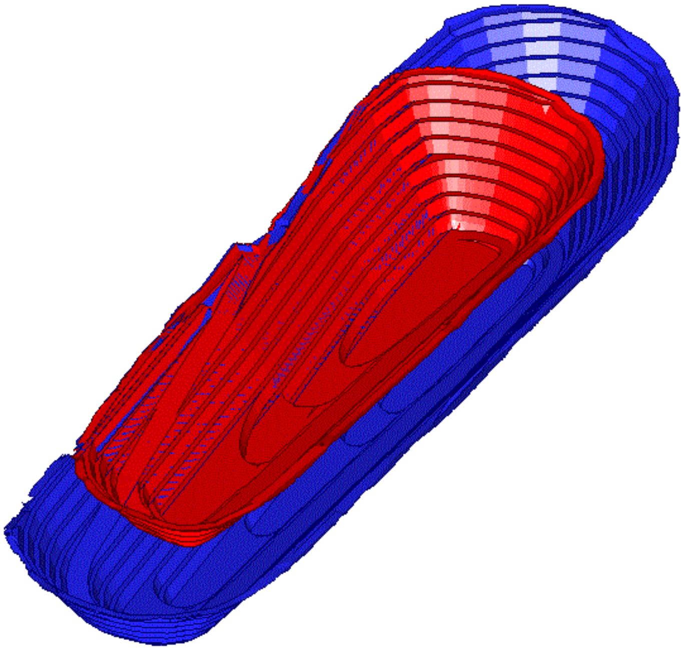


Figure 16.1.3 3-D Phase Designs 1 and 2

Figure 16.1.3 shows the progression from the first phase to the second phase. The same haul ramp is used to continuously provide easy access to both the Waste Rock Pile and the crusher.

The pushbacks present from Phase 1 to Phase 2 are realistic for a typical open pit operation. The minimum width maintained for the pushbacks in all of the images shown for the phases is 70m. However, most of the pushbacks exceed this amount.

The dimensions of the second phase are approximately 1500m long, 450m in width and 227m deep. The ramp exit is the same as that mentioned for the first phase.

The Phase 2 incremental ore tonnes are 75.68 million tonnes. The phase yields approximately 4 years of mining. The incremental strip ratio for Phase 2 is 0.55 (including overburden).

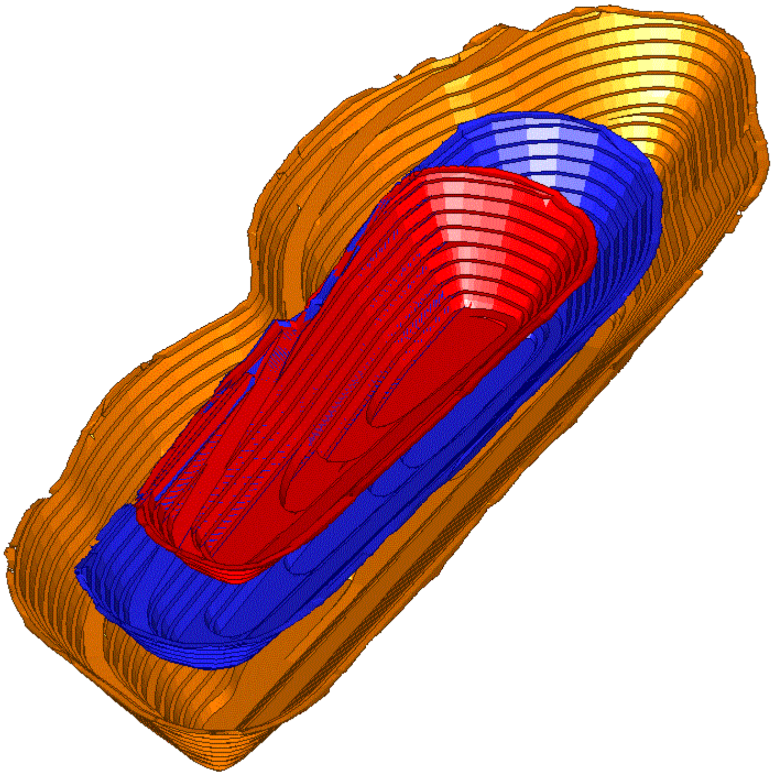


Figure 16.1.4 3-D Designs Phases 1, 2, and 3

During Phase 3, an overall widening of the pit occurs. Pushbacks occur in each direction, while maintaining the 70m minimum pushback width.

The temporary ramp from Phase 1 and Phase 2 is moved closer to the crusher location and the north-eastern waste rock pile access. The ramp for Phase 3, in Figure 16.1.4, joins the final ramp for approximately half of the length of the final ramp positioned on the North Wall.

The dimensions of Phase 3 are approximately 2000m long, 605m wide and 350m deep. The final ramp exit is at an elevation of z=456m.

The cumulative in-pit ore tonnes for the end of Phase 3 are 305.59 million tonnes, and yield approximately 16 years of mining. Due to the larger surface footprint of the Phase 3 design compared to the Phase 2 design, the SR is higher. The cumulative SR for Phase 3 is 1.04.

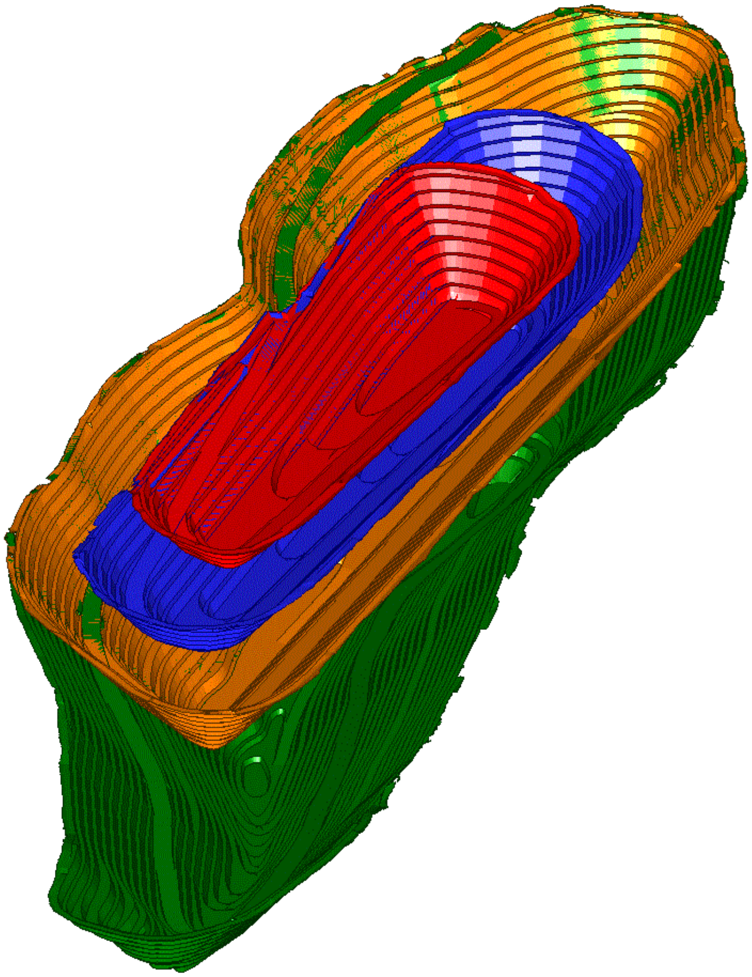


Figure 16.1.5 3-D Designed Phases 1, 2, 3, and 4

Phase 4 represents the final pit design. The final in-pit reserves and details are presented in Section 15.

16.2 Mine Planning

The annual production schedule is based on the designed mine phases from Section 16.1.2 Mine Phase Design. The incremental ore tonnes from one phase to the next are used in order to schedule the years of the mine plan using strategic planning tools. The incremental production tonnages are scheduled in conjunction with certain constraints:

- Yearly processing constraints.
- Maximizing Net Present Value (NPV).
- Keeping a low stripping ratio (SR).

Higher grades are attained by first mining Phase 1 and subsequently Phase 2.

Afterwards, the transitions to the larger phases within the strategic sequencing (Phase 3 and Phase 4) produce higher incremental SRs and lower grades.

16.2.1 Annual Production Requirements

At full production (100% ramp-up), the mill operating rate will be 55,000tpd for 339 operating days/year. This corresponds to an annual production capacity of 18.645 million tonnes ROM.

The ramp-up production period will consist of Period 1 (3 months) and Period 2 (6 months), with 35% and 80% ramp-ups, respectively. The ore production for each period will be as follows:

Period 1: (3 months) x 35% x (18,645,000 t / 12 months) = ~1,631,438t

Period 2: (6 months) x 80% x (18,645,000 t/ 12 months) = ~7,458,000t

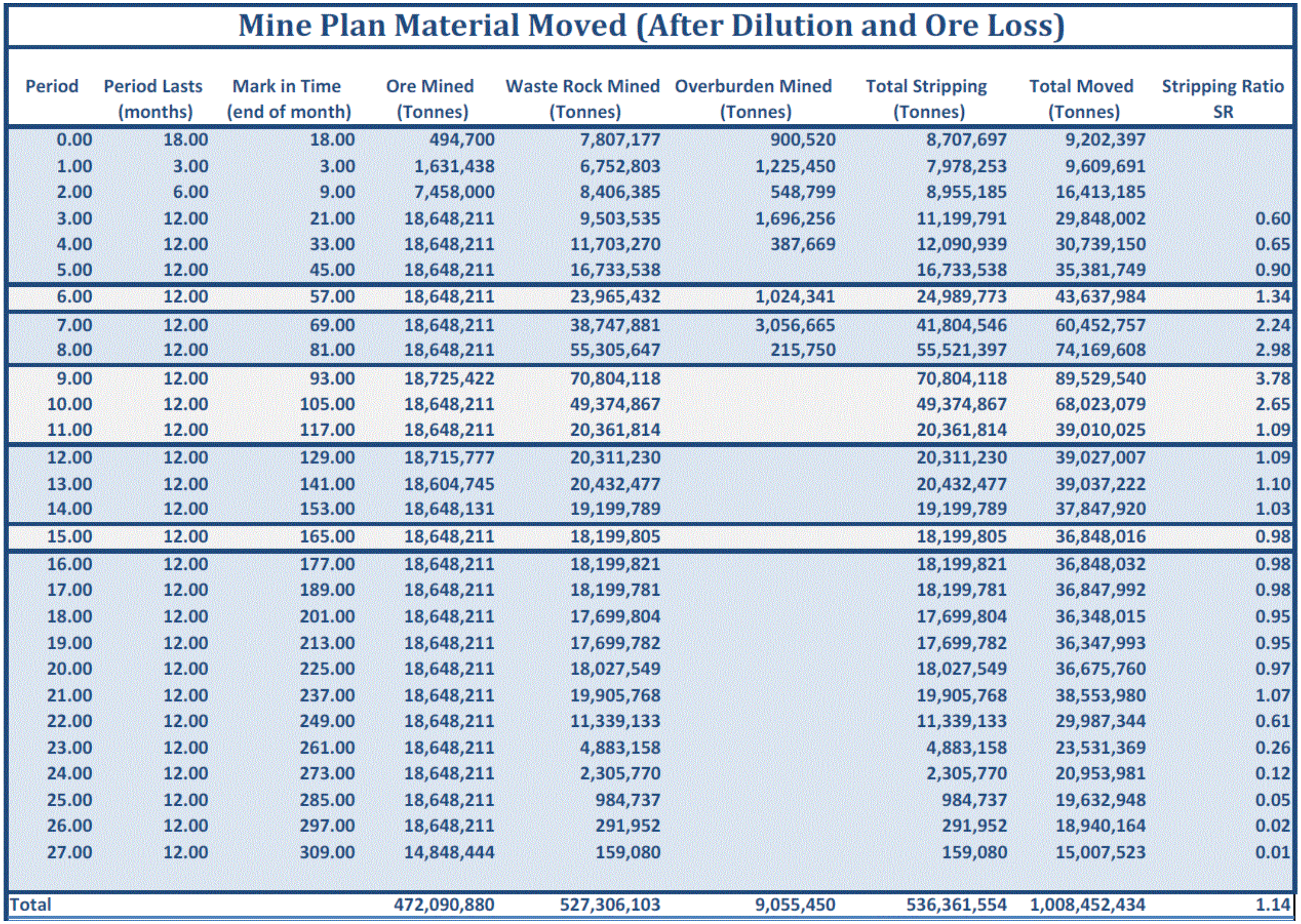
After the 9-month ramp-up period, the production will reach the full production capacity of 100%, to the equivalent of 55,000 tpd at the crusher.

16.2.2 Operating Work Schedule

The mine will operate 360 days/year. This number of days takes into account 5 lost days due to inclement weather. The mine will operate 7 days/week, with two 12-hour shifts per day.

16.2.3 Production Schedule

The annual mine plan is based on an annual production goal of 18.645 million tonnes ROM. This production goal satisfies the processing requirements for the LOM. A ramp-up is applied over the first few periods of the mine life as described in Section 16.3.1 Annual Production Requirements. The production ramp-up follows a 35%, 80%, 100% trend over above mentioned the periods. The production is estimated to be 25.75 years (excluding preproduction). Table 16.2.1 shows the yearly production schedule quantities; as well Table 16.2.2 shows the grade dispersion.



Mine Plan Material Moved (After Dilution and Ore Loss)

Period	Period Lasts (months)	Mark in Time (end of month)	Ore Mined (Tonnes)	Waste Rock Mined (Tonnes)	Overburden Mined (Tonnes)	Total Stripping (Tonnes)	Total Moved (Tonnes)	Stripping Ratio SR
0.00	18.00	18.00	494,700	7,807,177	900,520	8,707,697	9,202,397	
1.00	3.00	3.00	1,631,438	6,752,803	1,225,450	7,978,253	9,609,691	
2.00	6.00	9.00	7,458,000	8,406,385	548,799	8,955,185	16,413,185	
3.00	12.00	21.00	18,648,211	9,503,535	1,696,256	11,199,791	29,848,002	0.60
4.00	12.00	33.00	18,648,211	11,703,270	387,669	12,090,939	30,739,150	0.65
5.00	12.00	45.00	18,648,211	16,733,538		16,733,538	35,381,749	0.90
6.00	12.00	57.00	18,648,211	23,965,432	1,024,341	24,989,773	43,637,984	1.34
7.00	12.00	69.00	18,648,211	38,747,881	3,056,665	41,804,546	60,452,757	2.24
8.00	12.00	81.00	18,648,211	55,305,647	215,750	55,521,397	74,169,608	2.98
9.00	12.00	93.00	18,725,422	70,804,118		70,804,118	89,529,540	3.78
10.00	12.00	105.00	18,648,211	49,374,867		49,374,867	68,023,079	2.65
11.00	12.00	117.00	18,648,211	20,361,814		20,361,814	39,010,025	1.09
12.00	12.00	129.00	18,715,777	20,311,230		20,311,230	39,027,007	1.09
13.00	12.00	141.00	18,604,745	20,432,477		20,432,477	39,037,222	1.10
14.00	12.00	153.00	18,648,131	19,199,789		19,199,789	37,847,920	1.03
15.00	12.00	165.00	18,648,211	18,199,805		18,199,805	36,848,016	0.98
16.00	12.00	177.00	18,648,211	18,199,821		18,199,821	36,848,032	0.98
17.00	12.00	189.00	18,648,211	18,199,781		18,199,781	36,847,992	0.98
18.00	12.00	201.00	18,648,211	17,699,804		17,699,804	36,348,015	0.95
19.00	12.00	213.00	18,648,211	17,699,782		17,699,782	36,347,993	0.95
20.00	12.00	225.00	18,648,211	18,027,549		18,027,549	36,675,760	0.97
21.00	12.00	237.00	18,648,211	19,905,768		19,905,768	38,553,980	1.07
22.00	12.00	249.00	18,648,211	11,339,133		11,339,133	29,987,344	0.61
23.00	12.00	261.00	18,648,211	4,883,158		4,883,158	23,531,369	0.26
24.00	12.00	273.00	18,648,211	2,305,770		2,305,770	20,953,981	0.12
25.00	12.00	285.00	18,648,211	984,737		984,737	19,632,948	0.05
26.00	12.00	297.00	18,648,211	291,952		291,952	18,940,164	0.02
27.00	12.00	309.00	14,848,444	159,080		159,080	15,007,523	0.01
Total			472,090,880	527,306,103	9,055,450	536,361,554	1,008,452,434	1.14

Table 16.2.1 Lac a Paul FS Mine Plan (Material Moved)

Mine Plan Grade Item Dispersion (After Dilution and Ore Loss)

Period	Period Lasts (months)	Mark in Time (end of month)	Ore Mined (Tonnes)	Grade Mined (P2O5 %)	Grade Mined (WREC%)	Ore Stockpiled (Tonnes)	Grade Stockpiled (P2O5 %)	Ore Milled (Tonnes)	Grade Milled (P2O5 %)	Grade Milled (WREC%)
0.00	18.00	18.00	494,700	8.04	18.75	494,700	8.04			
1.00	3.00	3.00	1,631,438	7.78	18.13			1,631,438	7.78	18.13
2.00	6.00	9.00	7,458,000	6.96	16.22			7,458,000	6.96	16.22
3.00	12.00	21.00	18,648,211	7.09	16.52			18,648,211	7.09	16.52
4.00	12.00	33.00	18,648,211	7.03	16.38			18,648,211	7.03	16.38
5.00	12.00	45.00	18,648,211	7.12	16.59			18,648,211	7.12	16.59
6.00	12.00	57.00	18,648,211	6.40	14.91			18,648,211	6.40	14.91
7.00	12.00	69.00	18,648,211	6.68	15.57			18,648,211	6.68	15.57
8.00	12.00	81.00	18,648,211	7.22	16.83			18,648,211	7.22	16.83
9.00	12.00	93.00	18,725,422	6.68	15.58			18,725,422	6.68	15.58
10.00	12.00	105.00	18,648,211	6.05	14.12			18,648,211	6.05	14.12
11.00	12.00	117.00	18,648,211	6.68	15.58			18,648,211	6.68	15.58
12.00	12.00	129.00	18,715,777	6.66	15.54			18,715,777	6.66	15.54
13.00	12.00	141.00	18,604,745	7.29	16.99			18,604,745	7.29	16.99
14.00	12.00	153.00	18,648,131	7.46	17.40			18,648,131	7.46	17.40
15.00	12.00	165.00	18,648,211	6.66	15.53			18,648,211	6.66	15.53
16.00	12.00	177.00	18,648,211	6.32	14.73			18,648,211	6.32	14.73
17.00	12.00	189.00	18,648,211	6.83	15.92			18,648,211	6.83	15.92
18.00	12.00	201.00	18,648,211	6.79	15.82			18,648,211	6.79	15.82
19.00	12.00	213.00	18,648,211	7.39	17.23			18,648,211	7.39	17.23
20.00	12.00	225.00	18,648,211	7.09	16.54			18,648,211	7.09	16.54
21.00	12.00	237.00	18,648,211	6.32	14.73			18,648,211	6.32	14.73
22.00	12.00	249.00	18,648,211	6.13	14.28			18,648,211	6.13	14.28
23.00	12.00	261.00	18,648,211	6.58	15.34			18,648,211	6.58	15.34
24.00	12.00	273.00	18,648,211	6.75	15.73			18,648,211	6.75	15.73
25.00	12.00	285.00	18,648,211	7.29	17.01			18,648,211	7.29	17.01
26.00	12.00	297.00	18,648,211	7.75	18.07			18,648,211	7.75	18.07
27.00	12.00	309.00	14,848,444	7.73	18.02	-494,700	8.04	15,343,144	7.74	18.04
Total			472,090,880	6.88	16.04			472,090,880	6.88	16.04

Table 16.2.2 Lac a Paul FS Mine Plan (Grade Item Dispersion)

As shown in Figure 16.2.1 the material trend and SRs are shown over the LOM. The SRs are minimized over the first few periods of the production schedule. An increase in SR starts in Period 5, with the peak occurring in Periods 9, 10 and 11. The peak occurs over these three periods due to the pushback from Phase 3 to Phase 4 that widens the pit to its final surface area.

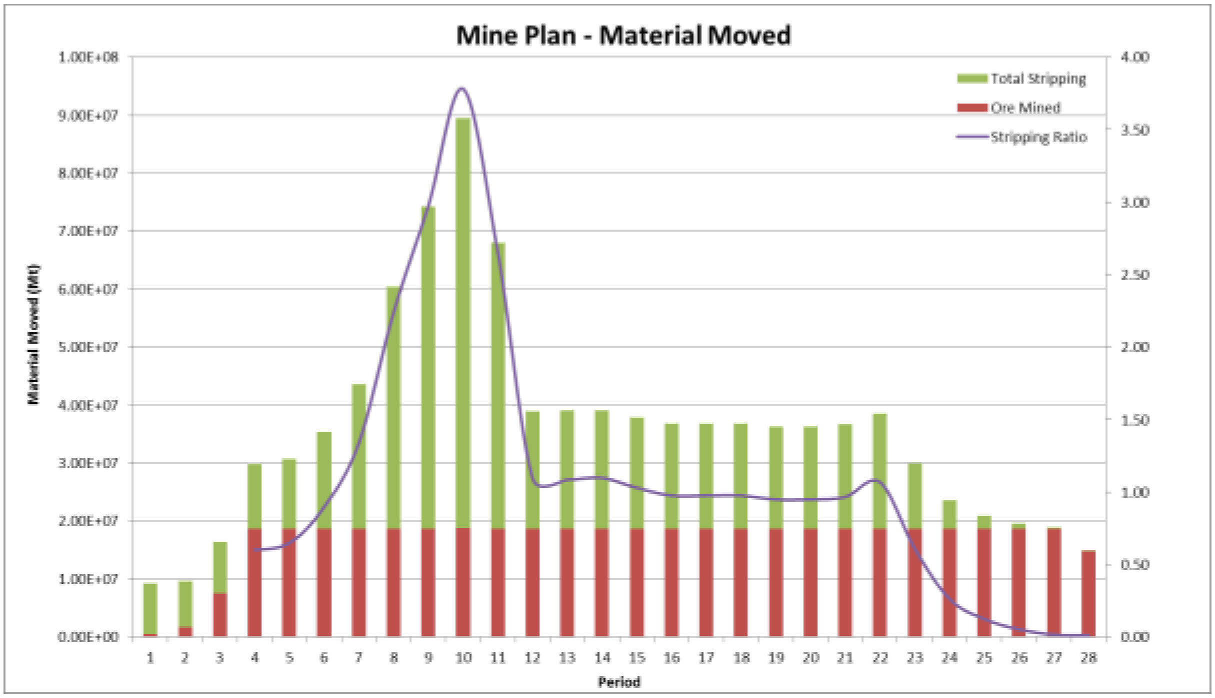


Figure 16.2.1 Mine Plan Material Moved and SR Trend

Figure 16.2.2 to Figure 16.2.9 show the key end-of-period contours, along with a description.

Period 0 (Pre-production) is designated as the “Pre-Strip” period and spans an 18-month period. (Shown in Figure 16.2.2).

Over the “Pre-Strip” period, 7.81 million tonnes of waste rock are mined, 0.49 million tonnes of ore and 0.90 million tonnes of overburden. (See Figure 16.2.2) Reducing SR in early years helps in avoiding an increased initial capital cost. The 0.49 million tonnes of ROM that is mined in this period represents the amount necessary to fill the ROM stockpile. This initial stripping period allows for temporary ramp access on the north-western edge of the pit, as well as the permanent north-eastern access.

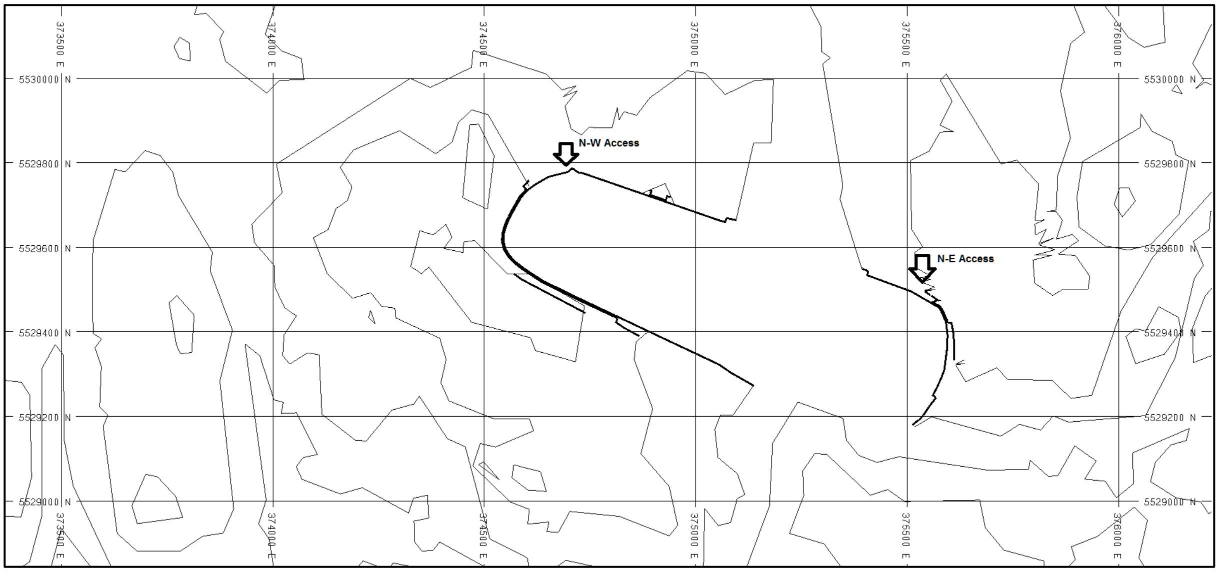


Figure 16.2.2 Pre-Strip End-of-Period (EOP) Map

After the initial pushback of the Pre-strip period, Period 1 continues mining in the smaller Phase 1 region. (See Figure 16.2.3) Taking cuts in this region in Period 1, allows the SR to remain low. The waste rock mined during this period amounts to 6.75 million tonnes approximately, as well as an overburden quantity of 1.23 million tonnes and 1.63 million tonnes of ore. The 1.63 million tonnes ROM represents the 35% production capacity ramp-up. This period still allows for access on both the North-Western and North-Eastern edge of the pit.

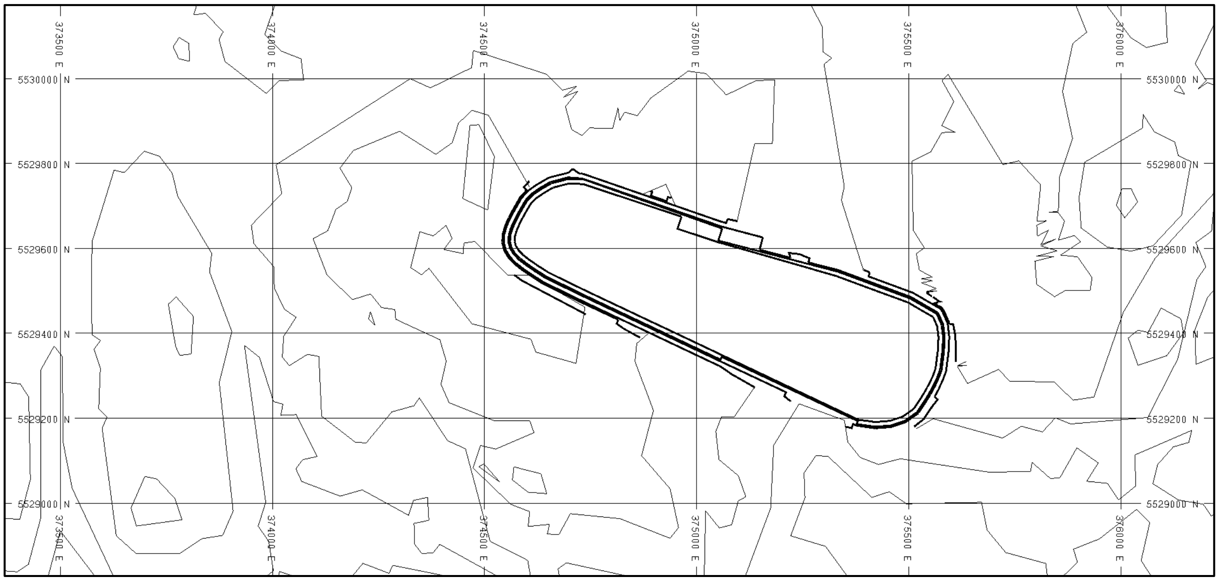


Figure 16.2.3 Period 1 End-of-Period (EOP) Map

Period 2 is shown in Figure 16.2.4. In this period, mining in Phase 1 continues. The waste quantities mined amount to 8.41 million tonnes, the overburden quantity amounts to 0.55 million tonnes and the production tonnage amounts to 7.46 million tonnes. At this time, ramp-up is 80% of the production capacity. Period 2 continues with a low SR.

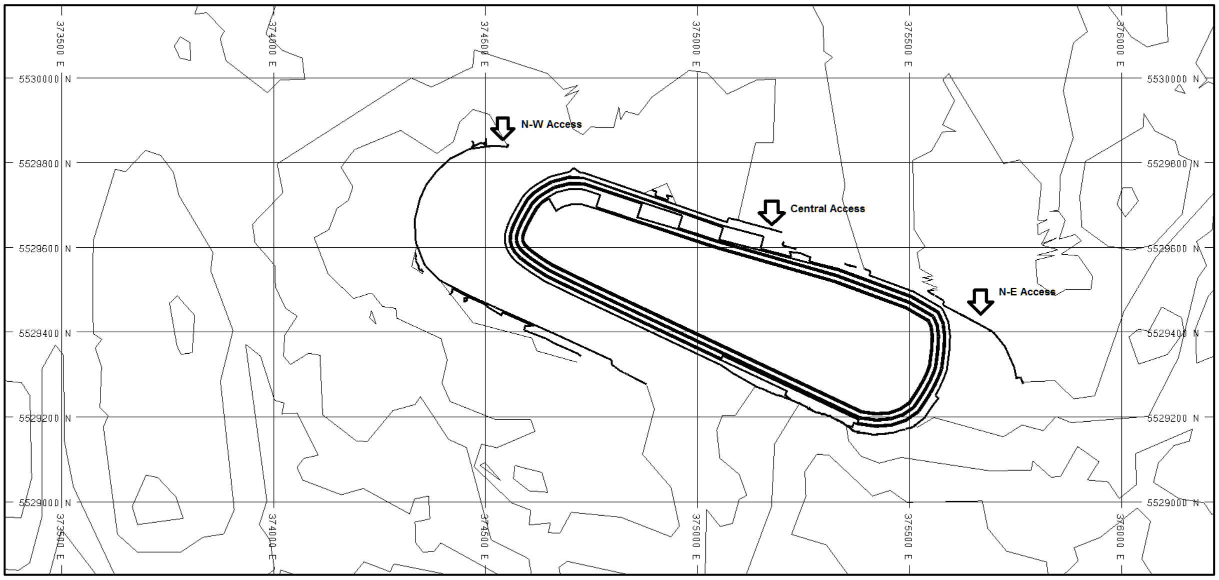


Figure 16.2.4 Period 2 End-of-Period (EOP) Map

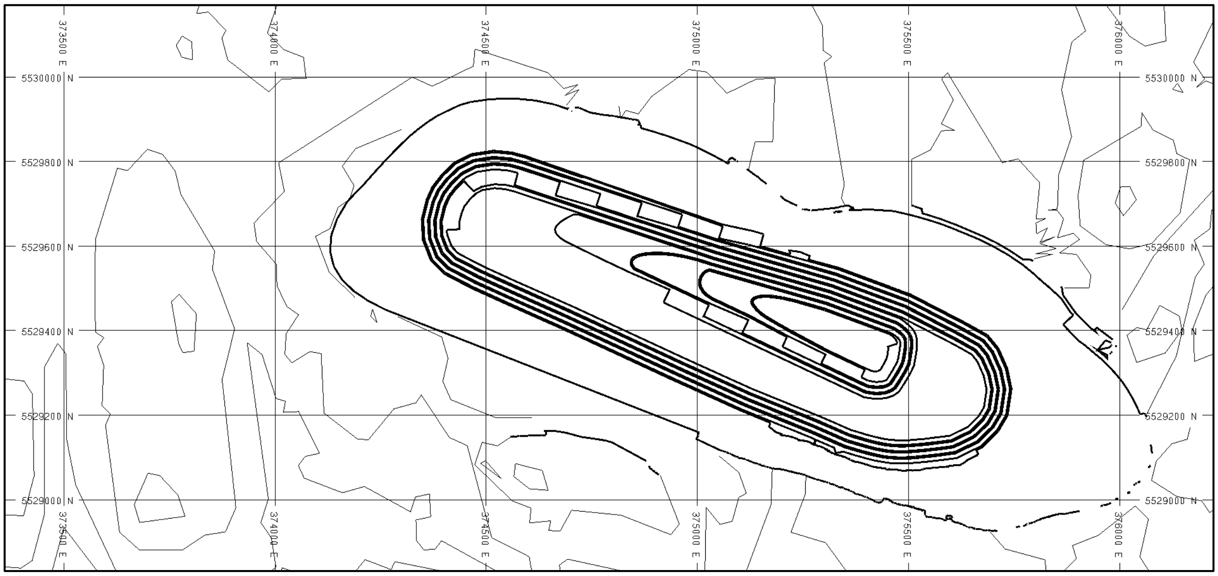


Figure 16.2.5 Period 5 End-of-Period (EOP) Map

Period 5 continues to strip the Phase 2 pit, and starts opening up the Phase 3 pushback (shown in Figure 16.2.5). In Period 5, the SRs start to climb towards the ultimate peak. 16.74 million tonnes of waste rock and 18.65 million tonnes of ore are mined in Period 5. The interruption of overburden stripping during this phase reflects that no additional stripping is required on the surface since the Pre-strip period was complete.

In Period 7 (Figure 16.2.6) the major pushback occurs from Phase 3 to Phase 4. This is shown by the western portions of the pit widening to a larger projected surface area. The stripping is evident when observing the waste rock and overburden tonnages being mined. In Period 7, 38.75 million tonnes of waste rock, 3.06 million tonnes of overburden, and 18.65 million tonnes of ROM are mined. At this time, an SR of 2.24 (waste (t): ore (t)) is observed.

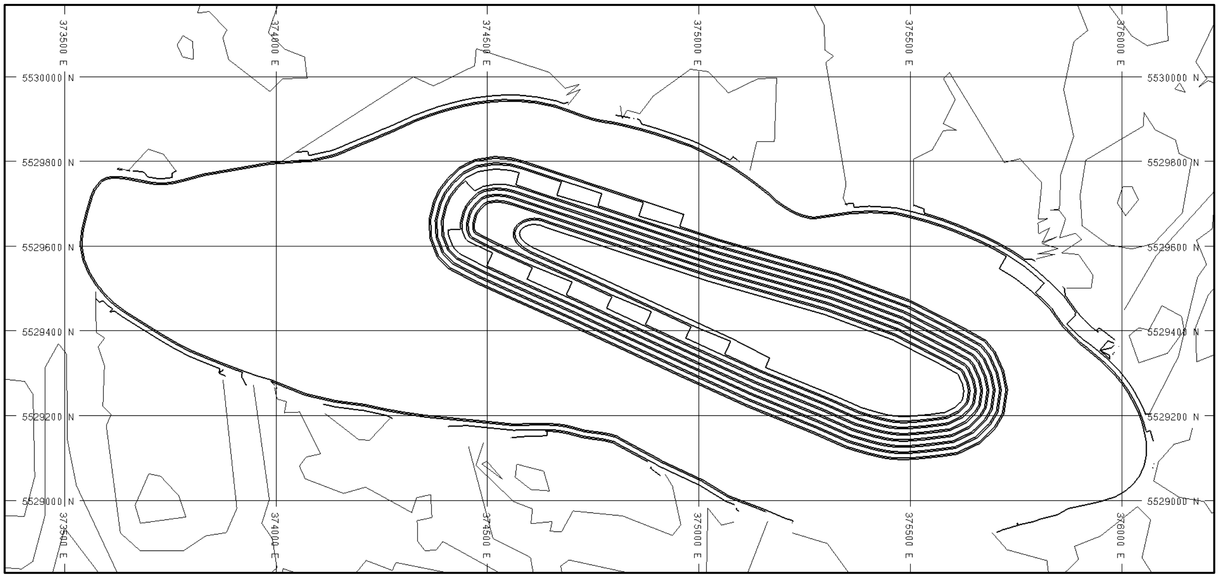


Figure 16.2.6 Period 7 End-of-Period (EOP) Map

Periods 8, 9 and 10 continue to mine Phase 2 in completion, mine deeper in Phase 3, and continue small amounts of surface stripping from Phase 4 (i.e. the final designed pit). The peak amount of stripping occurs in Period 9, where the SR is 3.78.

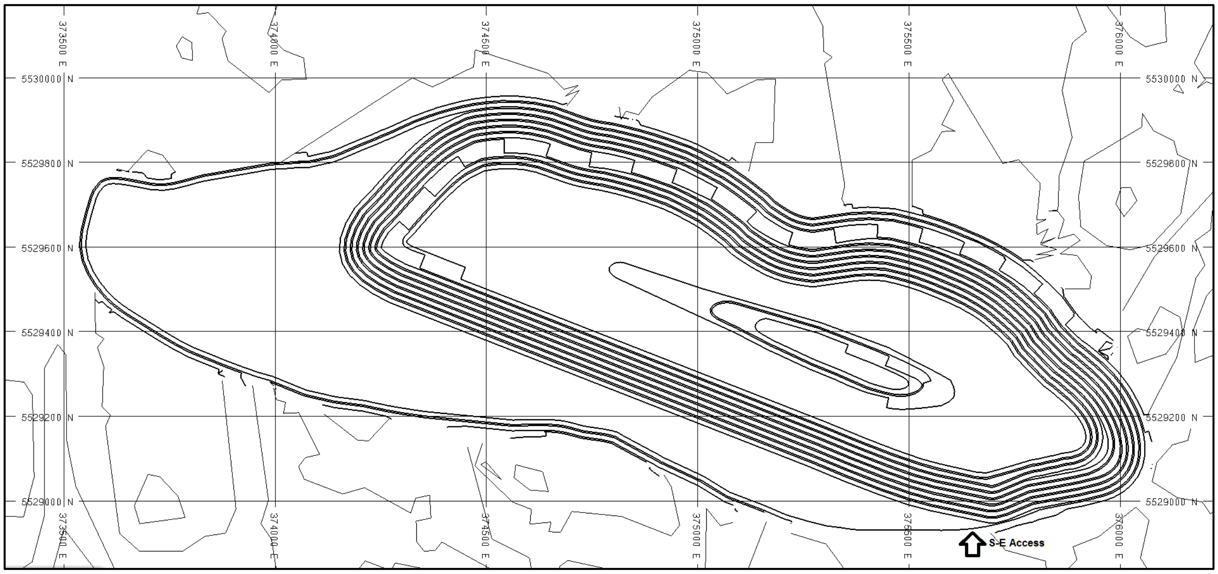


Figure 16.2.7 Period 11 End-of-Period (EOP) Map

Period 11 shows the final projected surface area of the pit, as in Period 7; however, many more benches of Phase 3 are mined. (As seen here in Figure 16.2.7). The final ramp provides the main access to the Period 11 pit; however, a new temporary access is formed in the south-eastern corner of the pit. In Period 11, there is no more overburden to be mined. 20.36 million tonnes of waste rock is mined, and 18.65 million tonnes of ROM is mined.

Periods 12 to 18 continue to mine Phase 3 as the inner pit and Phase 4 to its extents. The main access is always the final ramp exit on the North-Eastern side, with a temporary ramp access in the South-Eastern edge of the pit.

Period 19 shows that the pit is nearing completion, with one final ramp (and ramp access) coming down through the North Wall. (Figure 16.2.8) In Period 19, 17.70 million tonnes of waste rock is mined along with 18.65 million tonnes of ROM. At this point in the LOM, the SRs are steadily declining.

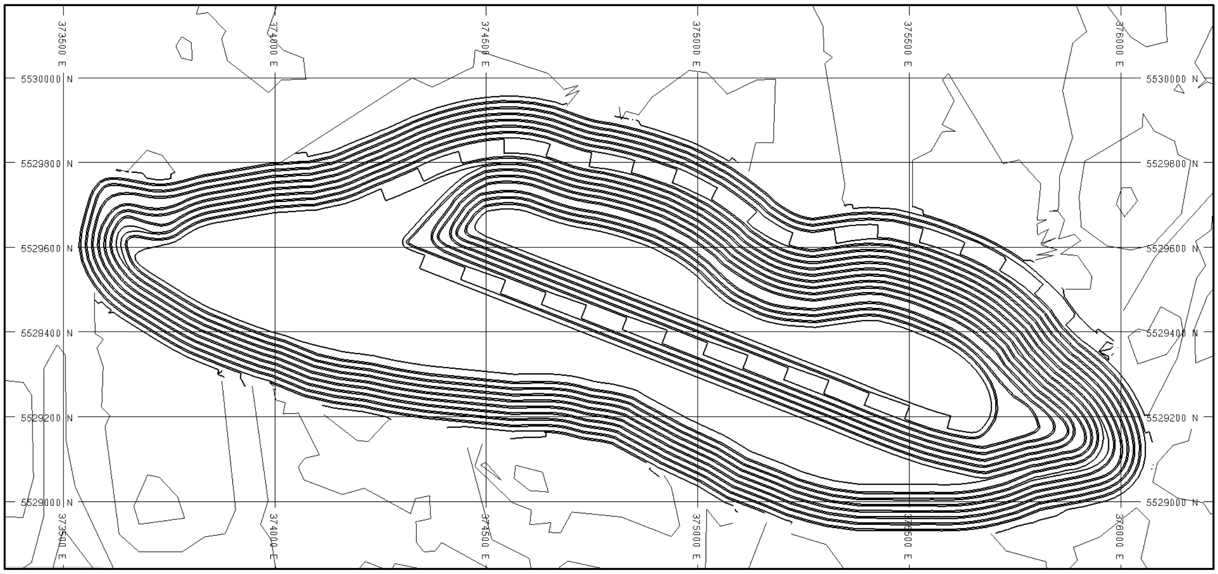


Figure 16.2.8 Period 19 End-of-Period (EOP) Map

The mine reaches completion in Period 27, shown below in Figure 16.2.9. In Period 27 only 0.16 million tonnes of waste rock is mined along with the remaining 14.85 million tonnes ROM. In this period, the initial stockpile is reclaimed and added to the milled quantities.

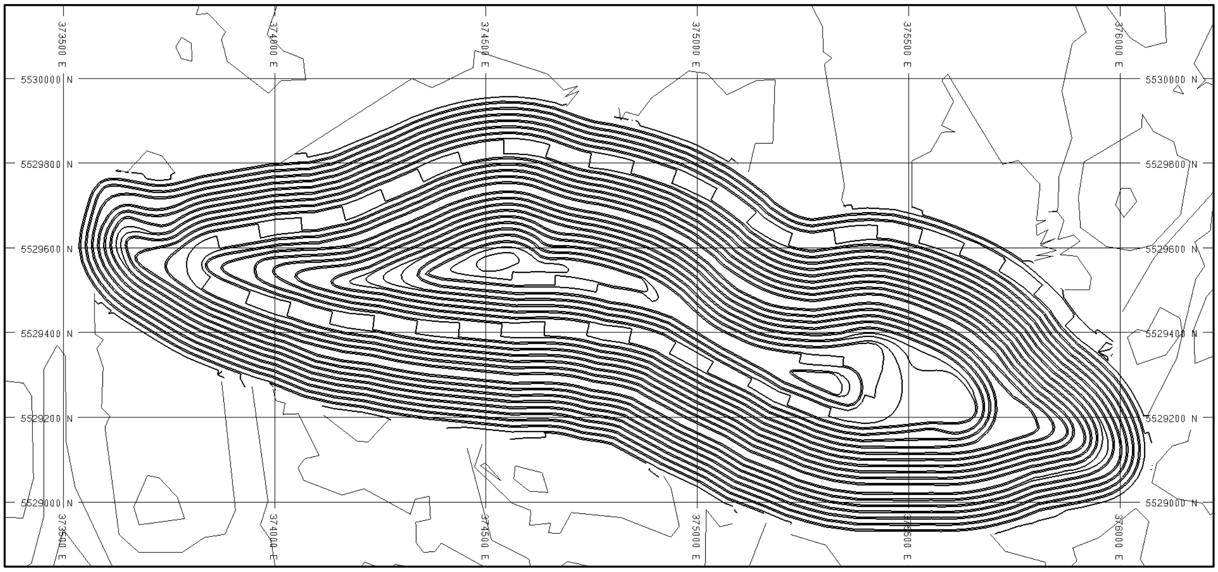


Figure 16.2.9 Period 27 End-of-Period (EOP) Map

16.3 Waste Rock Pile Design

The Waste Rock Pile was designed based on recommendations provided by Genivar. The design parameters used by WP are shown in Table 16.3.1.

Design Parameters	
BFA (Degrees)	34
IRA (Degrees)	27
Bench Height (m)	10
Ramp (m)	30
Ramp Grade (%)	10
Maximum Elevation (z=m)	520

Table 16.3.1 Waste Rock Pile Design Parameters

These parameters could on occasion be different than the ones recommended by Genivar; differences are associated to variations in the use of safety factors and the fact that parameters were adjusted based on the mine plan established by WP. The material characteristics used for the calculations of the waste rock pile include the density of rock types, as well as the associated swell factors. An average in-situ (in-ground) density of 3.0t/m^3 was calculated by CWP for the waste rock, and an in-situ (in-ground) density of 2.0t/m^3 was used for the overburden material. Also specified by Genivar were the swell factor and the re-compaction (settling) to be used for the waste rock. A swell of 35% with a re-compaction of 10% was suggested. Thus, a total swell after re-compaction of 25% was used.

The waste rock pile has been designed with enough capacity to satisfy the amount of in-situ waste rock coming from the pit. The total capacity of the waste rock pile is a final design for 527.3 Mt and 236.7 Mm^3, including a swell factor of 25%. An excess amount has been applied as a contingency to the waste rock amounts.

The overburden (OB) piles use different design parameters than the Waste Rock Pile. In addition, each pile is designed slightly differently due to their location and the change of elevation around the pile. The overburden design parameters are shown in Table 16.3.2.

Design Parameters Overburden Piles			
	OB Pile 1	OB Pile 2	OB Pile 3
BFA (Degrees)	22	22	22
Bench Height (m)	20	20	20
Number of Lifts	1	2	2
Ramp (m)	30	30	30
Ramp Grade (%)	10	10	10
Maximum Elevation (z=m)	455	490	480

Table 16.3.2 Overburden Pile Parameters

The cumulative capacity of the overburden piles amounts to 5.9 Mm^3, which also applies a contingency to the total amount.

The Waste Rock Pile is located to the north of the pit. There are two accesses that have been designated: one to the western half of the pile, and one to the eastern half. This is done as a measure to optimize the haul distances to the waste rock pile in the early years.

The overburden is spread among three smaller piles: one just south of the pit, one on the northern wall of the pit, and the third in close proximity to the western extents of the Waste Rock Pile (See Figure 16.3.1); refer to Figures 18.2.1 to 18.2.3 in section 18.2.4 for other details.

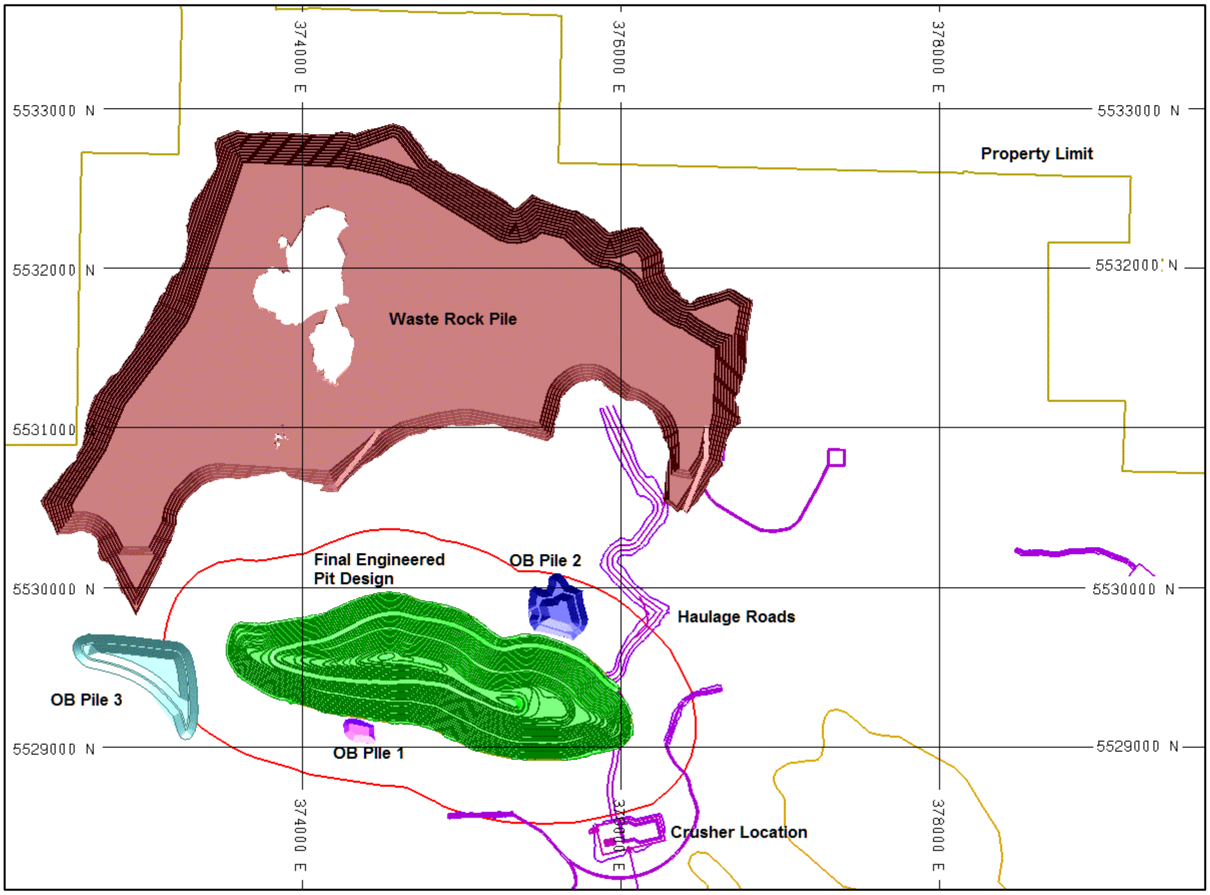


Figure 16.3.1 Waste Rock and Overburden Piles

All of the rock piles are positioned strategically, in order to avoid potential future expansion areas (i.e. potential mineralization areas).

In addition, a study compiled by the "Unité de Recherche et de Service en Technologie Minérale (URSTM)" (Research and Service Unit in Mineral Technology) in their Report "Évaluation du comportement géochimique des résidus de concentrateur, du minerai et des stériles du projet Lac à Paul" determined that the waste rock has been classified as "non-reactive" from the standpoint of acid generating. Therefore, no provisions need to be taken to divide the various rock types within the pile.

16.4 Haulage Road Design

In the pit designs allowances have been made for 30m wide roads including ditches and berms. Roads will have a maximum gradient of 10%.

Surface haulage roads will connect the pit ramps to the crusher, low grade stockpile, and waste dumps. These roads will be constructed using overburden and non-acid generating waste rock when available. As in the pit, roads will have a running width equal to twice that of the largest haulage truck with allowances for ditches and berms. Roads will have a maximum grade of 10%, but lesser gradients may be incorporated to improve haulage cycle times and reduce truck component wear.

16.5 Mine Equipment and Operation

The mine will operate conventional rotary drills, electric-hydraulic shovels, end dump trucks and a fleet of support equipment to maintain roads, dumps and stockpiles. The equipment fleet will incorporate large units which have been well-proven in existing operations.

16.5.1 Operating Time Calculations

The Net Productive Operating Hours (NPOH), required on a per shift basis, have been determined for the major pieces of equipment and their operators (i.e. haul trucks, shovels, loaders) (Table 16.5.1). The NPOH calculated for the drills is separate from that of the workers and other major pieces (Table 16.5.2).

Both NPOHs are used to calculate the exact operating shifts, operating machinery as well as operators that will be required annually over the LOM. The NPOH accounts for the scheduled and unscheduled delays, on a per shift basis. The scheduled delays include shift changes, fueling, inspections, coffee breaks and lunch. The unscheduled delays are taken into account in the Job Efficiency Factor (JEF). The JEF differs for the workers/major equipment and the drill; the drill will have comparatively less efficiency due to additional moving and spotting time. The JEF is a factor that is represented by the ratio of the number of minutes remaining in one hour after unscheduled delays have been taken into account. The calculated NPOH for the workers/major equipment is 9.5 hours/shift, and for the drill it is 8.06 hours/shift.

Worker and Equipment Shift Operating Time	
Category	***Time/Shift (min)***
Scheduled Time Per Shift	720
Scheduled Delays	
Shift Change	15
Inspection and Fueling	15
Coffee Break	15
Lunch	30
Net Scheduled Productive Time	645
Job Efficiency Factor* (Post Scheduled Breaks)	88.4%
Time Lost to Job Efficiency	75
Total Delays per Shift	150
Net Productive Operating Time/shift	570
Net Productive Operating Hours/shift	9.5

Table 16.5.1 Major Equipment Operating Parameters

Drilling Shift Operating Times	
Category	***Time/Shift (min)***
Scheduled Time Per Shift	720
Scheduled Delays	
Shift Change	15
Inspection and fueling	15
Coffee Break	15
Lunch	30
Net Scheduled Productive Time	645
Job Efficiency Factor* (Post Scheduled Breaks)	75.0%
Time Lost to Job Efficiency	161.25
Total Delays per Shift	236.25
Net Productive Operating Time/shift	484
Net Productive Operating Hours/shift	8.06

Table 16.5.2 Drill Operating Parameters

16.5.2 Equipment Mechanical Availability and Utilization

The mechanical availability is the percentage representing the equipment downtimes. This may be due to either planned Preventative Maintenance (PM) or due to unforeseen machinery breakdowns. For each major piece of equipment, a mechanical availability percentage has been defined based on Supplier recommendations, company domain expertise, and internal database information. The percentage shown for the mechanical availability is calculated based on the remaining minutes worked over 60-minutes. The utilization (or use of availability) defines how productive the piece of machinery can be, despite the downtimes due to mechanical factors. Table 16.5.3 displays the key percentages over the LOM for the major equipment.

Haul Trucks	Y0	Y1	Y2	Y3	Y4	Y5	Y6-Y26
Mechanical Availability	89%	89%	88%	87%	87%	87%	87%
Utilization	90%	90%	95%	95%	95%	95%	95%
Shovels							
Mechanical Availability	87%	87%	86%	85%	85%	85%	83-84%
Utilization	95%	95%	95%	95%	95%	95%	95%
Drills							
Mechanical Availability	83%	83%	83%	83%	83%	83%	83%
Utilization	98%	98%	98%	98%	98%	98%	98%

Table 16.5.3 Mechanical Availabilities and Utilizations for Major Equipment

16.5.3 Loading Parameters

The primary loading and hauling units that will be used for the pre-production period (i.e. P0, first 18 months) are the Komatsu PC2000- 15.5m^3- bucket diesel hydraulic shovels and the HD785 91-tonne-haul trucks. After the initial pre-production period, it is assumed that the smaller fleet is kept for production support. (i.e. smaller fleet quantities do not increase). The loading assumptions are shown in Table 16.5.4.

Design Parameters Overburden Piles				
Loading Specifications				
Category	Materials			Units
	Ore	Waste	OB	
Bucket Size	15.5	15.5	15.5	**m³**
Fill Factor	93	88	78	**%**
Insitu Bulk Density	3.3	3.0	2.0	**t/m³**
Swell Factor	35	35	35	**%**
Loose Density	2.44	2.22	1.48	**t/m³**
Tonnes per bucket	35.2	30.3	17.9	**Tonnes**
Truck Capacity	91	91	91	**Tonnes**
Time/pass	0.67	0.67	0.67	**Min**
Passes/truck	2.50	3.0	5.0	**Passes**
Truck Loads/Shift	285	285	171	**loads/shift**
Tonnes Per trip	88.1	90.9	89.6	**tonnes/trip**

Table 16.5.4 Loading Parameters for 91t haul trucks with 15.5-m^3 Capacity (CAP) Bucket Shovels

The primary loading and hauling units for the pit for production starting in Period 1 consist of Caterpillar (CAT) 793F - 226t haul trucks and Komatsu PC5500-6 - 28m^3- bucket capacity electric hydraulic shovels moving ore, waste and overburden. The electric shovel is chosen due to inexpensive electrical power available in Québec (It is important to note that the PC2000s and HD785s fleet will remain after pre-production for production support).

The loading assumptions are shown in Table 16.5.5.

Design Parameters Overburden Piles Loading Specifications				
Category	Materials			Units
	Ore	Waste	OB	
Bucket Size	28	28	28	**m³**
Fill Factor	92%	91%	88%	**%**
Insitu Bulk Density	3.30	3.00	2.00	**t/m³**
Swell Factor	35%	35%	35%	**%**
Loose Density	2.44	2.22	1.48	**t/m³**
Tonnes per bucket	63.0	56.6	36.5	**Tonnes**
Truck Capacity	226	226	226	**Tonnes**
Time/pass	0.67	0.67	0.67	**Min**
Passes/truck	3.50	4.00	6.00	**Passes**
Truck Loads/Shift	214	214	143	**loads/shift**
Tonnes Per trip	220.4	226.5	219.0	**tonnes/trip**

Table 16.5.5 Loading Parameters for 226-t haul trucks with 28-m^3 CAP Bucket Shovels

16.5.4 Hauling Parameters

The haulage times and cycle times were calculated based on the strategic yearly mine schedule and the location of different rock types (ore, waste, ob) mined during each year.

The distances were measured manually in MineSight using the yearly mine plans previously prepared. For each year of the mine life, the distances were measured separately for:

- Flat in-pit haul.
- In-pit inclined (ramp) haul.
- Distance from pit exit to pile/crusher location.
- Pile/Crusher inclined (ramp) haul.
- Pile/Crusher flat haul.

For in-pit flat and dump/crusher flat hauls, centroid distances were measured from the access point of each separate year. In-pit inclined (ramp) distances were averaged dependent on the number of benches mined in one year and on the quantities mined from each bench.

Since the Waste Rock Pile has two separate accesses (north-west and north-east), the access within closer proximity to the pit was used for the initial years of the mine life. The shorter haul distances allowed for fleet optimization at the start of the mine life.

The truck speeds were selected based on the truck model (CAT 793F), Supplier-provided data, and truck study results.

The speeds were segmented for flat hauls, slope up and slope down hauls, deceleration and acceleration.

Figure 16.5.1 shows the cycle time trends for the different rock types (ore, waste, ob) over the LOM.

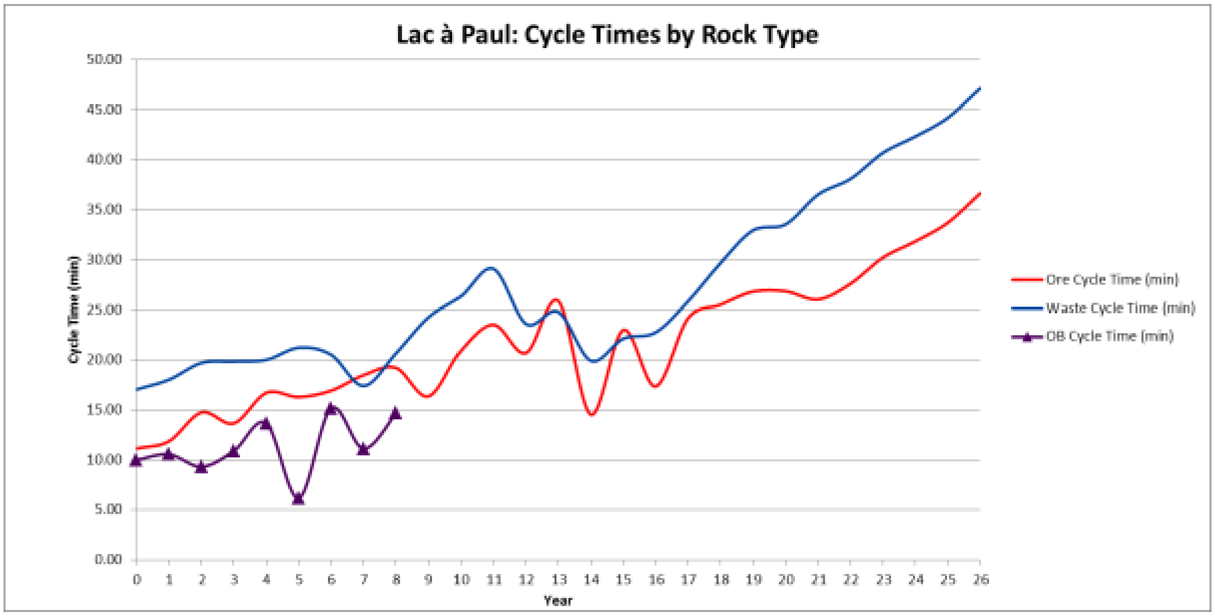


Figure 16.5.1 Cycle Times by Rock Type

16.5.5 Drilling and Blasting

Drilling will be performed on site by the Owner with the aid of a third-party contractor for blasting work. CWP has used its internal database and benchmarking from other projects in the region with the expert input of the contractor for the drill and blast design parameter choices. The drills will be owned and operated by Arianne. The third-party contractor will provide:

- All blasting materials and workers, as well as transportation.
- Construction of two shelters on site.

- Explosives permit.
- Down-the-hole services.
- Operation and Maintenance.
- SHOTplus software.

Drilling will be done on site using primary blasthole drills that will be diesel-powered rotary machines capable of drilling 203.2 mm-diameter holes. Drilling hours for the project are expected to be within the capacity of the three bench drills until Period seven when an additional unit will be purchased. A fourth drill will be acquired in Period seven, and then a fifth drill will be acquired in Period 8. It is expected that cycle times will average approximately 0.40 hours per hole drilled when drilling in ore and in waste (The electric power supply to the site is expected to be robust so the option of using electric powered versions of the selected drills exists).

The blastholes will be drilled 11.0 meters deep (10 meters bench depth plus 1.0 meter sub-drill depth). The 1.0m sub-drill depth will allow for even breakage to the design bench elevation. The drills selected have the capability to drill the required holes in a single pass. Pre-splitting will be practiced and off-vertical holes will be drilled as required.

Blasthole cuttings will be sampled and assayed for grade control. In general, overburden will not require blasting.

A 6.0 m x 6.0 m blast pattern has been selected for blasting in ore. The drill pattern in waste will be 7.0 m x 6.0 m. Blast holes will be single-primed and initiated using non-electric methods. The non-electric detonators will provide the in-hole delays and will provide easy deployment. The explosives contractor will deliver bulk explosives (100% emulsion) to the drillhole. The explosives contractor will supply and arrange storage facilities on site.

In general, it is expected that adequate wall control will be achievable using the smaller secondary hydraulic drill to produce102mm angle holes. It is expected that a single row of holes will be tried initially; if results are not satisfactory a modified pattern will be used.

Table 16.5.6 provides a detailed summary of all drilling and blasting design parameters and calculations for the Lac a Paul operations.

Category	Materials		
	Ore	Waste	OB
Dimensions			
Hole Diameter	8.00	8.00	**inches**
Hole Diameter	203.2	203.2	**mm**
Bench Height	10.0	10.0	**m**
Subdrill Length	1.0	1.0	**m**
Stemming Length	2.0	2.0	**m**
Volume/m	0.03	0.03	**m^3/m**
Drill/Blast Pattern			
Hole Spacing	6.0	7.0	**m**
Burden	6.0	6.0	**m**
Material Characteristics and Mass			
Insitu Bulk Density (On average)	3.3	3.0	**t/m^3**
Rock Mass per Blast-hole	1188	1260	**tonnes**
Drill Operation			
Penetration Rate	28	28	**m/hr**
Shift Drill Time	8.1	8.1	**hr**
Meters/Shift	225.8	225.8	**m**
Redrill	5%	5%	**%**
Holes/Shift	19.55	19.55	**holes**
Bulk Emulsion			
Usage	100.0%	100.0%	**%**
Density	1.25	1.25	**gm/cc**
Kg/Hole	364.8	364.8	**kg**
Tonnes/Shift	**23,220**	**24,627**	**tonnes**
Powder Factor	**0.31**	**0.29**	**kg/tonne**

Table 16.5.6 Drilling and Blasting Parameters

16.5.6 Equipment Selection

The loading fleet in Period 1 will consist of one Komatsu PC5500 electric-hydraulic shovel with a second unit commissioned during Period 5 and a third in Period 7. There will also be a LeTourneau L1850 wheel loader available for additional production support that may be required during downtimes, and for stockpile reclamation and management.

The primary haulage trucks used for overburden, ore, and waste will be CAT Model 793F rigid mechanical drive dump trucks. (The Komatsu HD785s will be kept after pre-production, without an increase in numbers, to aid with production).

Drilling will be done on site using primary blasthole drills that will be diesel-powered rotary machines capable of drilling 203.2 mm holes. Characteristics that were considered for the choice of the support fleet, included items such as long lead times, unit capital costs, machine efficiencies and market availability. The support equipment includes wheel and track dozers (in-pit and stockpile work), motor graders, and water and sander trucks.

16.5.7 Auxiliary Equipment

A comprehensive fleet of mobile equipment will be purchased to build and maintain pit and site roads, maintain the mining equipment, and to supervise the operation. The auxiliary equipment is presented in the full fleet listing shown in Table 16.5.8 which is also included in Appendix 3. The auxiliary fleet has lower utility percentages, in general, when compared to the primary or support fleet. Many of the pieces of auxiliary equipment are used for services, maintenance, operations support, Preventative Maintenance (PM), etc.

16.5.8 Long Lead Delivery

Long lead delivery times were provided by the Suppliers for many of the pieces of equipment. These times are shown below in Table 16.5.7. All lead-times that have been provided for this FS are within the range of 25 weeks, which shows positive improvement from the PFS Update. Once firm pricing and more detailed information become available, an update on these lead-times will be possible. At the moment, there are no exceptionally long lead-items that require special attention.

Within the third and fourth quarter of 2013, the updates to the information presented herein will be underway. The lead-times are subject to change without notice. In addition to factory availability, factory preparation is another factor that should be considered within long lead times.

Equipment	Model	Lead time (wks)
Mining Trucks	CAT 793F	25
Hydraulic Shovel	PC5500-6 (ELEC)	30
Production Drill	Atlas Copco FlexiRoc D65	20-30
Wheel Loader	Wheel Loader (L-1850)	30-50
Track Type Dozer	Track Dozer (D10)	25
Wheel Dozer	Wheel Dozer (CAT 844H)	25
Motor Grader	Motor Grader (CAT 16M)	15
Water/Sander Truck	Water/ Sander Truck (777G)	25
Wheel Loader (Reeler)	CAT 980K	10
Skid-steer	CAT 242B3	20
Tow Truck	CAT 789D	25
Utility Excavator	CAT 320E	20
Fuel/ Lube Truck	CAT CT660	20
Service Truck (250 HP 22,000 GVW)	CAT CT 660	20
Tire Handler	CAT Kalmar DCD200-12lb	22

Table 16.5.7 Anticipated Lead Times for Pieces of Equipment

16.5.9 Mining Equipment Fleet

Duration (months)	**18**	**3**	**6**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
Equipment Type	**P 0**	**P 1**	**P 2**	**P 3**	**P 4**	**P 5**	**P 6**	**P 7**	**P 8**	**P 9**	**P 10**	**P 11**	**P 12**	**P 13**	**P 14**	**P 15**	**P 16**	**P 17**	**P 18**	**P 19**	**P 20**	**P 21**	**P 22**	**P 23**	**P 24**	**P 25**	**P 26**	**P 27**
PC2000BH -15.5cubic yards	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
HD785-7 100T Class	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4				
Shovel (PC5500)- Electric		1	1	1	1	2	2	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
Wheel Loader (L-1850)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mining Truck (CAT 793)		6	6	6	6	12	12	14	17	19	19	12	12	12	12	12	12	12	12	12	12	12	11	9	9	9	9	9
Blasthole Drill (Atlas Copco FlexiRoc D65)	1	3	3	3	3	3	3	4	5	5	5	3	3	3	3	3	3	3	3	3	3	3	2	2	2	1	1	1
Total Primary Equipment	**7**	**16**	**16**	**16**	**16**	**23**	**23**	**27**	**31**	**33**	**32**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**22**	**22**	**22**	**20**	**18**	**13**	**12**	**12**	**12**
Wheel Dozer (Caterpillar 844H)	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Track Dozer (D10)	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Motor Grader (Caterpillar 16M)	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Water/ Sander Truck (777G)	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
Total Secondary Equipment	**3**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**7**	**7**	**7**	**7**	**7**	**7**	**7**
Hydraulic Crane (P&H truck mounted 100 t)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Air Track Drill (200 HP 80 to 100mm)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Wheel Loader (Reeler) (Caterpillar 980K)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Articulated Dumper (Caterpillar 735)	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Skid-steer (CAT 242B3)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tow Truck (789D)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Utility Excavator (Caterpillar 320E)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fuel/ Lube Truck (CT660)	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Prime Mover For Low Bed	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Service Truck (CT 660) (250 HP 22,000 GVW)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tire Changer (attachment for 99H)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mini Bus (12 passenger Ford E series)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Pick Up Truck (4x4 crew cab Chevrolet 2500)	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2
Pick Up Truck (4x4 single cab Chevrolet 2500)	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2
Light Tower MLT3060K (1000 w. diesel generator	2	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Dewatering Pump (250 HP electric submersible)	2	3	3	3	3	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Tow Low Boy LPM (120-48-20)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tire Handler (Kalmar DCD200-12lb)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Auxiliary Equipment	**16**	**24**	**30**	**30**	**30**	**30**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**29**	**29**
Total Mine Equipment	**26**	**48**	**54**	**54**	**54**	**61**	**64**	**68**	**72**	**74**	**73**	**64**	**64**	**64**	**64**	**64**	**64**	**64**	**64**	**63**	**63**	**62**	**60**	**58**	**53**	**52**	**48**	**48**

Table 16.5.8 Lac a Paul FS Mine Equipment Fleet

16.6 Mine Dewatering

CWP provided incremental 5-year preliminary pit shells to Hydro-Ressources for their hydrogeological study. With these preliminary pit shells (5-year, 10-year, 15-year, 20-year and final pit shell), Hydro-Ressources defined the relative water inflows.

CWP used the information attained from the hydrogeological report entitled “Services Professionnels-etude hydrogéologique les Ressources D’Arianne rapport technique – Dossier PR12-117”, performed by Hydro-Ressources in order to establish design assumptions and costs for the dewatering of the Pit.

A small hydraulic drill will be available for size reduction and for drilling sub-horizontal drain holes for wall slope depressurization. This drill could also be used for pre-split drilling. If necessary, vertical wells will be drilled outside of the pit, for long term pumping and inside of the pit for short term dewatering. The necessity of those wells will be defined during the operation.

A perimeter ditch will be established around the pit area to collect surface water. Sumps will be established in the pit and 250hp (186.5 kW) centrifugal pumps will pump water to the surface water treatment system through a Sclair-type pipe. Submersible pumps will be used as required.

Electric power will be provided in the pit to supply the shovels and pumps. The power sled will have outlets available for 115v, 600v, and 4160v power.

While major water inflows are not expected in the pit it may be necessary to periodically drill sub-horizontal drain holes for the purpose of wall slope depressurization.

The hydrogeological context was analysed and included in the environmental impact assessment. Seven site visits and field investigation work were performed in order to build an appropriate numerical model.

For this hydrogeological analysis, the following steps were taken:

1. Analysis of existing data.
2. Ten (10) slug tests were performed in existing exploration drill holes.
3. Drilling of 26 holes in overburden and six (6) holes in the bedrock.
4. Perform slug tests in all of these new boreholes (26 in overburden and 6 in bedrock).
5. Perform a massive packer test survey in 12 NQ holes.
6. Drilling of a 292 m deep pumping well.
7. Perform a step test and a 5 days long pumping test, followed by recovery measurement.

8. Sampling of water samples in seven (7) observation wells and in the pumping well for chemical purpose.

9. Measurement of surface water runoff.

10. Development of a groundwater flow simulation model with Feflow and Mike She programs.

During the first slug test analysis, a low to medium hydraulic conductivity was determined with values of about 1e-6 m/s. This range shows a conductivity similar to the one generally observed in igneous aquifer of the Saguenay-Lac-Saint-Jean region.

The drilling of several holes in overburden shows a small thickness of overburden, from 1 to 12 m around the Paul pit. Most of the pit region is under an overburden thickness ranging between 1 to 6 m. The hydraulic conductivity of this layer is always around 1e-4 m/s, showing a medium hydraulic conductivity. This value fits perfectly with the type of overburden, mainly composed of a till, which includes sand, silt and traces of fine gravel. The amount of silt varies between 10 to 30%, decreasing the permeability.

Drill holes conducted in rock show a relatively intact rock mass all around the pit and everywhere on the site. No rock type seems to be more fractured than others. Rock quality designation normally varies between 80 to 100% and no significant fault was detected in the core. An exception remains in the borehole PZR-28, located more than 2 km south-east of the pit, where hydraulic conductivity reaches 1e-4 m/min in the subsurface of the rock (0-20 m). For the remaining of the tested holes, the hydraulic remain around 1e-6 m/min.

The pump test conducted in pumping well #1 shows hydraulic conductivity higher than the one derived by slug test and packer test. Values vary from 1e-5 to 2.4e-4 m/min. The flow rate during the long term pump test was 227 l/min and the drawdown generated by this pump test was of about 45 m in the well. The area of influence is significant on a low distance of about 500 to 800 meters around the well (upon direction from the well). Chemical analysis derived from this pump test shows concentration under the limits determined by the Environmental Ministry and suggests that water pumped from the pit will not need any treatment.

With these data, a groundwater flow simulation model was built on Feflow, a finite element computer program. The flow was first calibrated on steady state and several simulations were done in transient state. The model properties were exported to build another numerical model, on Mike She, a finite difference program. Feflow is a very powerful program for groundwater flow but have limited capacities for surface flow simulation. Mike She was used for this purpose and data were compared and fit to get appropriate results.

Several sensitivity analyses were performed in order to assess the variability of different parameters on results. Also, simulation was conducted in both transient and steady state for results comparison.

Both models show very similar results and water infiltration in Feflow is almost the same than infiltration results derived by Mike She program.

Results of simulation allow for dewatering flow rate analysis. Five different stages of the mining plan were simulated, which correspond to 5, 10, 15, 20 and 25 years of operation. Flow rates derived from these simulations are respectively 3.6, 5, 6.8, 9 and 12 m^3/min. These flow rates seem realistic and are considered on the low average side for a pit of this size.

Simulations done using the Mike She program suggest that dewatering will not affect any flow rate of any rivers close to the pit. In fact, connection between surface and groundwater seems poor and flow rates of the actual surrounded rivers are too high to be affected by this dewatering. The proposed connection of the lakes, located north of the Paul's pit, will increase flow rates of the rivers in this area.

16.7 Manpower Requirements

Manpower requirements have been based on the assumption to operate four production crews. For non-production personnel it is recognized that some positions can be staffed five days per week while others require coverage seven days per week by assigning additional duties.

Sickness, vacation, and other absences will be accommodated by use of personnel that is normally assigned to auxiliary equipment.

Manpower requirements vary considerably over the years, mainly because of the variation in numbers of haul trucks.

Manpower requirements are shown in Table 16.7.1:

Duration (months)	**18**	**3**	**6**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
Position	**P 0**	**P 1**	**P 2**	**P 3**	**P 4**	**P 5**	**P 6**	**P 7**	**P 8**	**P 9**	**P 10**	**P 11**	**P 12**	**P 13**	**P 14**	**P 15**	**P 16**	**P 17**	**P 18**	**P 19**	**P 20**	**P 21**	**P 22**	**P 23**	**P 24**	**P 25**	**P 26**	**P 27**
Shovel / Loader Operator	4	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	4	4	4	4	4	4	4	4	4	4
Haul Truck Operator	12	34	34	34	34	52	52	58	70	76	76	54	52	52	52	52	52	52	52	52	50	50	50	44	44	44	44	44
Drill Operator	4	8	8	8	8	12	12	16	16	16	16	12	12	12	12	12	8	8	8	8	8	8	8	8	4	4	4	4
Wheel Dozer Operator	4	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Track Dozer Operator (D10)	0	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Grader Operator	4	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Water Truck Operator/ Snow Plow/ Sanding	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2
Other Auxilliary Equipment (e.g. drill operator assistant)	4	4	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	4	4
General Labour (e.g. cable crew and assistants, etc)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Field Gen Mechanics	4	6	6	6	6	12	12	12	16	16	16	12	12	12	12	12	12	12	12	8	8	8	8	8	8	4	4	4
Field Welder	4	4	4	4	4	8	8	8	8	8	8	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2
Field electrician	4	4	4	4	4	4	4	8	8	8	8	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2
Shovel mechanics	4	8	8	8	8	12	12	16	16	16	16	12	12	12	12	12	12	12	12	8	8	8	8	8	8	8	4	4
Shop Electrician	2	8	8	8	8	8	8	8	8	12	12	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	2	2
Shop Mechanic	4	12	12	12	12	12	16	16	20	20	20	16	16	16	12	12	12	12	16	16	16	16	12	12	12	12	4	4
Mechanic Helper	2	4	4	4	4	4	4	4	8	8	8	8	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2
Welder-machinist	2	2	4	4	4	4	4	4	8	8	8	8	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2
Lube/Service Truck	1	2	2	2	4	4	4	4	8	8	8	8	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2
Electronics Technician	1	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2
Janitor	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hourly Personnel Total	**67**	**139**	**145**	**145**	**147**	**183**	**189**	**207**	**239**	**249**	**249**	**199**	**185**	**185**	**181**	**181**	**177**	**177**	**177**	**169**	**167**	**165**	**159**	**153**	**149**	**139**	**113**	**113**
Mine Superintendant	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
General Mine Foreman	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Mine Shift Foreman	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Drill & Blast Foreman	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Dispatcher	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
Training Foreman	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Production Mine Clerk/ Secretary	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maintenance Superintendant	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maintenance General Foreman	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maintenance Planner	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Project Engineer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maintenance Foreman	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Maintenance Trainer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maintenance Clerk	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chief Engineer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Senior Mine Planning Engineer	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Open Pit Engineer	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
Geotechnical Engineer	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mining Engineering technician	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mine Surveyor	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Chief Geologist	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Geologist (Covers Grade Control)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Geology Technician	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sampler	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Salaried Personnel Total	**25**	**27**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**28**	**28**
Total Personnel	**92**	**166**	**176**	**176**	**178**	**214**	**220**	**238**	**270**	**280**	**280**	**230**	**216**	**216**	**212**	**212**	**208**	**208**	**208**	**200**	**198**	**196**	**190**	**184**	**180**	**170**	**141**	**141**

Table 16.7.1 Lac a Paul FS Mine Personnel List

17. RECOVERY METHODS

Process flowsheets and plant layouts were prepared for a milling rate of 55,000 tpd of ROM ore. The following section summarizes the process developed for the project, detailed information may be found in the Feasibility Study Report.

The phosphate ore beneficiation activities are located at the Lac a Paul site and include crushing, grinding, flotation, filtration and drying of the concentrate. The phosphate rock concentrate is then transported from the site by trucks.

17.1 Processing Plant Design Basis

The processing plant is scheduled to operate three hundred sixty five (365) days per year, seven (7) days per week and twenty four (24) hours per day less an allowance for regular scheduled planned maintenance activities. The crusher plant will have an overall availability of 70% and the milling and downstream plants will have an overall availability of 93% (339 days of effective mill operation). Regular planned maintenance shutdowns are included in the overall availability factor for the plant.

The crushing plant is scheduled to operate on average eighteen (18) hours per day at an average hourly rate of 3,041 t/h. The milling plant will be fed from a 50,000 tonne dome storage silo.

The Feasibility Study is based on run-of-mine from the mine pits with weighted average P_2O_5 content of 6.88%. The process plant is designed for a nominal milling capacity of 55,000 tpd for a phosphate rock concentrate average production rate of 3 million tonnes per year at a grade of 38.6% P_2O_5 and P_2O_5 recovery of 90%. The nominal SAG mill capacity is 2,289ph, the turndown capacity is 1,245tph based on one ball mill being removed from service along with a flotation train. The maximum SAG Mill capacity is 2,726tph. The plant capacity is also dependant on the type of ore being processed from the mine, with a change in ore density impacting the throughput and grind size.

A summary of design criteria is presented in Table 17.1.1.

Parameter	Unit	Value
Ore nominal processing rate	metric tonne / year (tpy)	18,648,025
	metric tonne / day (tpd)	55,000
Concentrate Average Production Rate	metric tonne / year (tpy)	3,000,000
Average head grade (Weighted) (ore)	% P_2O_5	6.88
Crushing Plant Overall Availability	%	70
Crusher nominal feed rate (Dry basis)	metric tonne / hour (tph)	3,041
Crushed ore Silo capacity	metric tonne (t)	50,000
ROM stockpile capacity (total)	metric tonne (t)	500,000

Parameter	Unit	Value
Overall Benefication plant availability	%	93
Processing plant nominal feed rate (Dry basis)	metric tonne / hour (tph)	2,726
Concentrate nominal production rate	metric tonne / day (tpd)	8,740
Overall Concentrate Weight Recovery	%	16.04
Concentrate storage capacity – Mine Site	metric tonne (t)	200,000
Final P_2O_5 product moisture	%	1±0.5
Concentrate Recovery	%	90
Concentrate Grade	% P_2O_5	38.6

Table 17.1.1 Basis of Design-Summary

Table 17.1.2 summarises the phosphate rock concentrate annual production rate for the life of mine.

Year	Period	Run Of Mine (tpy)	Run Of Mine P_2O_5 Grade	Mine Plan P_2O_5 Weight Recovery	Concentrate Production (tpy)
0	0	494,700 [1]	8.04	18.75	Pre start up
1	1 [2]	1,631,438	7.78	18.13	295,804
1	2[2]	7,458,000	6.96	16.22	1,209,604
2	3	18,648,211	7.09	16.52	3,081,058
3	4	18,648,211	7.03	16.38	3,055,218
4	5	18,648,211	7.12	16.59	3,094,274
5	6	18,648,211	6.40	14.91	2,780,591
6	7	18,648,211	6.68	15.57	2,904,236
7	8	18,648,211	7.22	16.83	3,139,379
8	9	18,725,422	6.68	15.58	2,917,295
9	10	18,648,211	6.05	14.12	2,632,485
10	11	18,648,211	6.68	15.58	2,905,415
11	12	18,715,777	6.66	15.54	2,907,875
12	13	18,604,745	7.29	16.99	3,161,116
13	14	18,648,131	7.46	17.40	3,245,122
14	15	18,648,211	6.66	15.53	2,895,380
15	16	18,648,211	6.32	14.73	2,747,133
16	17	18,648,211	6.83	15.92	2,968,358
17	18	18,648,211	6.79	15.82	2,950,209
18	19	18,648,211	7.39	17.23	3,213,950
19	20	18,648,211	7.09	16.54	3,084,619
20	21	18,648,211	6.32	14.73	2,747,511
21	22	18,648,211	6.13	14.28	2,663,648
22	23	18,648,211	6.58	15.34	2,860,089
23	24	18,648,211	6.75	15.73	2,934,113
24	25	18,648,211	7.29	17.01	3,171,229
25	26	18,648,211	7.75	18.07	3,369,696
26	27	15,343,144	7.73	18.02	2,764,401

Note:

1. *This mass of ore is material recovered as part of the mine pre stripping and development.*
2. *Year 1 periods' 1 and 2 are the operational commissioning and production ramp up phases of the project*

Table 17.1.2 Phosphate Rock Concentrate Production - Summary

17.2 Flow Sheets and Process Description

17.2.1 Simplified Flow Sheet

A simplified block flow sheet is presented in Figure 17.2.1 and can also be found in Appendix 4. It summarizes the phosphate rock beneficiation process as adopted for the Lac a Paul project. The mechanical equipment list was created based on the flowsheet diagrams and the equipment sized based on the mass balance.

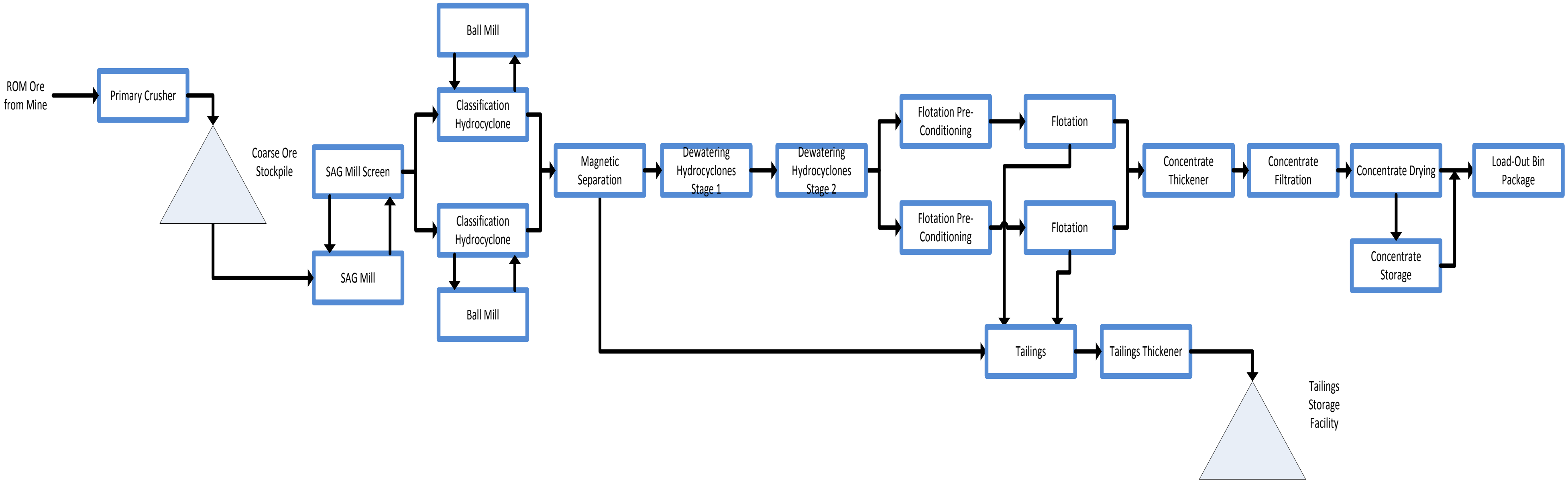


Figure 17.2.1 Simplified Flowsheet for Phosphate Concentration

17.2.2 Process Description

The run of mine (ROM) ore will be transported by 226 tonne mine haul trucks and discharged into a gyratory crusher dump hopper located within the perimeter of the mine pit. The crusher is driven by a 615 kW motor. The ore will be crushed at a nominal rate of 3,041tph. Any oversize ROM ore will be broken in the crusher dump pocket using a hydraulic long boom rock breaker. The ROM ore is crushed to a particle size having a P_{80} of 150 mm and discharged onto the short takeaway conveyor belt. The ROM ore is stored on a 1,000 tonne surge pile from where it is fed onto the main overland conveyor that feed the coarse ore storage dome silo located at the beneficiation plant.

The crusher product is stored in a 50,000 tonne monolithic dome silo that feeds the two stage grinding circuit.

The coarse ore from the coarse ore dome silo is reclaimed using three (3) apron feeders and discharged onto the SAG mill feed belt conveyor to feed the primary grinding circuit at 2,289tph nominal fresh feed. The primary grinding circuit is composed of a single SAG mill. The 15,000 kW SAG mill operates in a closed circuit with a single (1) double deck vibrating pebble screen. The pebble recycle circuit is designed to handle 20% of the SAG mill fresh feed as recycle material. The SAG mill feed rate is controlled with a belt scale operating in conjunction with the variable speed coarse ore dome silo reclaim apron feeders.

The secondary grinding circuit consists of two 11,000 kW grate discharge Ball Mills operating in parallel in closed circuit with two clusters of classification hydrocyclones. The slurry in the mill discharge pump hopper will be diluted to attain a desired slurry density prior to being pumped to the classification hydrocyclones. The ball mills are designed with a recirculating load of 200%.

The product from both of the Ball Mills combine with the SAG Mill screen undersize and is then pumped to two sets of classification hydrocyclones. The classification cyclone underflow from each of the clusters is returned to the ball mills. The grind in the ball mills will be monitored by means of an on stream particle size analyser sampling the classification hydrocyclone over flow streams from both of the hydrocyclone clusters. The onstream analyser data will feed back to the central control room with respect to key particle sizes.

The hydrocyclone overflow material gravity flows to a central slurry distributor that feed the LIMS circuit. The LIMS circuit is designed to recover magnetite from the slurry prior to the phosphate flotation circuit. The non-magnetic material from the LIMS circuit is pumped to the dewatering hydrocylones to remove water prior to flotation. The magnetic material recovered in the LIMS circuit is pumped to the combined process tailings pump box.

Dewatering is carried out using two stages of hydrocyclones, each stage containing one cluster of dewatering hydrocyclones. The overflow from the second stage dewatering hydrocyclones will be directed into the process water reservoir.

The dewatered slurry is then collected in a large, flat bottomed agitated tank which acts as a buffer volume to ensure the pumped flowrate to the flotation circuit is kept constant. The feed to the flotation slurry conditioning circuit is pumped from the dewatering hydrocyclone underflow storage tank. The slurry conditioning consists of three agitated tanks in series.

Reagents are added stage wise and allowed to mix with the slurry. Reagent addition is carried out in the conditioning stages of the process ahead of the rougher flotation circuit. The slurry is required to contain more than 50% solids by weight which is known to improve flotation efficiency. The conditioning of the flotation feed is crucial so as to have the reagents properly mixed and attached to the slurry particles by the time the slurry is diluted and fed to the rougher flotation circuit. The design for the Lac a Paul Project is a conditioner circuit operating at >50% solids by weight with high speed mixers in unbaffled tanks.

Sodium silicate is added in tank 1 to aid in the depression of silicate materials in the slurry. Causticised starch and sodium hydroxide are added to tank 2. The starch is added to aid in the depression of the residual iron left in the slurry after the LIMS circuit. The sodium hydroxide is added to modify the pH to 9.5 as defined in the pilot plant testwork. The phosphate collector (saponified fatty acid) is added in conditioner tank 3. The conditioned slurry overflows the tank and is then diluted in the rougher flotation distributor box.

The introduction of sulphuric acid to the feed to the first cleaner was brought about due to the need to more effectively depress the micas in the slurry. This was achieved using pH modification.

The Lac a Paul Project has selected (based on pilot plant testwork) to make use of column flotation cells for all stages of flotation. The use of column cells instead of mechanical cells is due to the presence of minus 20 micron fines in the slurry. Pilot plant testwork also demonstrated that better grades and P_2O_5 recoveries are achievable using flotation columns instead of mechanical cells. The flotation feed has not been deslimed as this was deemed uneconomical due to phosphate unit losses to the slimes fraction. Column cells also have the added benefit of froth washing which helps to dislodge fine gangue material entrained in the P_2O_5 rich froth.

The flotation circuit is composed of two (2) trains, each train containing the following:

- Three (3) high density pre-conditioning tanks to reagentize the slurry at >50% solids (w/w) prior to flotation (47 m³ (2 mins residence time), 118 m³ (5 mins residence time) and 118 m³ (5 mins residence time) respectively).
- Four (4) rougher flotation column cells (12m (H) x 4.88m (D) each).
- One (1) clean-scavenger feed conditioning tank (19 m³).
- Four (4) cleaner-scavenger flotation column cells (12m (H) x 3.67m (D) each).
- Two (2) first cleaner feed conditioning tanks (118 m³ each).

- Four (4) first cleaner flotation column cells (10m (H) x 4.88m (D) each).
- Two (2) second cleaner feed conditioning tanks (118 m^3 each).
- Four (4) second cleaner flotation column cells (10m (H) x 4.88m (D) each).

The rougher columns recover as much phosphate as possible to the concentrate. The first cleaner tails are recycled to the cleaner-scavenger columns to recover phosphate lost from the first cleaner columns. Tails from the rougher, cleaner-scavenger and second cleaner columns is sent to the combined plant tailings pump hopper for feeding to the plant tailings thickener. Concentrate from the rougher and cleaner-scavenger columns is fed to the cleaner 1 and 2 circuits to increase the phosphate rock concentrate grade to the required level.

The concentrate from the first cleaner is pumped to the second cleaner circuit. The second cleaners concentrate is the final product and is pumped to the concentrate thickening and filtration circuit.

The flotation concentrate is pumped to the concentrate high rate thickener (22 m diameter) which has a unit loading area of 0.030 m^2/tpd. The thickener overflow is directed to the process water reservoir for recycling to the processing plant. The underflow is thickened to 65% solids by weight and pumped to the two filter feed storage tanks.

The flotation tailings from the two trains are combined with LIMS magnetic separation tailings and pumped to a single high rate tailings thickener (38 m diameter) which has a unit loading area of 0.025 m^2/tpd. The tailings thickener underflow at 70% solids by weight is pumped to an intermediate tank from where the thickened slurry is pumped via a four in series pump train to the tailings storage facility.

The phosphate rock concentrate thickener underflow at 65% solids by weight is pumped to two (2) agitated storage tanks. The storage tanks feed two (2) filtration packages installed in parallel. Each filtration package contains two (2) parallel plate and frame pressure filters which dewater the concentrate to a moisture content of 8%. The filtrate is pumped back to the concentrate thickener for recovery of any P_2O_5 solids and recycle of process water. The filter cake is conveyed to an electric heated flash dryer to further dry the concentrate to 1±0.5%.

The dried concentrate coming out of the flash dryer is then conveyed on a series of belt conveyors, directly to the concentrate load-out facility which contains two (2) dome silos (200,000 t total capacity). The load out facility can load up to two trailer trucks simultaneously at a rate of 800 tonnes per hour per lane. The loading of the concentrate transport is achieved using air slides and travelling loading heads. All transfer points in this area are equipped with dust collectors to recover lost material.

The phosphate rock concentrate is trucked from the mine site to Saint-Fulgence on the north shore of the Saguenay River in 120 tonne truck trailers.

17.2.3 Reagents

There are six (6) reagents used in the phosphate flotation process including one flocculent used for thickening:

The reagents used for phosphate flotation to produce apatite concentrate are:

- J2, a modified fatty acid as a collector for the phosphate (possibility of a second phosphate collector).
- Sodium silicate, to depress silicates and aluminates.
- Causticized starch, to depress the ilmenite and iron bearing minerals.
- NaOH, to adjust the pH in the flotation circuit.
- Sulphuric acid, to adjust the pH for the cleaner flotation circuit (Mica depression).
- Flocculent, to help sedimentation during concentrate and tailings thickening.

The reagent bulk storage and preparation section will be housed in a heated building to cater for the winter conditions expected on site. Reagents will be delivered to site in bulk tankers and off loaded into five to ten day bulk storage tanks. The daily stock tanks will be prepared using reagents from the bulk storage tanks. They will be prepared so as to have sufficient reagent for a 24 hour shift (except for the flocculant the capacity of the tanks is 12 hour).

Flocculent will be prepared so as to allow the material time to hydrate. The flocculents will be distributed to the two thickeners (concentrate and tailings) using progressive cavity pumps so as not to break down the floc chains in solution. The sulphuric acid will be off loaded using compressed air to evacuate the delivery tankers.

17.2.4 Plant Services

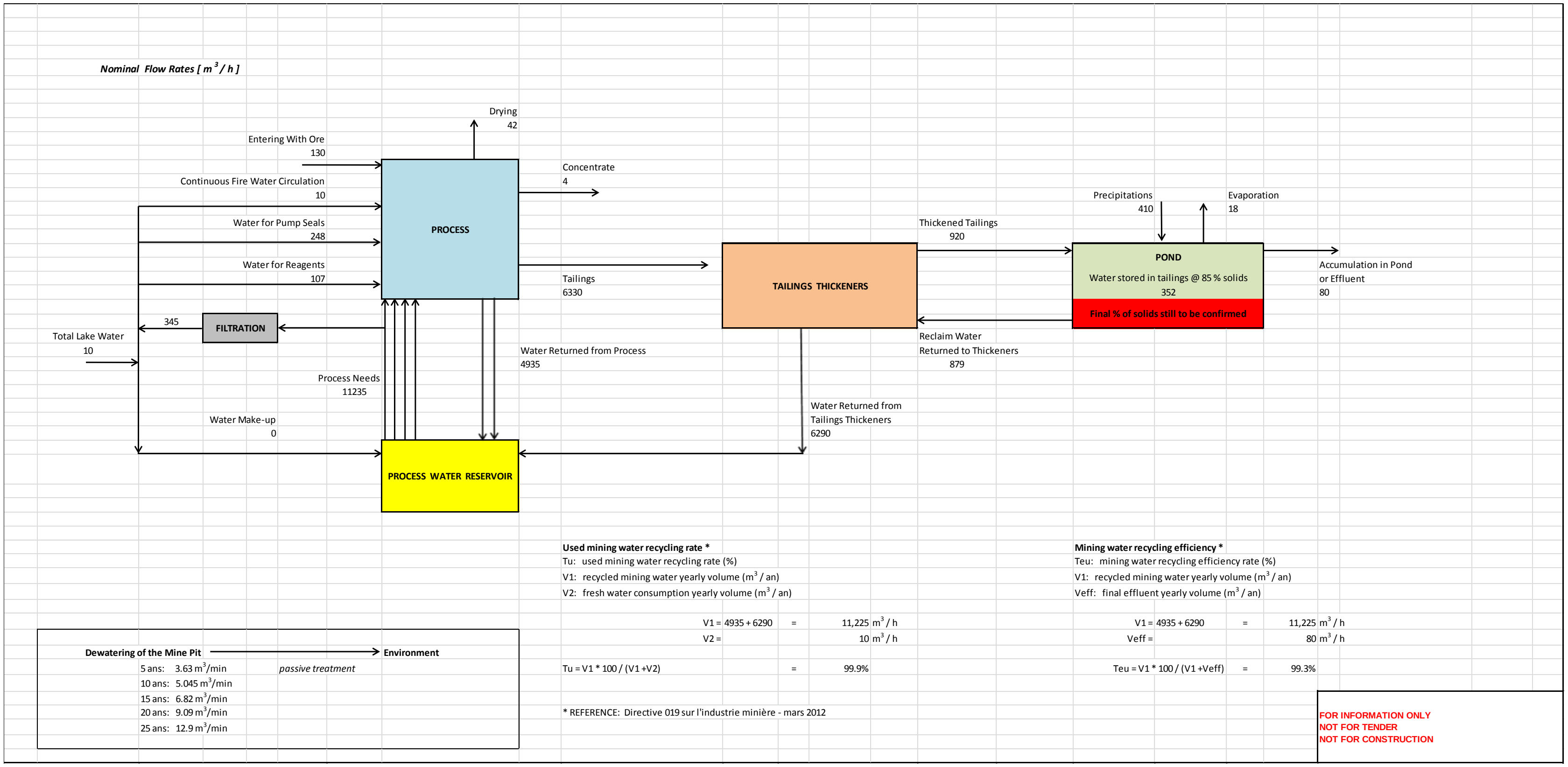
Plant Air, Instrument Air, Process Air (for plant consumption and flotation) and Process Water systems will support the utility requirements for the process plant. Water is recycled wherever possible to reduce the fresh water make-up required from Lac a Paul. The density of the tailings slurry will be such that maximum recovery of water is achieved at the beneficiation plant prior to disposal on the tailings storage facility.

17.2.5 Water Balance

The water balance is presented below in Figure 17.2.2 and in Appendix 5.

Approximately 130 m³/hr of water enters the process as moisture in the ore, while 4 m³/hr leaves with the product (as product moisture). 31 m³/hr leaves as evaporation from the flash dryer and 18 m³/hr exits as evaporation from the tailings pond. Process water is recycled from the concentrate and tailings thickeners and the tailings dam. Wherever water can be recovered, it is recycled back into the process.

The tailings dam retains about 351 m³/hr of the entering water within the tailings mud. Approximately 134 m³/hr of water shall accumulate in the polishing basin or become effluent. Based on the available data, 410 m³/hr of average precipitation is allowed for in the water balance.



Used mining water recycling rate *

Tu: used mining water recycling rate (%)
V1: recycled mining water yearly volume (m^3 / an)
V2: fresh water consumption yearly volume (m^3 / an)

V1 = 4935 + 6290 = 11,225 m^3 / h
V2 = 10 m^3 / h

Tu = V1 * 100 / (V1 +V2) = 99.9%

Mining water recycling efficiency *

Teu: mining water recycling efficiency rate (%)
V1: recycled mining water yearly volume (m^3 / an)
Veff: final effluent yearly volume (m^3 / an)

V1 = 4935 + 6290 = 11,225 m^3 / h
Veff = 80 m^3 / h

Teu = V1 * 100 / (V1 +Veff) = 99.3%

5 ans:	3.63 m^3/min
10 ans:	5.045 m^3/min
15 ans:	6.82 m^3/min
20 ans:	9.09 m^3/min
25 ans:	12.9 m^3/min

* REFERENCE: Directive 019 sur l'industrie minière - mars 2012

Figure 17.2.2 Process Water Balance

17.2.6 Long Lead Items

The estimated lead delivery time for major process plant equipment is presented in Table 17.2.1.

Equipment	Source	Lead Delivery Time (weeks)
Gyratory Crusher	Metso	68
SAG Mill	Metso	70
Ball Mill	Metso	70
Classification Hydrocyclones	FLSmidth	26
Flotation Cells	Eriez Flotation Group	60
Thickener	FLSmidth	52
Filters	Outotec	42
Flash Dryers	GEA Bar Rossin	34 (after design approval)
Magnetic Separator	TBD	68

Table 17.2.1 Long Lead Delivery Time

17.3 Plant Layout

The process plant facilities from crusher to thickener and final product material handling are illustrated in Figure 17.3.1 and in Appendix 6.

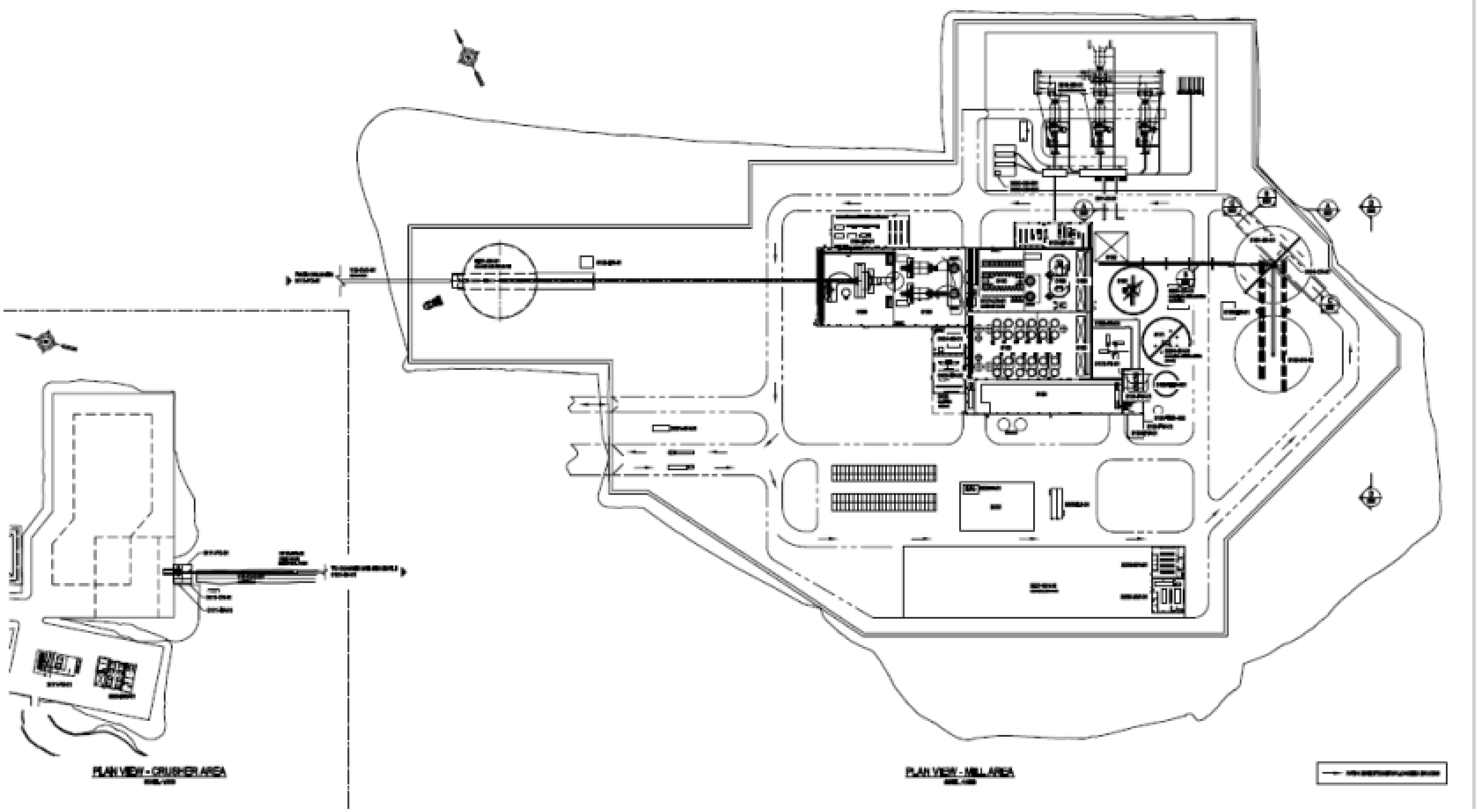


Figure 17.3.1 Plant Layout

18. Project Infrastructure

18.1 Off-Site Infrastructure

18.1.1 161 kV Power Line

The Lac a Paul site will be powered by Hydro-Québec through Rio Tinto Alcan (RTA) electrical network from the Chute-des-Passes power plant. A step-down substation from 345 kV to 161 kV will be constructed at Chute-des-Passes. This new substation will supply the power through a 45 km long, 161 kV transmission line. The substation and the line will be owned by Arianne and the Hydro-Québec metering apparatus will be located at Chute-des Passes. The line will be a Single-Circuit type mounted on wooden structure. The wooden structure will consist of two poles with guy wires and steel crossbars.

18.1.2 Main Access Road

The future Mine Site is easily accessible using the already existing out of norms road called Chemin-des-Passes. The two most commonly used roads to reach Chemin-des-Passes are the one starting from the St-Ludger-de-Milot village, north of Alma city, and the one starting from the St-David-de-Falardeau village, north of Chicoutimi.

The Lac a Paul Mine Site is located at about 175 km (road distance) north of the St-Ludger-de-Milot Village. The Chemin-des-Passes road goes through the forest from the SW region to the NE. This main access road meets class 1 standards for out of norms roads and is being used by other users such as out of norms logging truckers, Hydro-Québec and RioTintoAlcan. The latter two companies have hydroelectric power dams and power lines requiring a continuous presence of operating and maintenance people. Chemin-des-Passes is a 10 m wide gravel road with very good maintenance, including in winter time, thus providing for a safe access all year around. The road is designed for loads not exceeding 165 tonnes (bridge capacity).

Speed limit is 70 km/h and the road is also used by weekenders, mostly for outdoor activities such as fishing, hunting and snowmobile.

18.1.3 Concentrate Transportation and Load-Out Facilities

18.1.3.1 Introduction

The following information summarizes the Arianne's Lac a Paul Project orientation with regards to concentrate transportation and handling, load-out equipment, storage facilities and ship loading equipment. Many options were analyzed and discarded from a cost and/or feasibility standpoint. The recommended scenario described in the following sections was thought out and analyzed to minimize impact on costs, environment and communities, while being proven and reliable. It is designed on a short and long term basis, in line with the development and production capacity of the Lac a Paul Project. The design of the concentrate transportation, load-out site and concentrate storage facilities, will require some additional optimization work and analysis to be done in the detail design stage.

Indeed, public review sessions of the Lac a Paul Project will take place through the BAPE process, as well as other review sessions under Arianne's initiative with governing Authorities (municipalities, provincial and federal government). Changes might be required based on recommendations from the BAPE and based on other stakeholders' inputs to Arianne management. A letter of intent (LOI) for the proposed new wharf facilities is in progress since a meeting with the Port Authority was held in early October.

Other important efforts in terms of time invested were also made with political levels, government departments, industrial entities (small, medium and large companies) as well as with professionals from engineering firms/consultants.

Integrating key inputs to the project design will likely favor support and social acceptance from the global population and stakeholders to the Lac a Paul Project; indeed, not only does it improve the project design in line with Arianne's objectives and needs, but it also allows for a larger consensus through stakeholders.

18.1.3.2 Transportation facts related to the Arianne's Lac a Paul Project and basis of design/inputs used to develop the transportation strategy

a) Three million metric tonnes/year of phosphate rock concentrate will be transported from Mine to Port.

b) Phosphate rock concentrate is a powder type product with a moisture content <2%; it is transported in bulk form and density numbers used for engineering calculations were 1,500 kg/m^3 for transport, 1,700 kg/m^3 for storage and 1,900 kg/m^3 for structural.

c) Concentrate will need to remain dry through the course of its transportation, handling, storage and loading in sea vessels. Phosphate handling will always be performed under closed and dried conditions in order to minimize dust formation and phosphate contamination by water or snow. Dust collectors will be installed where appropriate to minimize dust creation during handling of phosphate rock concentrate.

d) Arianne's potential phosphate customers are located in Europe, Latin America and North America (Canada and eastern coastal cities in USA); all phosphate rock concentrate production is planned to be shipped to customers by sea. Dry bulk carrier vessels will be required for sea transportation; the preferred option used by ship charterers is Handymax type carriers (35-50 Kt in capacity; see Figure 18.1.1) and potentially Supramax type (60 Kt) on occasion. Equipment was designed to accommodate for these types of ships.

Figure 18.1.1 Handymax Dry Bulk Carrier

e) Given the Mine location compared to the chosen Port location on the north shore of the Saguenay River (Saint-Fulgence), and given the existing infrastructures within the Saguenay-Lac Saint-Jean area, phosphate rock concentrate will be transported by trucks on a 237 km long heavy haul road, which will meet F1 class standards once investments to the existing road have been completed.

A new wharf will be needed on the north shore of the Saguenay River. Intents are to have the Saguenay Port Authority to build the new wharf and to have Arianne to share some costs associated with the new wharf. As previously mentioned, a letter of intent (LOI) for the proposed new wharf facilities is in progress. With this scenario, concentrate transport trucks will cross the regional road No. 172 only once and will not need to cross over the Saguenay River (Figure 18.1.2). This option is the most cost effective one for concentrate transportation (OPEX and CAPEX).

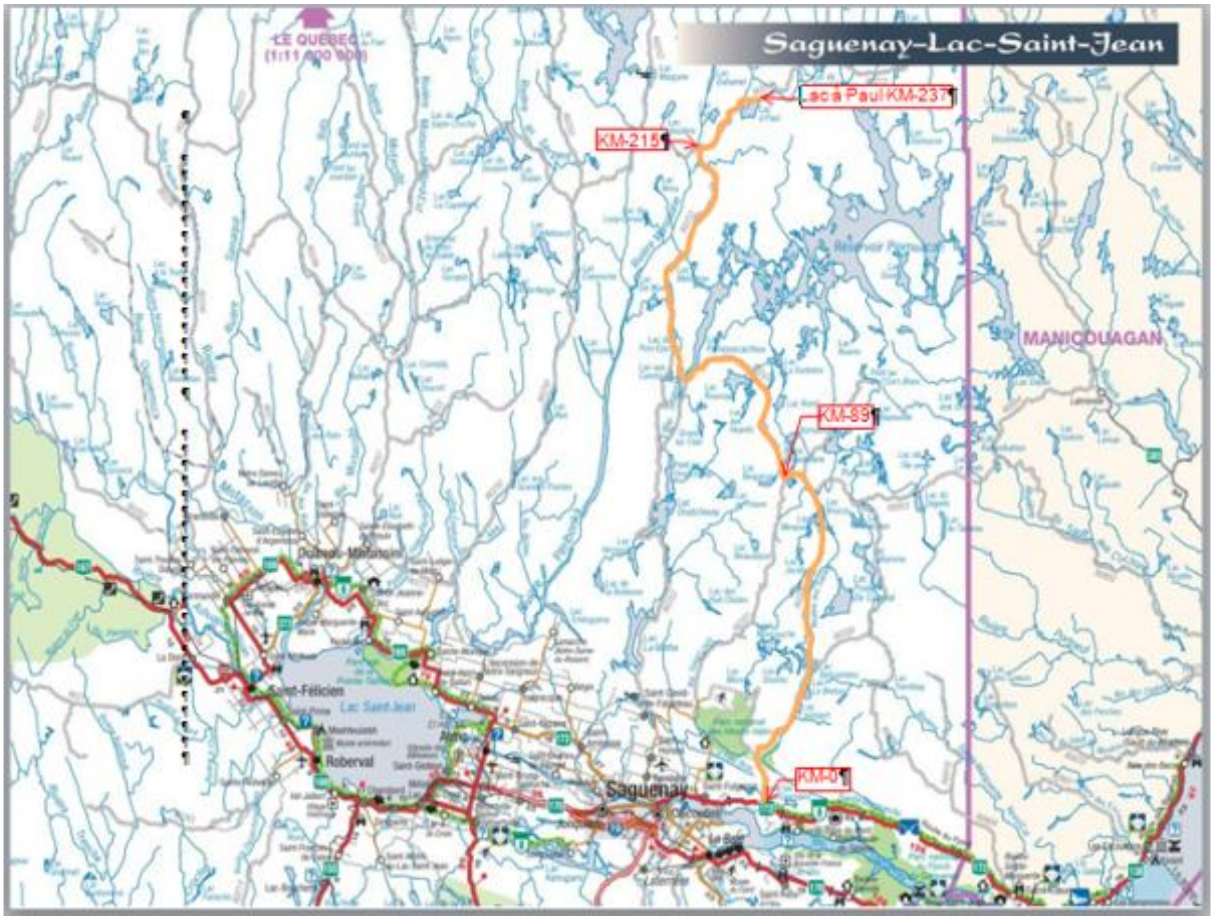


Figure 18.1.2 Concentrate Transportation Route from Mine to Port

f) The road is operational 7 days a week and each truck will make 2 trips per day.

g) Arianne will subcontract to partners and experts in bulk concentrate transportation and handling; Arianne will own and provide custom built 120 tonnes trailers for truck transportation, whereas trucks will be provided by truck brokers; Arianne will also provide all required storage and handling equipment to allow for concentrate handling and storage.

h) Reference data used for calculating transportation and silo capacities were taken from the mining plan along with the number of days (21) without truck transportation during the thaw period and a reduced production rate for the same period (planned shutdowns); recovery factors, number of days in operation and other relevant data came from project inputs. Table 18.1.1 shows these reference data.

Production	
Yearly production of phosphate rock concentrate (Mt)	3.0
Operating days per year (mine)	339
Process efficiency	90%
Phosphate % in concentrate	38.6%
Concentrator availability	93%
In storage from thaw period	
Required storage capacity (days)	21
Time allowed to empty thaw build up (months)	8
Time allowed to empty thaw build up (weeks)	32
Trucks	
Trailer capacity (t)	120
Filling time per trailer (min)	9
Round trip duration (hours)	12
Weekly round trips per truck	14
Traveling distance per round trip (km)	474
Average speed (km/h)	50
Truck/trailer washing and unloading time (min)	20
Ship Loader	
Loading capacity (t/h)	2,700
Overall loading efficiency	50%
Ships capacity (Kt)	35-60

Table 18.1.1 Reference Data for Calculating Transportation and Silo Capacities

18.1.3.3 Summary Description of the Mine to Port Transportation Route

Phosphate rock concentrate will be transported by trucks, hauling 120 tonnes custom built trailers from the Mine to a load-out site at Saint-Fulgence; this site will be used for trucks/trailers washing, and trailer unloading. Road distance from the Mine to the load-out site will be about 237 km. From Km 0 (Saint-Fulgence) to Km 89 there is no need for major road repairs, except some upgrade work on one bridge and the resurfacing of the existing road. For the next 126 km, this portion of the road will have to be widened and some curves on the road will have to be corrected in order to reclassify the road according to the heavy haul road class 1 standard. One bridge and some culverts will require modifications in this section. When the Saint-Fulgence road meets with the class 1 “Chemin-Des-Passes” road, the proposed Lac a Paul mine site is located a further 22 km on from this point.

Upon reaching Saint-Fulgence, the bottom side of trailers will first be washed and dried to remove any contaminant; concentrate will be unloaded from trailers and air lifted to two (2) 100 Kt silos.

Concentrate will be transferred by a ≈2,125 m long pipe conveyor to a 50 Kt silo located near the wharf (to be built), which will be used to feed the Arianne's stationary ship loader to be installed and used to load Handymax or Supramax ship types. A winch with a pulley system, operated by remote control, will be used to move vessels along the wharf (with dolphin type moorings).

The overall storage capacity located on the north shore of the Saguenay River (250 Kt), was determined based on the 21 days per year thaw period in Spring when truck transportation is not allowed or reduced, as well as a reduced production rate for the same period (planned shutdowns). This storage capacity will also be used as a buffer to compensate for potential issues impacting operations located upstream of the port (e.g. temporary closure of the truck road or equipment breakdown).

Phosphate rock concentrate will be transported from one 100 Kt silo (the second 100 Kt silo is used for storage only; there is no truck loading equipment), located near the mine concentrator, to the truck unloading site in Saint-Fulgence. It will be loaded in trailers through pneumatic top lids of sealed custom-built Belly-dump trailers. Filling time is estimated to be nine (9) minutes per trailer and there will be two (2) side by side loading stations. Trucks will be weighted and filling will be controlled using weight measurement scale.

Trucks will be owned by small trucking brokers and no provision in the CAPEX estimate is made for this purpose. The truck's GCW (gross combined weight) must not exceed 165 tonnes to comply with the existing road and bridges specifications.

Trailers will be owned by Arianne (see Figures 18.1.3 and 18.1.4) and will be custom designed for Arianne's need. Arianne decided to own these trailers since they were informed that the high trailers cost would prevent small truck brokers from being able to do business with Arianne, thus reducing service offer and competition level between trucking companies.

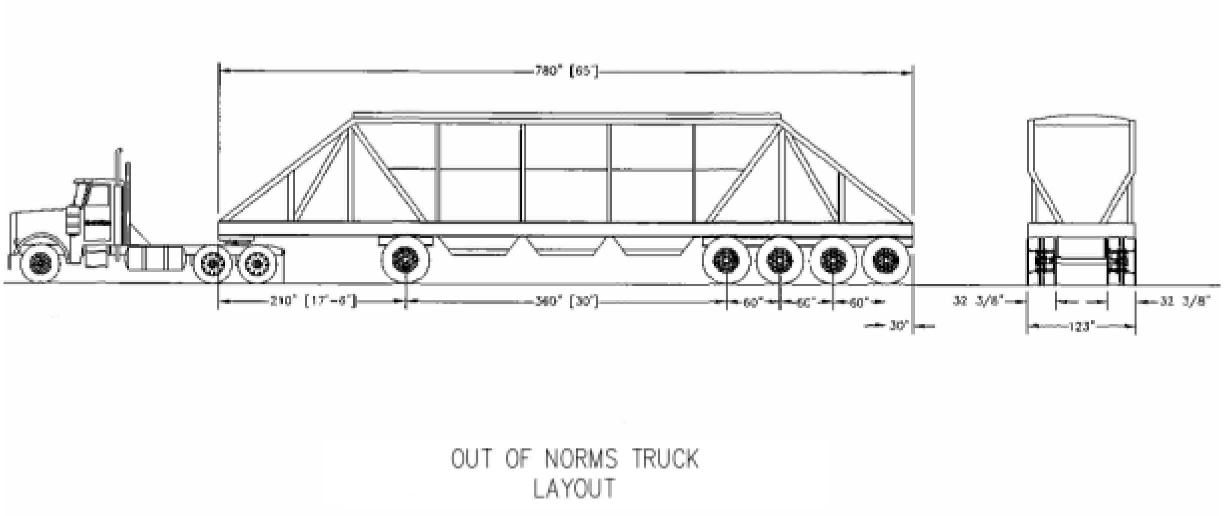


Figure 18.1.3 Sketch of a 120 tonnes Custom Built Trailer for Phosphate Rock Concentrate Transportation

Figure 18.1.4 Belly-Dump Type Trailer

The number of trailers required was calculated upon the mining plan with 10% of the trailer fleet being added as spares for preventive and assigned maintenance. At the peak of the mine production, forty-six (46) trailers and trucks will be in continuous operation and five (5) trailers will be purchased as spares, for a total of fifty-one (51) trailers. Forty-two (42) trailers along with four (4) spares will be required as of year 2 of the mine production. This will be confirmed in the next phase of Project development.

The number of trailers required was determined using the reference data from Table 18.1.1, but more specifically by taking into account the following assumptions:

- Estimated daily production of phosphate rock concentrate based on weight recovered in the mining plan and 55 Kt/day of ROM production.
- Twenty-one (21) consecutive days of concentrate accumulation in silos due to the thaw period when truck transportation is not allowed.
- 7 days per week, 24 hours per day of operating time for truck transportation.
- Concentrate inventory built over the thaw period will be reclaimed within the next eight (8) months; therefore, four (4) additional trucks and trailers will be used during the same period in order to completely transfer concentrate inventory from the Mine to downstream silos located on the north shore of the Saguenay River.
- Truckers will normally ride in pairs for safety and assistance; a round trip will normally take less than twelve (12) hours.

18.1.3.4 Saint-Fulgence Truck Washing and Unloading

Trucks and trailers will be washed from underneath in a separate heated building which will include two (2) side-by-side trucks/trailers washers and unloading stations. An automatic truck/trailer washer will remove dirt, snow, dust and contaminants to avoid contact with of phosphate rock concentrate. Excess water will be blown off to prevent water contamination during phosphate unloading. The washing/drying cycle time is estimated to take 6 to 8 minutes and there will be two (2) washing/drying stations as well as two unloading stations located in the same closed building. Water will be heated up in winter time to avoid water from freezing on trailers hatches during washing. The water system will operate in closed loop to minimize water consumption.

Trailers will be emptied from the bottom in a 250 tonnes capacity pit. Truck drivers will open trailer hatches. Trailer unloading is estimated to take six (6) minutes per trailer. A full cycle time for washing/drying/unloading trailers is estimated to take twenty (20) minutes.

Phosphate handling will be made under closed and dry conditions in order to minimize dust formation and phosphate contamination by water. Dust collecting equipment will also be installed at the trucks unloading pit.

Phosphate rock concentrate will automatically be air lifted from the 250 tonnes pit to either of the two 100 Kt silos. Figure 18.5 shows a schematic view of the Saint-Fulgence site for phosphate rock concentrate load-out, handling, and storage facilities.

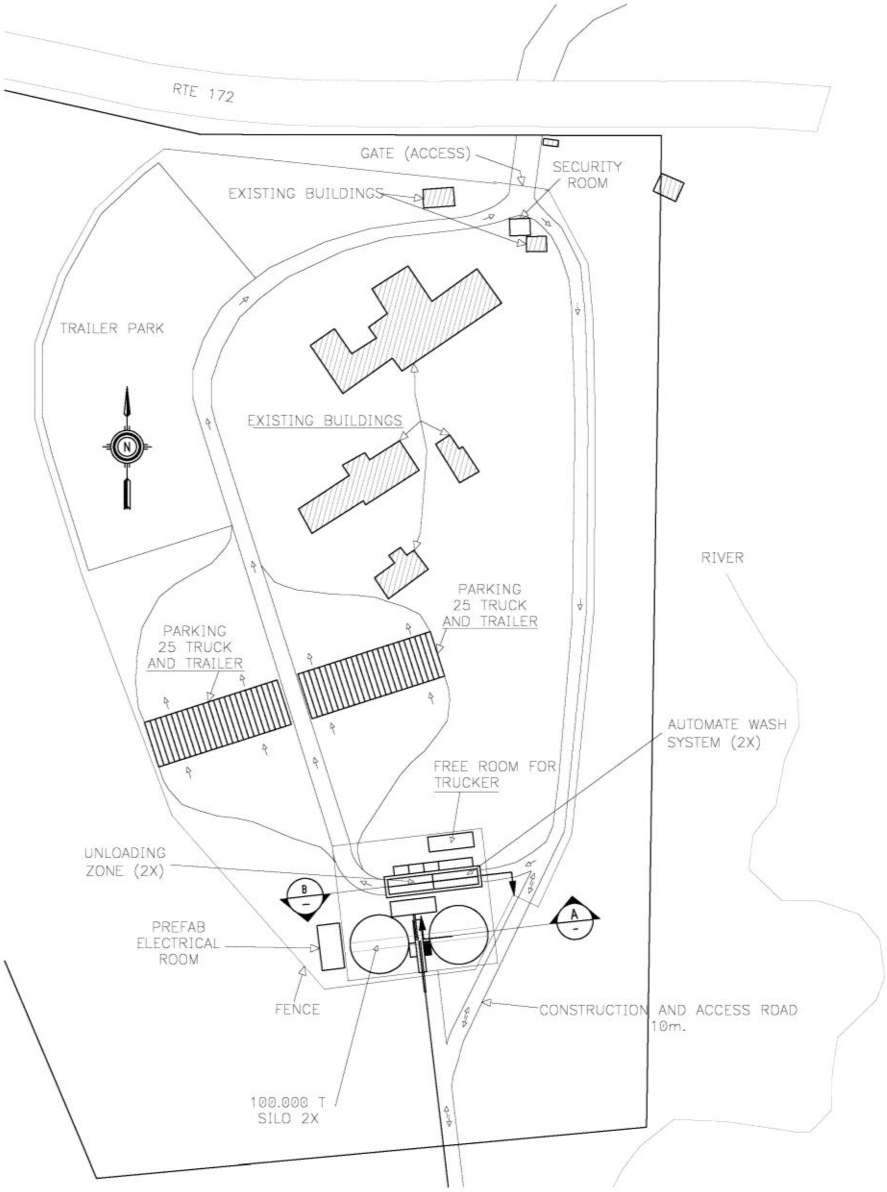


Figure 18.1.5 Schematic View of the Saint-Fulgence Unloading Area and Storage (see Appendix 13 for more details)

18.1.3.5 Saint-Fulgence Storage and Handling Equipment

Figures 18.1.6 and 18.1.7 show the proposed layout of the new equipment required in Saint-Fulgence and a schematic view.

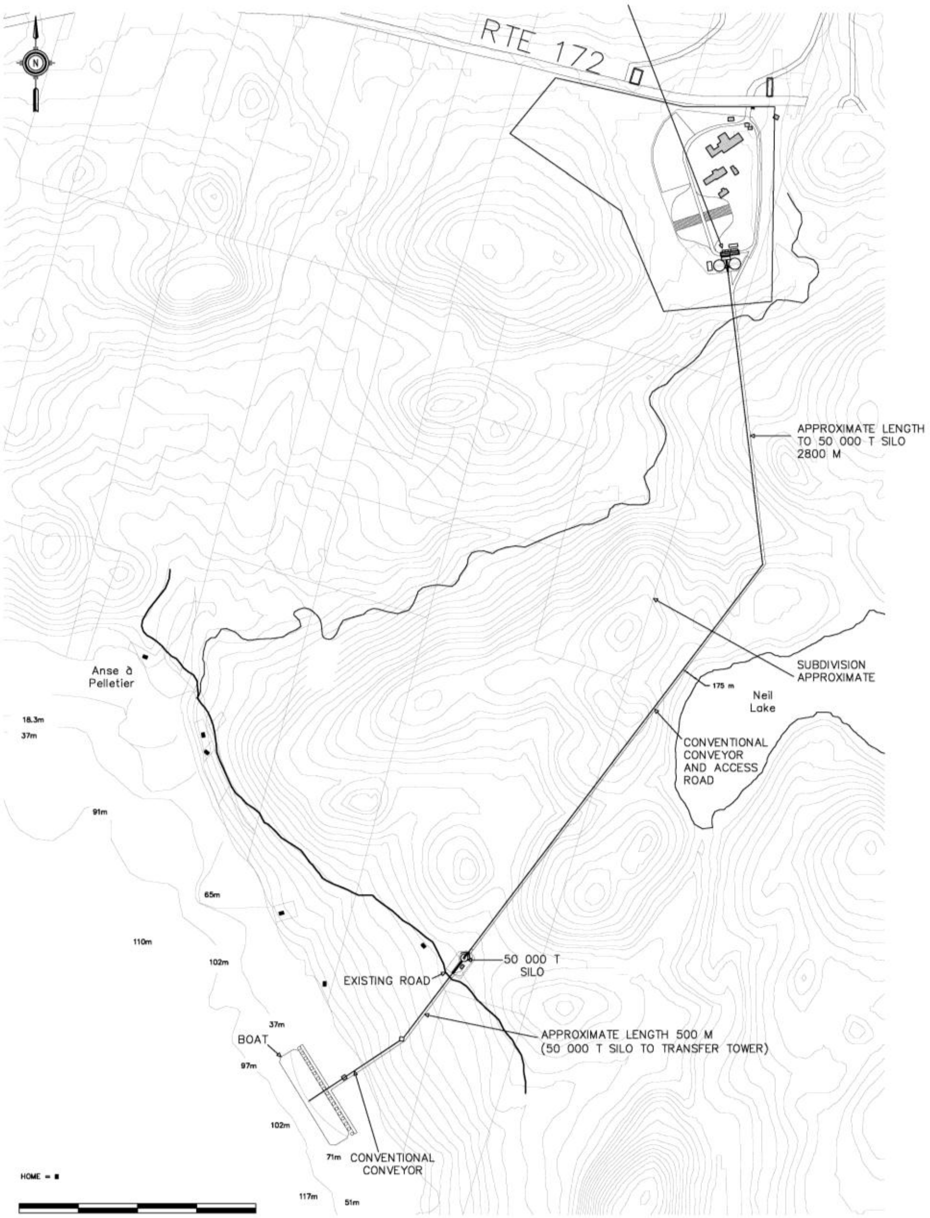


Figure 18.1.6 Proposed Layout of the Arianne's Equipment in St-Fulgence (see Appendix 14 for more details)

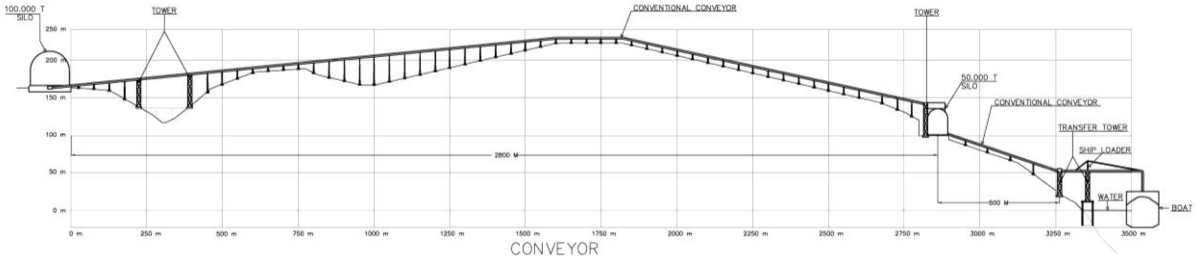


Figure 18.1.7 Elevation View of the Saint-Fulgence Site (see Appendix 15 for more details)

Phosphate rock concentrate will first be air lifted from the truck unloading pit to the two (2) 100 Kt silos; the next step will be to proceed with feeding the 50 Kt silo located near the wharf, which will be used to feed the stationary ship loader. A 2,125 m long belt conveyor will be used to move rock phosphate concentrate from the two 100 Kt silos to the 50 Kt silo near the wharf. The purpose of the second 100 Kt silo will be to store phosphate rock concentrate and build inventory in view of occasional stoppages in transportation, as well as to be in a position to meet sea shipment requirements while facing the thaw period in the spring season.

The 50 Kt silo and belt conveyor system were sized to efficiently fill a 35-60 Kt ship (Handymax (35-50 Kt in capacity) or Supramax type (60 Kt)). The ≈2 km long conveyor will be installed in a closed structure to avoid exposure to water and minimize dust emission, whereas the conveyor feeding the ship loader will be in a sealed tunnel to prevent dust emission and water contamination. Priority will always be given to filling up the 50 Kt silo in order to always be ready for ship loading, therefore minimizing the risks of having to pay demeurrage fees for ship laytime. No provision was made in the OPEX estimate for these potential demeurrage fees.

18.1.3.6 Stationary Ship Loader

Phosphate rock concentrate will be loaded in vessels through a 2700 t/h conveyor ended by an extended arm to be used to load concentrate into vessels cargo holds. Equipment will be designed to minimize exposure to water/snow as well as to minimizing dust propagation. Dust collectors will be installed where appropriate to minimize dust creation. Figure 18.1.8 respectively illustrates a schematic plan view of the ship loader and its location on the wharf.

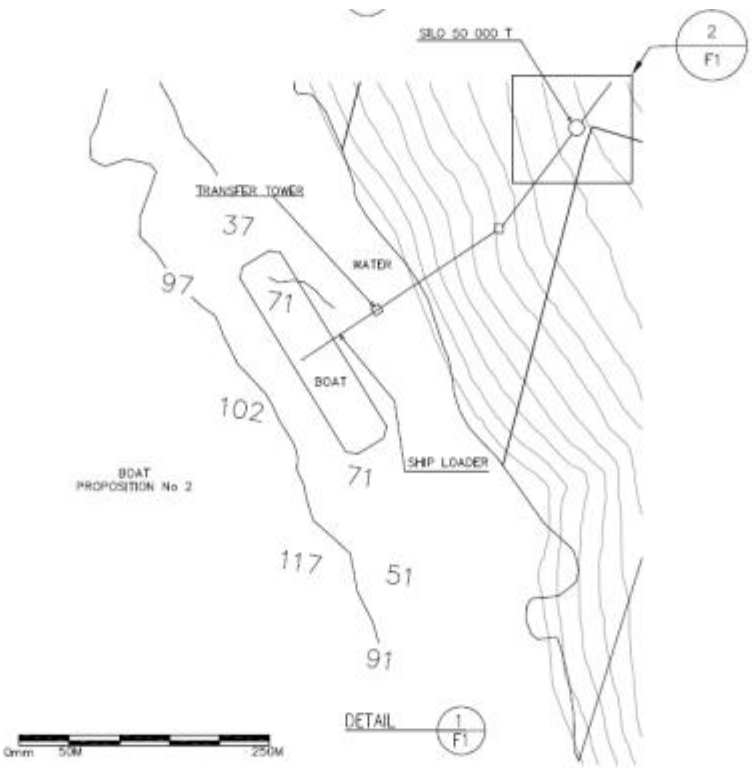


Figure 18.1.8 Schematic Location of the Ship Loader

The nominal ship loader capacity is estimated to include 50% loss in efficiency associated with normal daily operating parameters (e.g.: moving the vessel, opening and closing the hatch, trimming, lunch break, etc.).

The combined phosphate rock concentrate storage capacity located downstream of the Mine operation (250 Kt) will be enough to load four (4) 60 Kt vessels, five (5) 50Kt vessels or a combination of six (6) 35-50 Kt vessels during the thaw period, therefore allowing for a continuous supply and shipments to customers. The thaw period allowance is for twenty-one (21) days, i.e. the equivalent for a maximum of four (4) vessels of 60 Kt (worst case scenario).

Operation and equipment maintenance of the Arianne's Saint-Fulgence site will be contracted to a third party supplier (Arrimage Saint-Laurent) since this type of activity is not considered as part of Arianne's core business. These costs were factored in the OPEX estimate.

18.1.3.7 CAPEX and OPEX for Mine to Port

Following an unsatisfactory outcome from an OPEX viewpoint, the previous Mine to Port (transport of concentrate) option had to be discarded late in the feasibility study. This led Cegertec WorleyParsons to consider a more reliable, cost effective and optimized alternative. Given the limited time available to carry out the new Mine to Port alternative, the new route and associated logistics were brought to a level of definition corresponding to an estimate contingency of 25%. CAPEX and OPEX figures will be discussed in more details under the appropriate section; the summarized information is as follows (in $USD):

a) $232.2M in CAPEX, including about 12% of global design allowance and 10% in contingency.

b) $13.96/t of concentrate for OPEX.

c) Sustaining capital includes the cost of trailers being replaced every 12 years and infrastructure at Saint-Fulgence.

d) CAPEX accuracy level for mine to port study is +/- 25%.

18.1.3.8 Other information

The selected mine to port approach has been optimized in consideration of cost reduction, social impact reduction and environmental impact minimization. The wharf facilities have been selected to use a marine piling system. The ship loading facilities with a stationary loading arm has been selected as a basic operating technology. The vessel displacement approach used is also of basic technology in order to optimize cost without impacting operating cost.

The mine to port route selected is of the least impact to the cost for transportation by truck. Firm pricing for road upgrades have been received and included, from specialized contractor in design and construct of heavy haul roads. Budgetary prices were obtained for silos, air slide/air boom equipment and pipe conveyor. The selected road trajectory will avoid through traffic in existing urban communities.

18.2 Site Infrastructure

18.2.1 Tailings Storage Facility and Water Management

A tailings storage facility (TSF) to store and manage the tailings was selected for the life of mine of the Lac a Paul project, estimated at 25.75 years of production. The process water will be stored in a retention pond.. The scheme of operation proposes transfer of free water from the tailings park to retention pond to allow for sedimentation of fine particles. Water will be then transferred from the retention pond to the plant to be used in processing. A series of geochemical tests have been performed by URSTM in order to evaluate the acid generation potential. Preliminary tests results are showing no sign of acid generation (for waste rock or tailings). Figure 18.2.1 below shows the evolution of pH in the leach water from different column test over a period of 150 days. Since the tailings are classified as “low risk” as per geochemical tests ran by URSTM, the tailings park does not include a potential acid generating tailings storage pond.

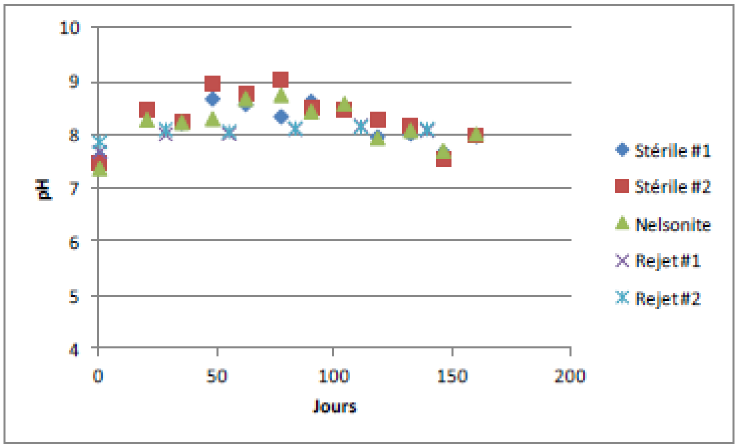


Figure 18.2.1 Evolution of pH in the leach water from the column test over a period of 150 days

The tailings storage requirements were based on the production of approximately 15.58 M tonnes of mill tailings per year over a period of 25.75 years. Design criteria were based on an assumed final depositional density of 1.83 t/m³ and a total tailings placement requirement of about 203 Mm^3. Summary of design criteria is presented in the Table 18.2.1.

The preferred system comprises a multiple cell dyke type storage facility utilising competent and durable un-mineralised mine rock extracted from the open pit to construct the perimeter walls, embankments and protective covers. Drainage pathways are projected to drain off water in order to optimize tailing's consolidation and strength. The construction of the drainage pathways will also be realized with mine waste rock. Rock cover ensures that the downstream face is erosion resistant.

The client opted for a high density thickening of the tailings during the pre-feasibility stage. An increase of the solids fraction of the slurry by weight (w/w) to 70% reduces free water seepage and the footprint of the facility as a whole.

The design is in compliance with the requirements of "Directive 019" of the "Ministère du Développement Durable, Environnement, Faune et Parc (MDDEFP)". The tailings are considered as "low risk" according to Appendix II of this Directive.

Item	Parameter
Operational life of TSF	25 years
Annual tailings generation, year 1	5 to 6 Mm³
Annual tailings generation, year 2	9 Mm³
Annual tailings generation, subsequent years	15,58 Mm³
Total tailings placement requirement	203 Mm^3

Item	Parameter
Capacity of the tailings facility	250 Mm^3
Type of tailings	Low risk
Tailings characteristics	Non-toxic, non-radioactive, not biologically reactive
The solids fraction of the slurry	70%
Average enbankment rise per year	3,5 m
Final deposit density	1.83 t/m^3

Table 18.2.1 Operating parameters

Several scenarios were examined in order to optimize the location of the tailings park and minimize the height of the various dykes and hence material quantities and costs. The tailing park locations and construction scenarios examined were based on the information made available for the project, including topography, required capacity, groundwater conditions, foundation materials and construction materials. They take into account the location of infrastructure and of additional mineral potential on the Property.

A series of slope stability analyses have been carried out using data obtained from the field and laboratory investigations (natural soils and rock) and from literature (tailings). In addition, the risks of instability when subjected to earthquake loading have been calculated. The factors of safety are in compliance with «Directive 019» of MDDEFP. Shear strength parameters used in the analyses are presented in Table 18.2.2. The analysis confirms that the proposed design is suitable and manages potential risks to an acceptable level both during operation, as well as in the long term after closure. Also, additional investigations should be carried out during detail design phase leading up to implementation and the structure stability periodically monitored during operation and closure. The additional investigations are detailed in the recommendations section.

Item	Parameter
Dry unit weight of tailings	12 kN/m^3
Internal friction angle of tailings, drained condition	30 º
Cohesion of tailings, drained condition	0 kPa
Ratio Cu/(vertical effective stress) for tailings in undrained condition	0,2

Item	Parameter
Compressibility index of tailings	0,2
Coefficient of consolidation	0.02 cm²/s

Table 18.2.2 – Strength and consolidation parameters of tailings

During the winter, the height of ice build-up will exceed the spring thaw depth. At the detailed design stage, it will be necessary to evaluate the behavior of this layer, which will potentially remain frozen, with respect to failure, consolidation, density, drainage of thaw water.

Monitoring will be necessary during the entire period of operation, as well as in the long term after closure. Monitoring data is critical for effective risk management as it may trigger adjustments in the operations and provide important information for future designs. Monitoring will include in situ strength testing, moisture content, water level piezometer and all other in situ testing to obtain all parameters defined in the monitoring plan established during the detailed design.

The system will be audited annually. The inspection will include all structural aspects of the tailings system in accordance with the design. In situ geotechnical testing and water level piezometers to validate the adequate consolidation of the tailings will be installed. The slope armour is successful in minimising erosion on embankment slopes.

This section does not cover design, installation and management of delivery and discharge pipes.

18.2.1.1 Geotechnical studies

A preliminary geotechnical investigation has been carried out, during which in-situ properties of the soils and rock were determined for various locations of the project, including the proposed processing plant, the tailings facility, the tailings pond and the mining residues disposition area.

A hydrogeological study has been carried out to evaluate permeability, ground and underground water flows and water balance.

18.2.2 Tailings Water management

In order to manage the water quality from tailings cells and precipitation, a retention pond will be constructed. The process water with tailings will be discharged into the TSF at a rate of approximately 920 m^3/h. The tailings facility will retain about 85% of that amount while 15% will be infiltrated and evaporated, i.e. 782 m^3/h will be available.

Hydrologic and hydraulic analyses have been carried out for the water balance and for the appropriate design of the pond. Both analyses take into account both natural phenomena (rain, snow and evaporation) as well as wastewater recycling. A summary of these two analyses is presented below:

18.2.2.1 Determination of precipitation

The precipitation of the studied area consists of two components:

- The rain, of which we study not only the yearly rainfall but also extreme events that may occur at the site, Figure 18.2.2.
- The snow, of which we study the maximum thickness, the period and the melting rate, see Figure 18.2.3.

Depending on the data collected at stations surrounding the study area and the data needed for analysis, different stations have to be retained.

1. Stations locations

All the data from rain measurement stations located within a reasonable distance of the studied area has been reviewed and analysed. Table 18.2.3 presents the different stations used, and Figure 18.2.4 shows the stations position in comparison to the study area (quoted as “Zone d’étude”).

Station ID	Position in reference to study area	Measurement period	#Years available	Depth of snow cover measurement	Use for study
7061541	30 km O	1960-2007	17 (1960-1976)	No	Extreme rain events
7063090	160 km S-O	1980-2001	18	Yes	Annual max depth of snow
7065667	140 km S-O	1980-1992	11	Yes	Annual max depth of snow
7043540	110 km S-E	1980-1994	14	Yes	Annual max depth of snow
7060825	100 km N	1980-1999	20	Yes	Annual max depth of snow
7064620	85 km N	1955-1961	13	Yes	Annual max depth of snow
7065960	160 km S-O	1971-2005	28	Yes	Annual max depth of snow Daily rain and snowfall

Table 18.2.3 – List of stations used for hydrologic analysis

2. Extreme rain events analysis

   Only station 7061541 can be considered relatively close to the study area; however, this station provides only a relatively old daily data and does not give snow cover depth data. Its use has been then reduced to comparing its daily statistical rain event to the ones presented in the Hydrological Atlas of Canada. This comparison showed that values provided in the Atlas correctly represent the daily amount of rain precipitation in the study area. Also, as it gives rain intensity for shorter period than a day, the Atlas has been used for determining any rain event intensity depending on the return period and the length of the event (Intensity-Duration-Frequency curve).

3. Annual maximum depth of snow

   Among all the stations showed on Figure 18.2.4, only 6 give measurement of snow cover depth. Comparison has been made between stations in order to approximate the mean annual maximum depth of snow encountered in the study area.

4. Daily rain and snow precipitation data.

   In order to analyze water level fluctuation in the retention pond and to determine retention pond capacity required for mining activities, a station giving both daily snow depth cover and rainfall data should be used. Station n°7065960 has been chosen because this station offers the longest data record.

18.2.2.2 Determination of evaporation

The annual and monthly evaporation rates have been considered in order to achieve the water balance needed to design the polishing pond (Figure 18.2.4). The consideration of several sources provided a monthly discretization of evaporation rate and the highest rate is detected in July with a monthly value of 98 mm.

18.2.2.3 Calculation of precipitations' flow rates for tailing facility, polishing pond and peripheral ditches.

The peripheral ditches are designed to allow drainage of a flood up to a 100 years return period. Their design is made assuming a same return period storm and which duration allows the contribution of the entire dam drained by the dike.

Hydraulic calculations, based on the slope of the ditch and the flow rate, allowed determining the minimal size for the design of the dikes and the necessary precautions against the risk of erosion.

For the basin, a similar method was used, but the return period was increased to 1,000 years, as required by «Directive 019» of mining industry.

18.2.2.4 Type and design of the basin considering account of these data and water balance

The retention pond has been designed to allow wastewater reuse and precipitation (rain and snow) recovery. The basin's volume and the critical levels (operation maximal level and extreme level) are determined in order to meet the following criteria:

- Maximum use of available water (wastewater and precipitation).
- The spillway's level and the basin's volume must ensure the passage of the 1,000-year flood without causing spills.
- The water from the pool must be treated before being released in the environment.
- The water balance must be optimized to maximize the use of the basin while minimizing its volume to comply with the «Directive 019» of MDDEFP.

18.2.2.5 Clarifications provided in the context of the detailed engineering design

Detailed engineering design should ideally rely on on-site measurements to validate the extrapolations from the surrounding weather stations. If measurements were started now, their results could be used to refine the hydrological data used in the design (rain volume and snow thickness).

The design of ditches and basin take into account the most critical conditions of the tailings facility and its dikes: that being when all the dikes and the tailings facility are filled completely, which results in a high runoff coefficient. A staged expansion scenario of the tailings facility would be beneficial for an evolving design of the ditches and the basin.

18.2.2.6 Water from ditch

The design of each dike ditch is based on the volumes generated by short and intense storms (Q_{Max} volume). At the each low point of the dams, retention ponds are planned in order to collect the water flows transported through the ditches. For one retention pond, a pumping station is planned to pump the water coming from ditches to the principal retention pond. For the other retention pond, a quality sampling station is planned for each basin. After quality check the water will be either treated or released in the environment.

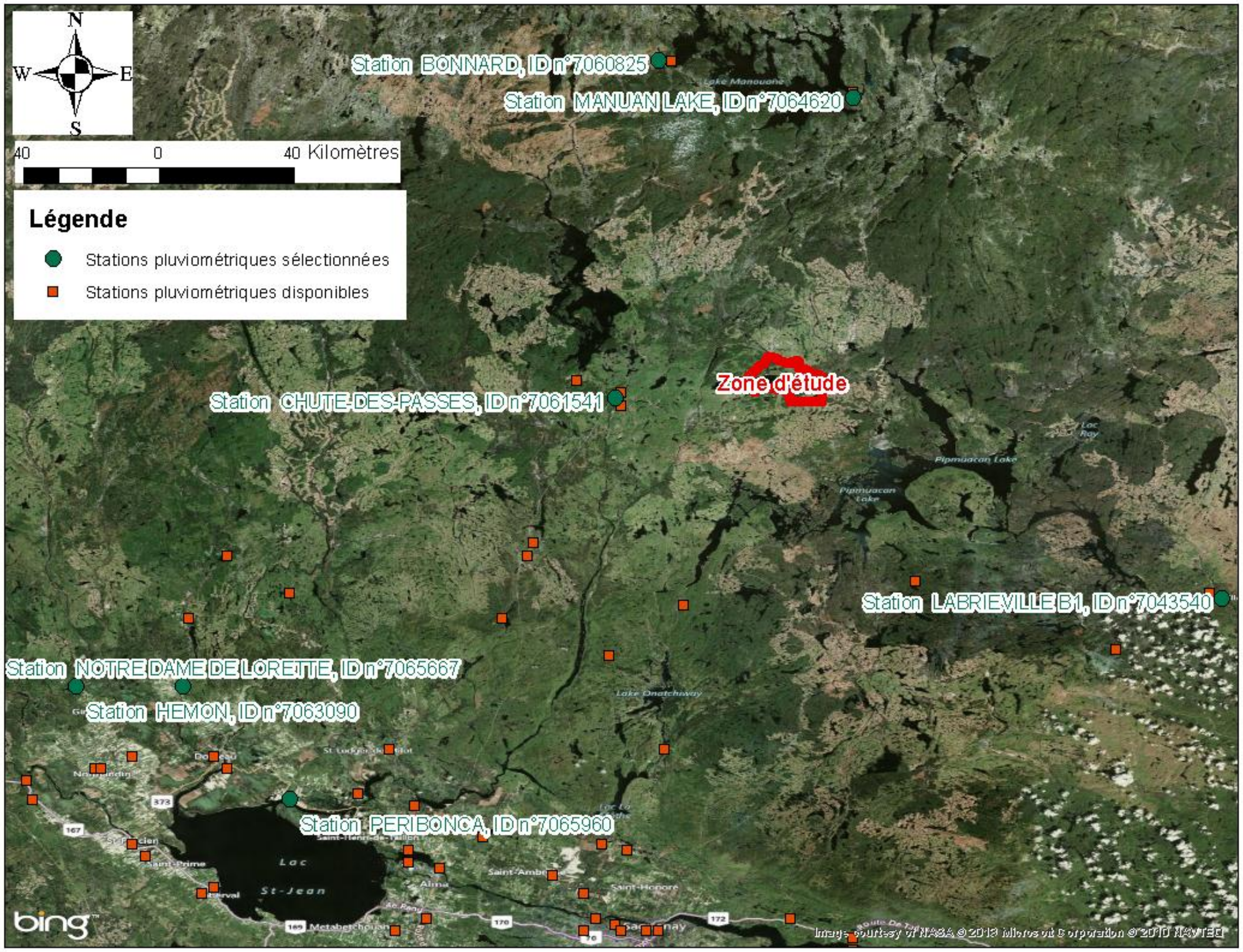


Figure 18.2.1 – Location of Climate Stations

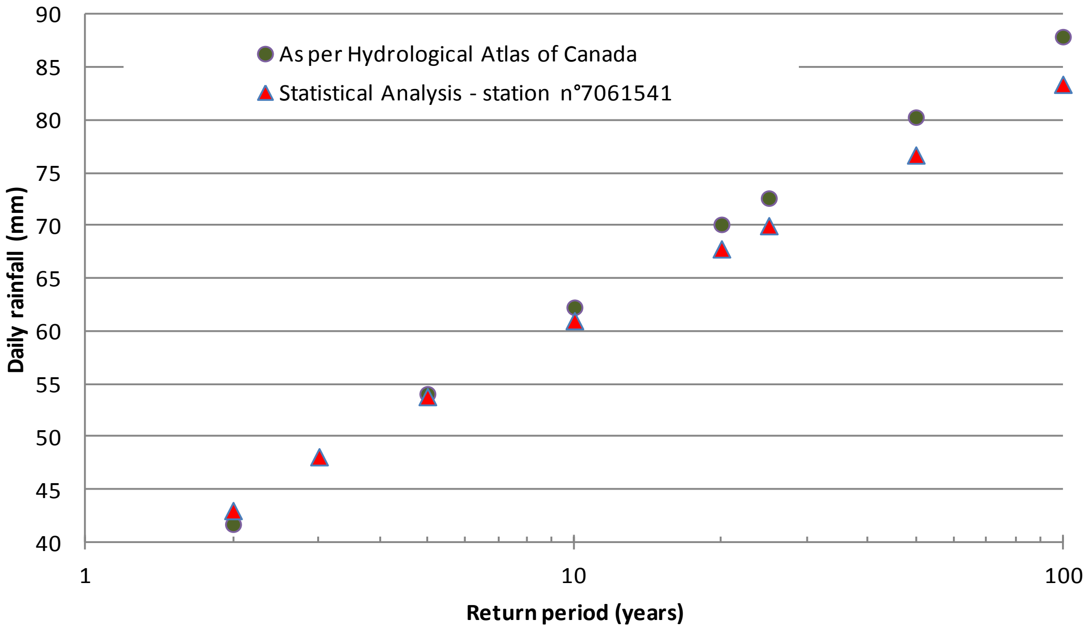


Figure 18.2.2 – Statistical daily rainfall events for the studied area, comparison between values defined at station no. 7061541 and values given in Hydrologic Atlas of Canada

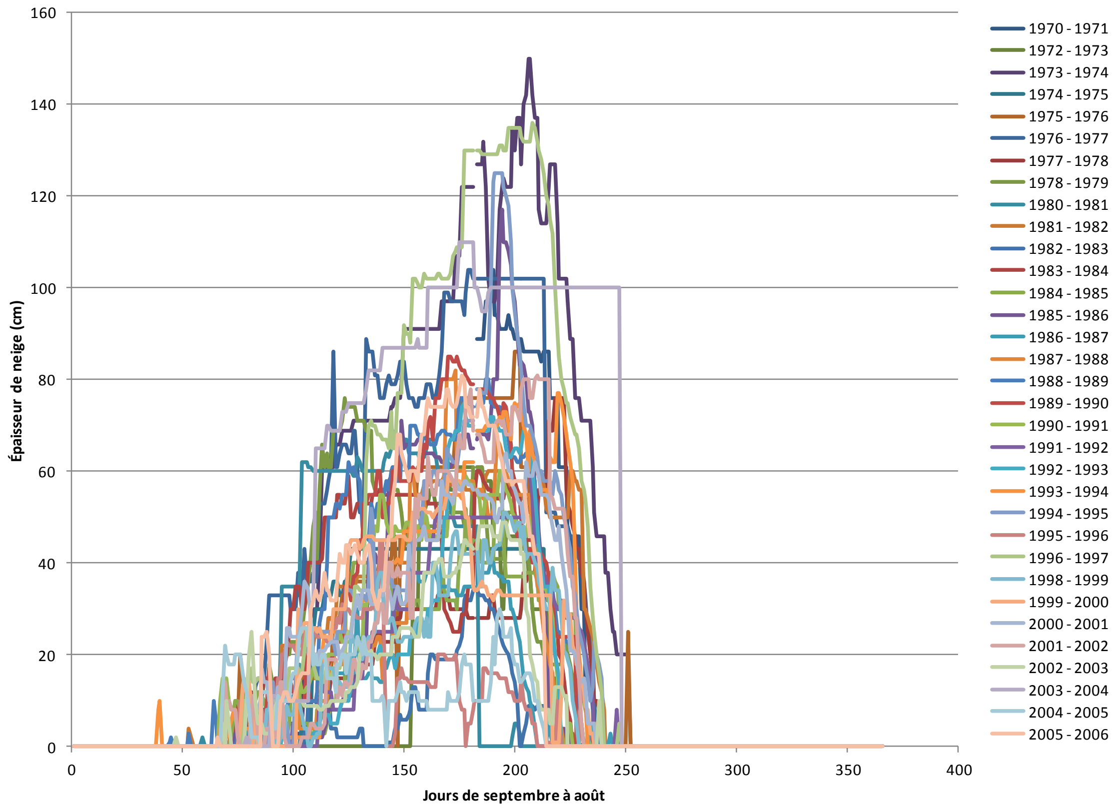


Figure 18.2.3 – Evolution of snow pack height measured between 1970 and 2006 at Peribonka meteorological station (no. 7065960)

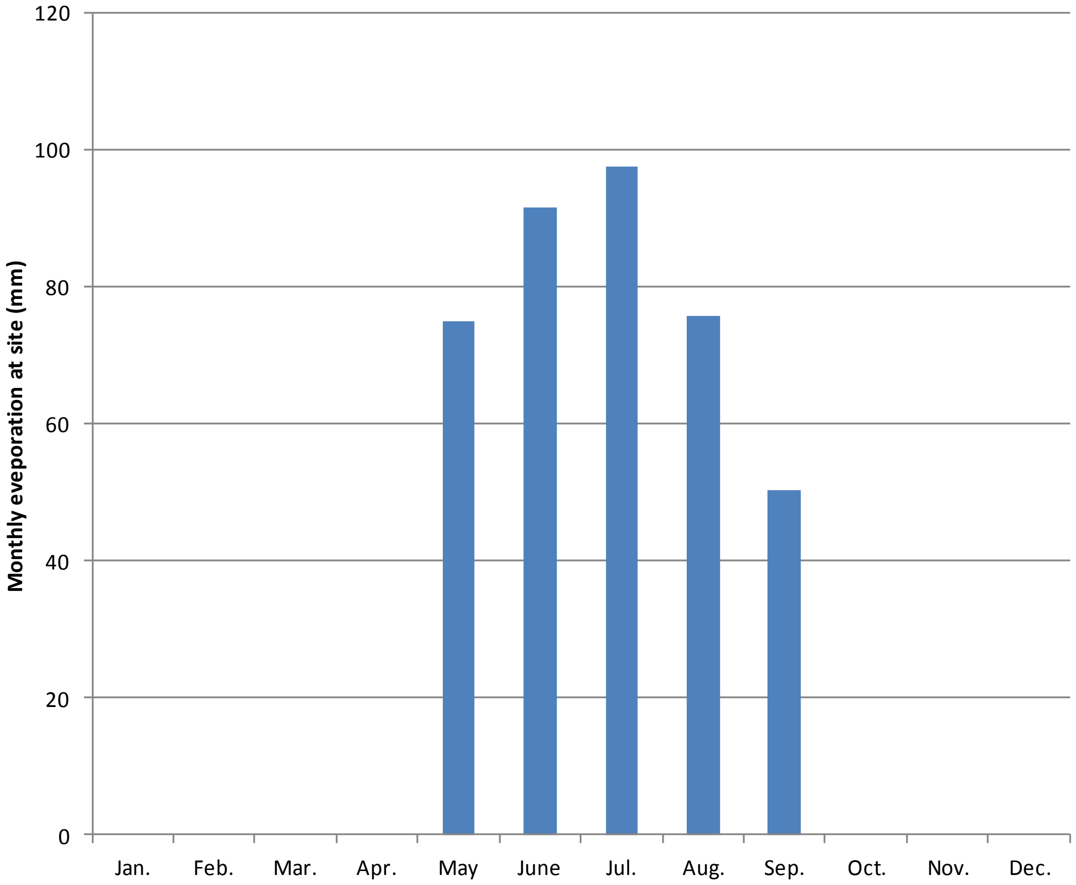


Figure 18.2.4 – Estimated monthly evaporation at site

18.2.3 Water Management and Hydrogeology

Actual results show that the operation could begin with dewatering from the bottom of the pit. Sump pump will be installed in order to remove water from surface runoff and groundwater infiltration. Ditch will be made all around the pit in order to minimise surface runoff, but topography indicates that this should not be a problem on site. Also, the small thickness of overburden will be a good aspect to create the required ditch at the beginning of operation.

Further adjustments will be made for mine dewatering and will be based on rock mass stability and water seepage from the pit floor. These adjustments could lead to the installation of some pumping wells around or in the pit. This aspect will have to be assessed during operation and it should not be a major concern for the future.

18.2.4 Waste Rock Dump

The open pit mining operation will generate approximately 180 Mm^3 of waste rock. Waste rock will be used in the construction of various site facilities, including the tailings dams and mine roads. The rest will be stored in the waste rock dump located north of the open pit.

The total waste rock storage requirement is designed for the total capacity of 180 Mm^3 and covers a 5.4-km^2 area.

The waste rock dump is expected to have a final elevation of 550 m for an average height of 50 to 70 m, a maximum height of 110 m. The natural topography of the waste rock dump area is irregular and can be steep in areas. Stability analyses were completed to confirm the slope stability. The addition of a buttress berm was required to get the applicable security factor; Figures 18.2.5 to 18.2.7 show details of the recommended design.

Preliminary geochemistry analyses indicate that the waste rock stockpiles will not be acid generating or metal leaching and runoff water will not require treatment in a water treatment plant before being discharged offsite. Channels will be constructed along the outer limits of the stockpiles in order to capture sediment-laden runoff water and route surface water flows to a network of five sedimentation ponds for treatment of total suspended solids (TSS). The sedimentation ponds were sized for 1:100-year return period flows. Water from the sedimentation pounds could be pumped and used for dust control if required.

A waste rock dump sequence was developed in order to minimize mining effluent. The waste rock dump total area was divided into five sub-watersheds and the construction sequence is expected to be implemented over a period of 3 to 5 years for each sub-watershed.

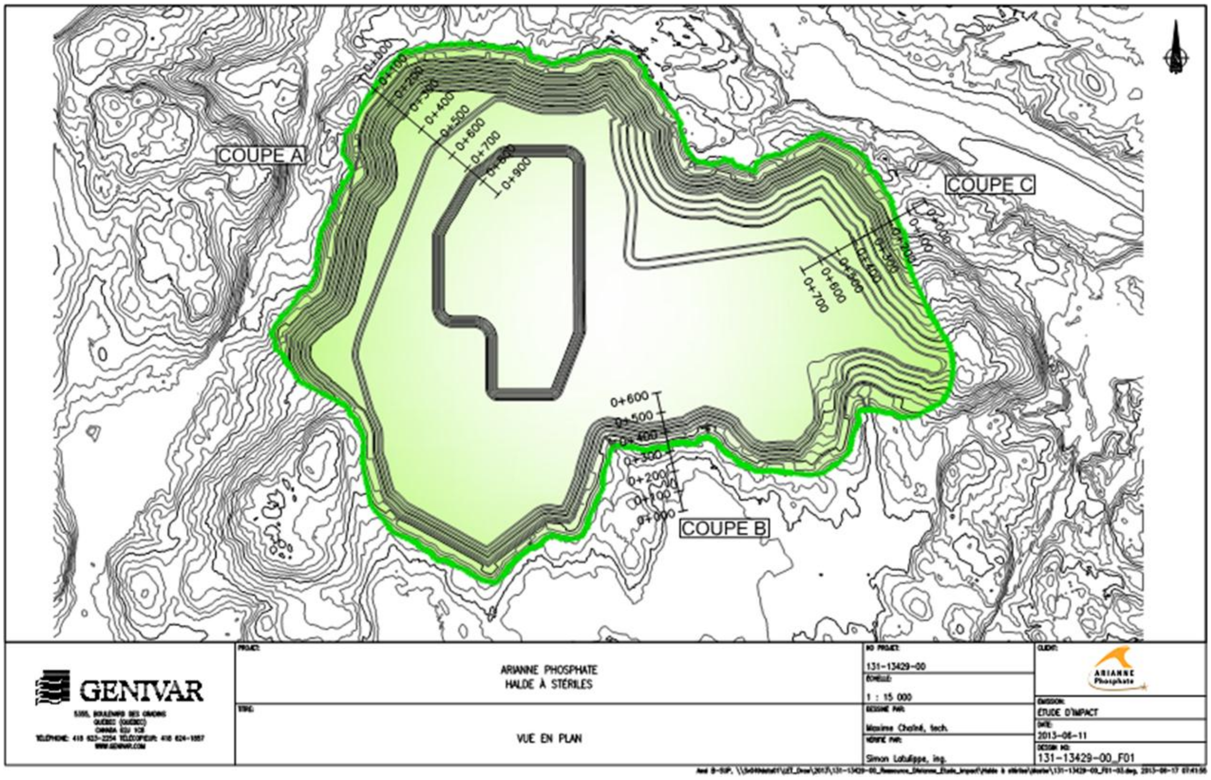


Figure 18.2.5   Waste Rock Piles

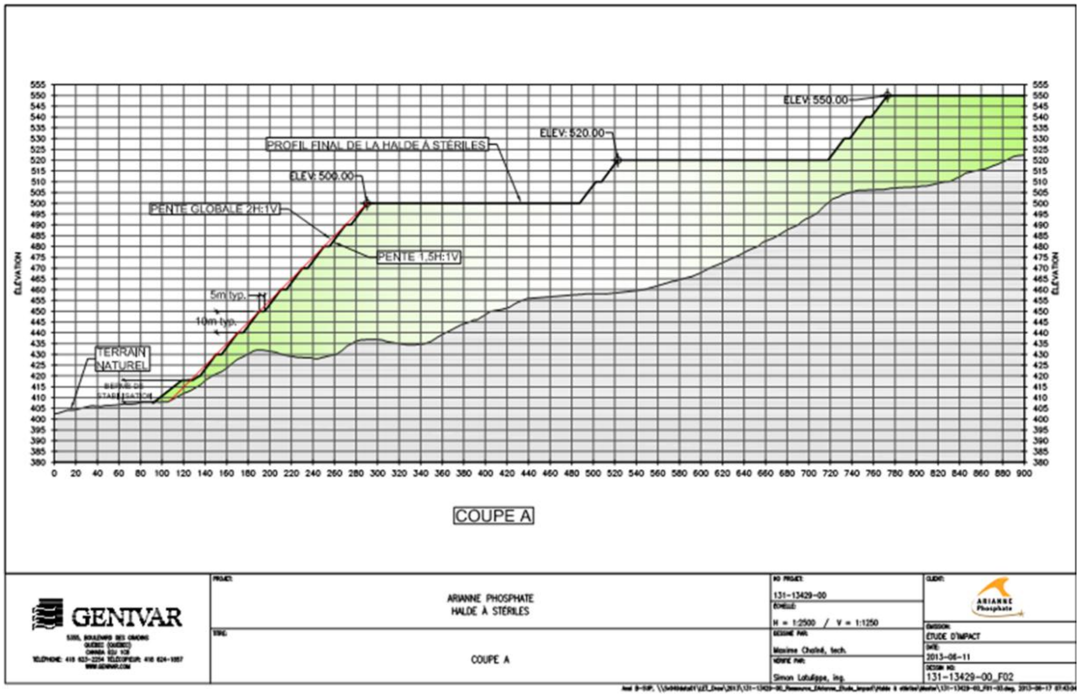


Figure 18.2.6 Cross-Section A view: Waste Rock Piles

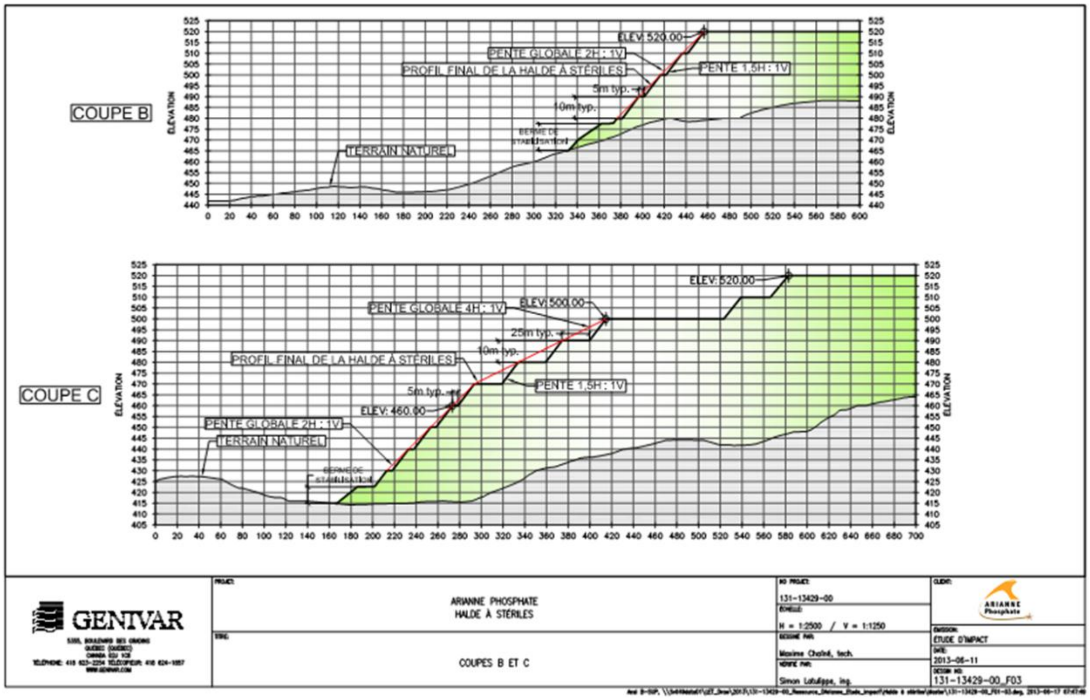


Figure 18.2.7 Cross-Section B and C Views: Waste Rock Piles

18.2.5 Site Layout and Camp Site Accommodations

Infrastructures planned for the Lac a Paul site are divided into three main sectors: Paul Pit, plant and work camp site, tailings pond. These sectors and their infrastructures are illustrated on development plan 207090-19468-3200-CI-DGA-0001 included in Appendix 7. Figure 18.2.8 shows a portion of this drawing.

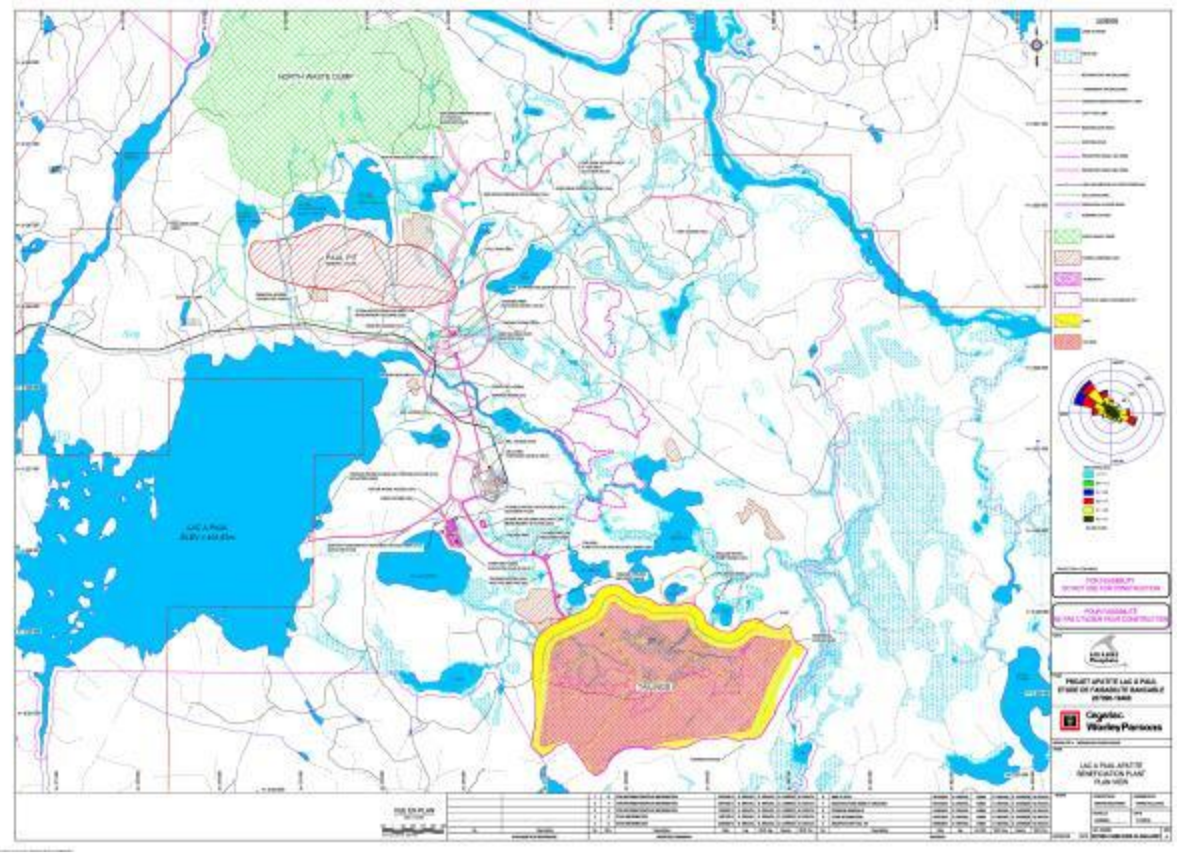


Figure 18.2.8 Mine Site Layout

18.2.5.1 Paul Pit Sector

The Paul Pit Sector is located north and northeast of Lac a Paul; it covers an area of approximately 20 km^2 (5 km x 4 km), and will be composed of the elements listed below.

The **Paul Pit** is located on the north side of the current Chemin-des-Passes. By the end of its mining period, it will extend ≈ 2.6 km from east to west and 0.8 km from north to south. A 400 m exclusion zone is planned around the perimeter of the Paul Pit.

The **North waste rock pile** is located north of the Paul Pit; it will cover an area of ≈ 567 ha by the end of its mining period.

The **Explosives zone** is located 1.5 km northeast of the Paul Pit, on the southern boundary periphery of the waste rock pile. This zone is composed of 2 distinct sites, each covering an area of 1 ha, ≈500 m apart. Two 1 km exclusion zones are planned around the perimeter of each of these sites. The first site, further to the west and closest to the Paul Pit, is planned for preparing loads, and the second site to the east and further away is planned for storage.

18.2.5.2 Plant and Work Camp Sector

The Plant and Work Camp Sector is located on the east side of Lac a Paul, approximately 800 m from the shore. It is divided into four distinct zones, spread over an area of approximately 600 ha (2 km x 3 km). The four zones are identified and described below.

The **Crusher** zone is located furthest north; it primarily includes the main crusher, a 4.9-ha platform where approximately 500,000 t of ore can be stored and a 1.8-ha platform for maintaining and refueling mining vehicles (garage and fuel). A conveyor is also planned for transferring the ore between the outlet of the main crusher and the Plant zone.

The **Plant** zone, covering an area of 18.5 ha is located 1.25 km south of the main crusher. This zone primarily includes an ore stockpile, the processing plant, concentrate reserves in silos, conveyors for transporting the ore and concentrate, a concentrate loading station, a tailings thickening station, a main electrical substation, mechanical maintenance workshops, a laboratory, a warehouse, locker/shower rooms, administrative offices, a nursery, a gatehouse, etc.

The **Work Camp** zone, covering an area of 4.8 ha, is located northeast of Lac du Grizzly, approximately 20 m from the shoreline and ±300 m southwest of the Plant zone. The Work Camp zone extends over ±400 m from north to south and ±200 m from east to west. It will feature buildings for employee accommodations and services, most notably a kitchen and dining room. During the mine’s exploitation period, 17 dormitory-type buildings will be installed. This number will be temporarily increased to 30 during the construction period. The Work Camp zone will also feature drinking water supply and wastewater treatment facilities, which will serve both the Work camp and Plant zones. These facilities will be located to the northwest and northeast of the Work Camp platform, respectively.

The **Water intake** zone covers an area of 0.33 ha and is located on the eastern shore of Lac a Paul, ±1.25 km from the Work Camp zone and ±2.1 km from the Plant zone.

18.2.5.3 Tailings Pond Sector

The Tailings Pond Sector is located ±3 km southeast of Lac a Paul and ±2 km from the plant. This sector extends ±2.3 km from north to south, and ±3.4 km from east to west. It is primarily composed of tailings piles with dikes, roads and water management equipment such as pumping stations, pipelines and ditches. By the end of the mining period, the piles will cover ±530 ha.

An above-ground effluent pipe will transfer effluents from the Processing Plant to the Tailings Pond and a water line will return treated water from the Tailings Pond to the plant. A recovery basin will allow the plant's effluent line to drain at its minimum level. Two other basins and ditches with watertight walls are also planned along the effluent pipeline to deal with any possible leaks.

The Camp will be located at approximately 0.5 km south-west of the mill area. Permanent housing will be built on the basis on National Code and will accommodate approximately 280 staff and operation personnel. Every modular building is ventilated, air conditioned and equipped with portable fire extinguishers.

18.2.6 Site Roads

The infrastructure work planned for the three main, previously identified sectors is presented below.

18.2.6.1 Local Roads and Mining Roads

Local roads will be used to access the various industrial sites and services, as well as to transport the concentrate to urban centres. Mining roads will be used for activities relating to mining production.

Local roads will intersect the existing Chemin-des-Passes. They will have a gravel surface and be 10 m wide, accommodating regular, non-mining vehicle traffic. There will be a total of ±11.4 km of local roads.

Mining roads will be built between the mining zone, the main crusher zone and the North waste-rock pile zone. Mining roads will have a gravel surface and be 28 m wide, accommodating mining vehicles, fuel trucks, maintenance vehicles, vehicles transporting explosives and vehicles transporting workers to and from the Mining and Explosives zones. There will be a total of ±3.2 km of mining roads.

All roads will be equipped with the appropriate information, regulatory and warning signs.

With the exception of Chemin-des-Passes, the existing paths and/or development roads on site are not adequate for the project's needs during the mining period. As a result, all of the local and mining roads needed for the project will require full construction.

With regards to Chemin-des-Passes, 2.5 km of it will be relocated due to the construction of the main crusher, the warehouse and garage platforms, as well as the refuelling area (Crusher zone described above).

18.2.6.2 Site Preparation

The work listed below will be performed at each industrial and service sites, as well as the Work Camp site:

- Land clearing and grubbing.
- Stripping of topsoil.

- Excavation and backfilling with adequate material up to infrastructure elevation, for construction of work platforms.

18.2.6.3 Layout of the Industrial and Work Camp Sites

The industrial and service sites will be laid out with the following components:

- Gravel roads.
- Gravel yards.
- Information, regulatory and warning signs.
- Perimeter fences with gates.

18.2.7 Site Buildings

In addition to the Crusher and the concentrator buildings which will house grinding, magnetic separation, flotation, concentrate filtering and drying, the site will include these other buildings (See Figure 18.2.9 or Appendix 8 for a magnified view):

- The administrative offices, a server room, nursing and a cafeteria located within the same building.
- The laboratory.
- The showers and lockers.
- The garage.
- The fuel storage & distribution.
- The gatehouse and war room.
- The warehouse shelter.

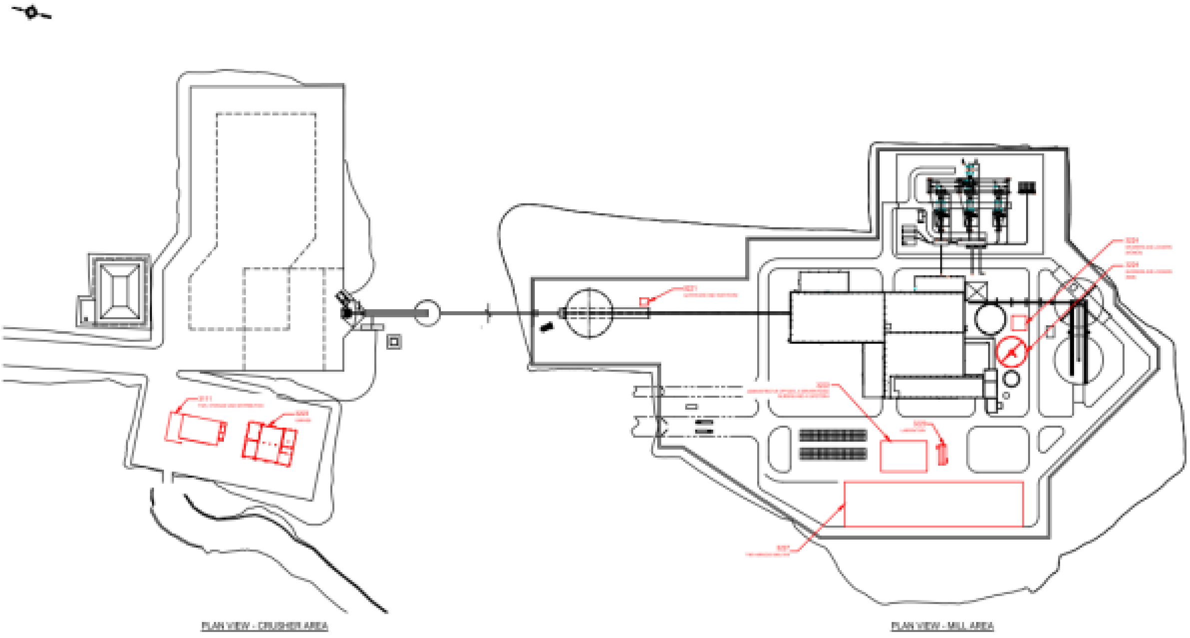


Figure 18.2.9   Site Buildings Layout

18.2.7.1 Building Services

18.2.7.1.1 Plumbing, water distribution and drainage

Mill buildings where mining equipment or floor wash-down operations will be required are equipped with reel hoses and a floor washing water system. Additionally, specific buildings will include oil and grease technology in drainage system to intercept potential petroleum based product spills on the floor.

18.2.7.1.2 Emergency showers

Emergency showers and emergency eye showers are installed in the most pertinent locations of the mill.

18.2.7.1.3 Compressed air

The Crusher building includes two air compressors, one for normal operation and the second one acting as a standby unit. The compressed air is primarily used for the instruments and dust collection.

The mill building is also equipped with two compressors, one of them being a standby unit again. Most of the compressed air will supply the flotation process, instruments, maintenance pneumatic tooling, dust collectors and dry fire protection sprinkler systems.

18.2.7.1.4 Heating, Ventilating and Air Conditioning (HVAC)

The HVAC systems supply the air and heat required for human occupancy and for air make up needs. Electricity will be the heating energy source.

All systems are designed to provide the minimum required fresh air for winter to keep heating cost as low as possible. They are all controlled to optimise efficiency and centralised to ensure proper operation.

18.2.7.1.5 Fire protection

In compliance with local regulations and insurance requirements, the fire protection systems are adapted to each significant plant area according to their specific requirements.

All areas are equipped with portable fire extinguishers. Fire cabinet hose systems are required in the process plant. Electrical rooms, mechanical rooms, hydraulic rooms, garage and conveyors are protected by sprinklers. Where freezing point can be reached, systems are dry. Gaseous fire suppression FM-200 systems (clean agent systems) are considered for control rooms and computer rooms.

18.2.7.1.6 Dust control

Hoods and ductworks are installed at the most significant dust emission points of the process line.

18.2.7.2 Fuel Storage & Distribution

A fueling station including fuel storage and distribution facilities is located close to the crusher. The fuel is transported by tank trucks and stored in fuel tanks with sufficient volume for few days of operation. The mining equipment on the extraction site will be serviced by a tanker truck while the remaining mine auxiliary fleet can be fuelled directly at the station.

The above ground fuel tanks will be of the full secondary, double wall containment design as specified in the CAN/ULC-S601-07 standard. Furthermore, the construction will be executed according to the article 8.12 of « chapitre VIII du Code de construction du Québec » and an official certificate of conformity will be issued accordingly.

18.2.8 Site Services – Water Management

18.2.8.1 Fresh Water Supply

Fresh water will be supplied from Lac a Paul from an intake located on the eastern shore. Fresh water is required for processing and for fire protection in the Plant zone.

The system will mainly be composed of the water intake, a screening station, a pumping station and a 300-mm diameter outlet pipeline (± 2.5 km in length) delivering the water to the processing plant. The system will have a rated capacity of 500 m^3/hour.

18.2.8.2 Drinking Water Supply

Drinking water will be supplied through 2 distinct systems.

The main station will supply the Work Camp, Plant and Crusher zones. It will be located near the Work Camp zone; the main pipelines will carry drinking water to the Plant and Crusher zones. The station will be equipped with 2 artesian wells, chlorination and other treatment equipment (if required), a 24-hour operating reserve for consumption, a firefighting reserve, and a pumping station for distribution. The firefighting reserve is exclusively for the Work Camp sector. The system, with a rated capacity of at least 145 m^3/day, will adequately supply all employees on the site.

The Explosives zone (processing building) will be serviced by an artesian well and will include a minimum operating reserve. No water treatment facilities are planned for this zone; drinking fountains with bottled water will be added if the water drawn from the well does not meet quality standards and requirements for human consumption.

18.2.8.3 Underground Service Systems

A drinking water distribution system totaling ±4.6 km of pipelines is planned to service the Work Camp, Plant and Crusher zones. The drinking water system will also be used for fire protection in the Work Camp zone.

A fire protection system totaling ±1.2 km of pipeline is planned to service the plant zone.

A wastewater collection network totaling ±2.8 km of pipeline is planned to service the Work Camp and Plant zones.

18.2.8.4 Wastewater Treatment

Wastewater will be treated by three distinct systems.

One main treatment station will treat wastewater from the Plant and the Work Camp. The wastewater will be sent to the treatment station through the wastewater collection network. The station's rated capacity will be at least 145 m^3/day during the exploitation period. Temporary equipment will be added during the construction period to increase the capacity to 290 m^3/day, since the number of workers during the construction period will be higher than the number of permanent workers during the exploitation period. This temporary equipment will be dismantled at the end of the construction period.

The wastewater from the Crusher and Explosives zones will be treated by two typical septic systems (septic tank and filtering elements). Each of these two systems will have a maximum rated capacity of 3.24 m^3/day; this capacity will suffice for the low number of employees in these zones.

18.2.8.5 Management and Treatment of Runoff

Runoff from the yards in the industrial zones (plant and crusher), service sites (water intake, drinking water, wastewater treatment, explosives, etc.) as well as the Work Camp will be collected by open drainage systems (ditches and culverts).

All drainage networks will be directed to the retention and treatment (settling or sedimentation) tanks before being discharged into the various receiving environments.

Two runoff measuring and sampling stations are planned: one in the crusher zone and one in the plant zone. The stations will be at the outlet of the retention and treatment tanks, before discharge into their respective receiving environments.

18.2.9 Site Power and Automation

18.2.9.1 Power Supply Facilities

The overall power demand required for the operation is estimated at 115 MW of which 107 MW is required for the process. The annual electrical consumption is estimated at 961 GW/h.

Based on the power requirements, three oil type transformers, rated at 161/25 kV, 45/60/75 MVA were selected to ensure the operation of the plant. Redundancy is designed in so that if one transformer fails, the two others will supply the total load of the plant.

The 25 kV distribution network, from the main substation to various areas, will be provided by air insulated switchgear installed in a separate prefabricated building. This building will be installed in the main 161 kV substation. Three harmonic filters will be used to ensure current and voltage quality and to optimize the power factor.

Three 25 kV overhead lines will be erected from the main substation to supply remote areas. These lines will supply electrical power to:

- The permanent camp and water treatment station.
- The tailing area.
- The fresh process water system and pumping station.

As electricity will be needed in the future for the extracting zone, it is planned to install two mobile substations with a 25/4.16 kV, 7.5 MVA transformer and five outdoor walk-in switchgears near the open-pit mine to supply power to the electrical shovel and the pump house.

The crusher electrical room and the coarse ore stockpile electrical room will be supplied from the drive house area by the means of cables running underground and through the conveyor.

An emergency system including two 2.5 MW standby diesel generator sets and a 4.16 kV synchronization bus will be installed in the main substation. A total of 5 MW can thus be supplied to critical process equipment and essential services during a main power outage.

The main concentrator building will include four electrical rooms to distribute the power at different voltages to process area through step-down transformers depending on the local requirements. The voltages will be 25 kV, 4.16 kV and 600 V.

18.2.9.2 Site Power and Automation

A communication network link between the Lac a Paul mining site and Arianne's other facilities is achieved via microwave and fiber optic links service providers. A new microwave tower will need to be built near the mining site. At either end of the microwave link, the networking medium changes over to a mix of fiber optic and standard RJ-45 copper cables to reach the end users' equipment.

The Process Control System (PCS) comprises three (3) control rooms (mill, crusher, load-out) and Engineering Workstations.

Due to the large footprint of the process site, a modular control strategy is used. There are 60 I/O panels distributed throughout the process area and 5 processor panels located in different electrical rooms of the mining site. The I/O signals are connected to input/output type cards mounted in the closest I/O panels. An automation dedicated fiber optic network links the I/O panels to the relevant processor panels of the mining site.

The redundant servers located in the computer rooms will provide data collection, historical trending and process control. Field instrumentation will be a combination of 4-20 mA signal devices and intelligent Hart transmitters. The control system will be easy to maintain and troubleshoot. The plant I/O will comprise approximately 535 analog points, 5,105 discrete points, 106 Resistance Temperature Detector (RTD) points, 306 intelligent motor starters, 6 intelligent Soft Starts and 41 intelligent Variable Frequency Drives. This system's design strategy sets a high level of confidence as to the robustness of the automatic operation of the plant.

Allowances have been included in the estimate for field instrumentation, automation, IT infrastructure, communication system, fire detection system and security system.

19. Marketing Studies and Contracts

Two separate market analysis reports were commissioned in support of this Feasibility Study, the first by CRU International Ltd. and the second by Integer Research Limited, both of London, England. Both reports are respectively on Appendices 1 and 2.

The CRU report, dated from May 2013, focuses on the macro-market outlook for Arianne product, including analyses of the global agricultural markets, the implications for phosphate fertilizer demand, and the expected phosphate production response from existing and new suppliers. The cost analysis of existing and new mining operations factors prominently in CRU's predictions for phosphate rock prices over the life of the Lac a Paul Mine. CRU also provides an analysis of the potential markets for Arianne's phosphate rock, but focuses solely on a competitive pricing model relative to fertilizer producers' value-in-use across global markets in North America, Europe, India and Southeast Asia.

While the Integer report, dated from July 2013, also analyzes global phosphate fertilizer demand based on a macro-agricultural market outlook and specific new projects that it sees coming into the market, it focuses more specifically on price premium opportunities available by virtue of Arianne's high-P_2O_5, low-impurity content phosphate rock product, particularly the applications and customers which are known for paying significantly higher prices than those paid for fertilizer products.

Both reports provide a baseline benchmark price forecast for the largest global phosphate rock supply point and dominant commercial force in the industry, the Country of Morocco. Of particular note is the market discipline expected of the key players in an oligopolistic market; it is expected to cause an extended period of time over which constant dollar market prices for standard-grade phosphate rock exports may prevail at a low enough level to minimize investment in new phosphate capacity. It is expected that market prices will remain just below what is required for investment in certain high-cost greenfield phosphate rock mining projects, which is roughly 15-20% below the level of today's market prices of around $150/t FOB Casablanca.

The key aspects highlighted by both reports are Arianne's high-quality product, its proximity to importing markets, and its low geopolitical risks, making its product very desirable to both the fertilizer and high-purity phosphoric acid producers alike.

The reports are relatively consistent in expectations for benchmark Moroccan-quality export concentrate prices over the life of the Lac a Paul Mine, with a relative spread of ±15%. However, the CRU report credits Arianne with a selling price reflecting only P_2O_5 content, freight differentials and the cost of the acid necessary to convert the phosphate rock concentrate into fertilizer products at various consumer destinations. The Integer report also develops a premium based on value-in-use to high-purity phosphate product producers, also across various customer locations such as the US Gulf, Brazil and Northern Europe.

Based on the marketability of the concentrate as discussed in both reports, Arianne has developed a marketing plan for the life of the Lac a Paul Mine which includes both fertilizer customers and high-purity product customers, across various destinations where demand exists for product with the characteristics verified by the metallurgical testwork included in the product quality sections of this report.

Arianne expects to ramp up and produce 1.5Mt of product in its first full year of production and to reach its full capacity in the range of 3Mt on its second full year of production.

Based on expectations for fairly rigorous product testing protocols at high-purity phosphate customers, it is assumed that Arianne sells no product to these consumers in its first year of production, and successfully ramps up sales to these customers to two-thirds of its production, or 2 million Mt/yr, by year four. These sales are spread across known consumers of high-purity phosphate rock in Brazil, the Southeastern US and Northern Europe. The balance of Arianne's sales is assumed to be made to fertilizer producers in North America, particularly where Arianne has a relative freight advantage to Morocco, most notably Vancouver, B.C.

Using the projections from both CRU and Integer reports, Arianne has modeled its sales price forecast (in constant 2013 US$/t) over the life of the Lac a Paul Mine and in summary, the following figures in Table 19.1.1 were used (Appendix 9 provides more details):

Item	Selling Price $USD
Average Benchmark Morocco price for 65-75 BPL rock FOB Morocco	137
Price adj. for freight, P_2O_5 content and acid to N.A. fertilizer producers	60
Price adj. for delivery to Brazilian and European high-purity producers	80
Price adj. for delivery to US and Gulf high-purity producers	91
Average price for sales mix (1/3 to each market zone)	**213**

Table 19.1.1 Selling Price Forecast Summary from Arianne

The price adjustment for fertilizer producers is based on long-range projections by CRU for freight costs (which include a fuel cost projection), sulfuric acid prices and a P_2O_5 content of 39% for Arianne concentrate.

The price adjustments provided by Integer for sales to high-purity customers considers the minor elements contained in Arianne's concentrate, including Magnetite, Alumina, Magnesia, Sodium, Potassium, Fluorine, Silica, Cadmium, Arsenic, Uranium, Thorium, Lead and Chlorine; also considered, as with the CRU report were Phosphate (P_2O_5) and Calcite (CaO).

The price adjustments provided by Integer also consider the production capacity of other supply sources to various high-purity customers. This detailed analysis of Arianne's competitors includes a review of costs, mine life, new resource development costs and location advantage.

19.1 Global Phosphate Market

North America is the world's third largest producer of phosphates after China and Morocco, exploiting the large reserves of phosphate rock concentrated mostly around Florida in the southeastern United States. The large volume of rock extraction is expected to decline slowly due to resource depletion, leaving some phosphate chemical producers in need of new sources of rock and this creates a market for Arianne's project in Lac a Paul, Canada. In addition, the rock from Lac a Paul is of high grade with at least 38% P_2O_5 and low impurity content, as is required by high value specialty phosphate producers in various parts of the world. Supply of high quality phosphate rock is significantly more limited than standard grade phosphate rock, a situation that can add considerable premium for Arianne's production.

It is worth noting that both the CRU and Integer market study reports identify similar geographical locations where Arianne could potentially sell their product. The areas include South Eastern United States, the United States Gulf, North Western Europe, Brazil and Western Canada namely Vancouver.

19.1.1 North America

North America accounts for approximately 20% of global acid capacity. The US-based operations are concentrated in the south-east of the country, primarily across Florida, North Carolina and Louisiana. Plants in Florida and North Carolina are all integrated with upstream mining capacity, whereas those along the Gulf Coast (Louisiana and Mississippi) operate using purchased rock. In total, there were eleven operating plants in the USA during 2011, with a combined acidulation capacity of 9.2 million tpy P_2O_5 in 2011.

Four of the North American plants are operated by Mosaic, which also runs the region's largest, New Wales. As a whole, the company's acidulation capacity stood at 4.3 million tonnes P_2O_5 in 2011, making it the second largest acid producer around the world (behind OCP).

PotashCorp is North America's second largest phosphate producer, accounting for about 25% of its capacity. Its operations are spread across Florida, Louisiana and North Carolina. The latter (Aurora, North Carolina) is PotashCorp's largest, accounting for half its total phosphoric acid capacity. PotashCorp had been planning to further enhance the plant by developing a new sulphur melting facility at Morehead City; however, due to widespread public opposition, the plan has subsequently been scrapped. At present, CRU is not aware of any additional developments at PotashCorp's plants. Thus we expect its capacity to remain constant at 2.4 million tonnes P_2O_5 acid.

Most North American operations are integrated vertically with phosphate rock capacity. As much of this is good grade, located close to their respective phosphoric units, they have remained competitive even as existing plants/mines have aged. In fact, most of the region's capacity falls within the first two quartiles of the global production cost curve.

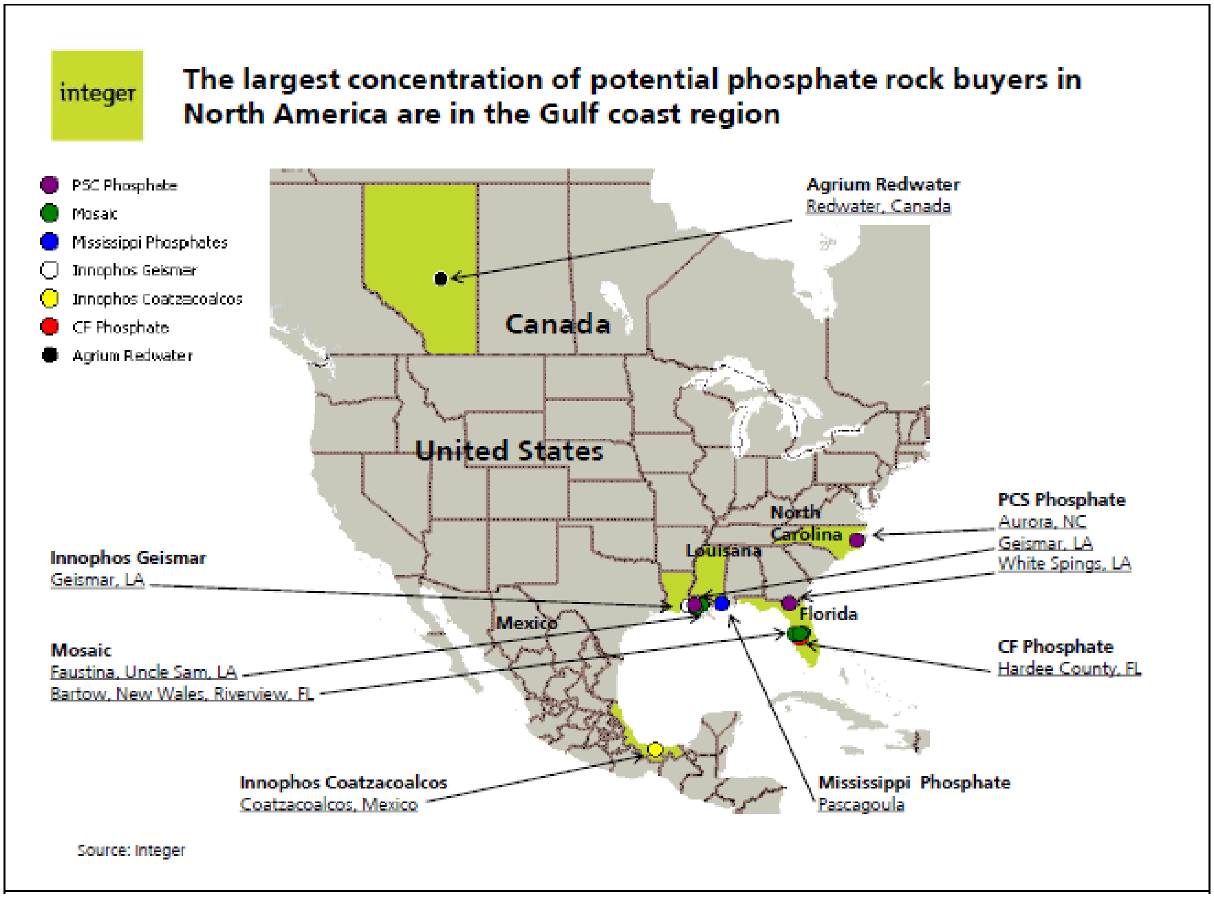
There are three US plants that use imported rock. Mosaic uses Peruvian rock from its Bayovar JV, in its acid plant in Louisiana (Uncle Sam/Faustina complex). Similarly, PotashCorp uses high grade rock from OCP's Bou Craa mine in North Africa at its Geismar complex. CRU believes these plants have a secure future. However, we are less certain of the prospects at the third importer, Mississippi Phosphates' plant in Pascagoula. The plant has encountered various operating problems in recent years, and most recently an explosion in June 2012, led to a forced shut-down by the US OSHA. Although the plant is back in operation, and even reported an operating profit for Q2 2012, conditions are likely to remain tough. The plant is old, and in need of new capital investment.

In Canada, there are likely to be changes at Agrium's Redwater plant. The plant produces MAP and a host of nitrogen products. The rock feedstock is currently sourced from Kapuskasing (Ontario), but is set to shift to Moroccan rock, as Kapuskasing is scheduled for closure in H2 2013. The contract with OCP is a "take-or-pay" agreement, running from H2 2013 through to 2020, with an option to extend for a further two years.

Although details have not yet been made public, pricing is reportedly a formula based calculation based on global DAP prices. One certainty, though, is the new supply arrangement will result in a considerable increase in the relative cost position of this plant. Redwater is a long way away from

Morocco (Vancouver is 8,300 nautical miles from Casablanca and Redwater is an additional 1,200 km by rail). That said, CRU's base case forecast is that Redwater will continue to operate over the medium term. Clearly, it represents a marketing opportunity for Lac a Paul once the OCP contract expires (or indeed potential exists for a swap transaction).

North America's remaining capacity is shared between CF Industries (Florida), Simplot (Wyoming and Idaho) and Agrium (Idaho), all of which are vertically integrated. One of the more significant developments at these locations includes Simplot's proposed expansion of its liquid and dry phosphate production at Rock Springs, which may be completed as soon as 2014.



Source: Integer

Figure 19.1.1 Geographical Location of Phosphate Potential Buyers in North America

Despite its location advantage, North America offers limited marketing opportunities for Lac a Paul. Wet Process Phosphoric Acid (WPA) capacity is expected to be flat and the majority of the plants are integrated. The main opportunity is clearly in Canada with Agrium. There may be limited US opportunities by shipping to the Gulf Coast. Another opportunity may open up if some of the Florida based plants are unable to secure environmental permits for the new mines they require to replace those that will deplete by 2020. In particular, Mosaic is facing challenges in this regard.

19.1.2 Europe

Europe (outside a very small quantity of rock produced in Finland) is entirely dependent on imported phosphate rock. It obtains most of this from Morocco. However, European rock consumption has diminished dramatically in recent years. This has particularly been the case in Western Europe where acid production has ceased in Denmark and been dramatically curtailed in France and Spain. Prior to 2005 Western European rock consumption had been running at 7-8 million tpy. It was under 5 milllion tpy in 2011 and CRU expects it will decline further to 4 million tpy by the 2015-2020 period. The main rock consuming countries are Belgium, Netherlands, Norway and Finland. However, Finland is vertically integrated and is actually a small net exporter of rock.

In Eastern Europe, rock consumption has remained more stable at around 3.5 million tpy and CRU expects this to continue for the medium term. The largest sources of demand are Poland and Lithuania which each imports 1.25- 1.5 million tpy of rock annually. **Eurochem** is the leading company in Lithuania and supplies its plant with phosphate rock from the Koydorky GOK apatite mine, located in the Kola Peninsula. However, Lithuania also imports some rock from Morocco.

It is CRU's opinion that Lac a Paul can potentially sell rock into the European market. All of the countries mentioned import rock from both North Africa (Morocco and Tunisia) and Russia and a number of them also import from the Middle East (Israel and Syria). However, this is arguably the most competitive part of the market. Moreover, European rock demand is unlikely to increase so it is a matter of displacing an incumbent supplier, which is always challenging. It seems clear that most European chemical producers are likely to meet growth in their markets by investing in downstream joint ventures with offshore mining companies and, in fact OCP has already engaged in several transactions of this nature.

In 2011, Western and Central Europe imported a total of 854,600 tonnes of phosphate rock with 36% or above P_2O_5 content, of which 604,100 tonnes were imported from Russia, which is the only significant export supplier of igneous rock with typical 38--39% P_2O_5 content. In addition, Yara Finland produced 870,000 tonnes of apatite phosphate rock at its Siilinjarvi mine, a resource that is expected to last at least 20 more years. Given that additional production is likely to become more expensive due to the increasing depth of igneous apatite reserves, as mining progresses, Yara may become increasingly reliant on imports in the future.

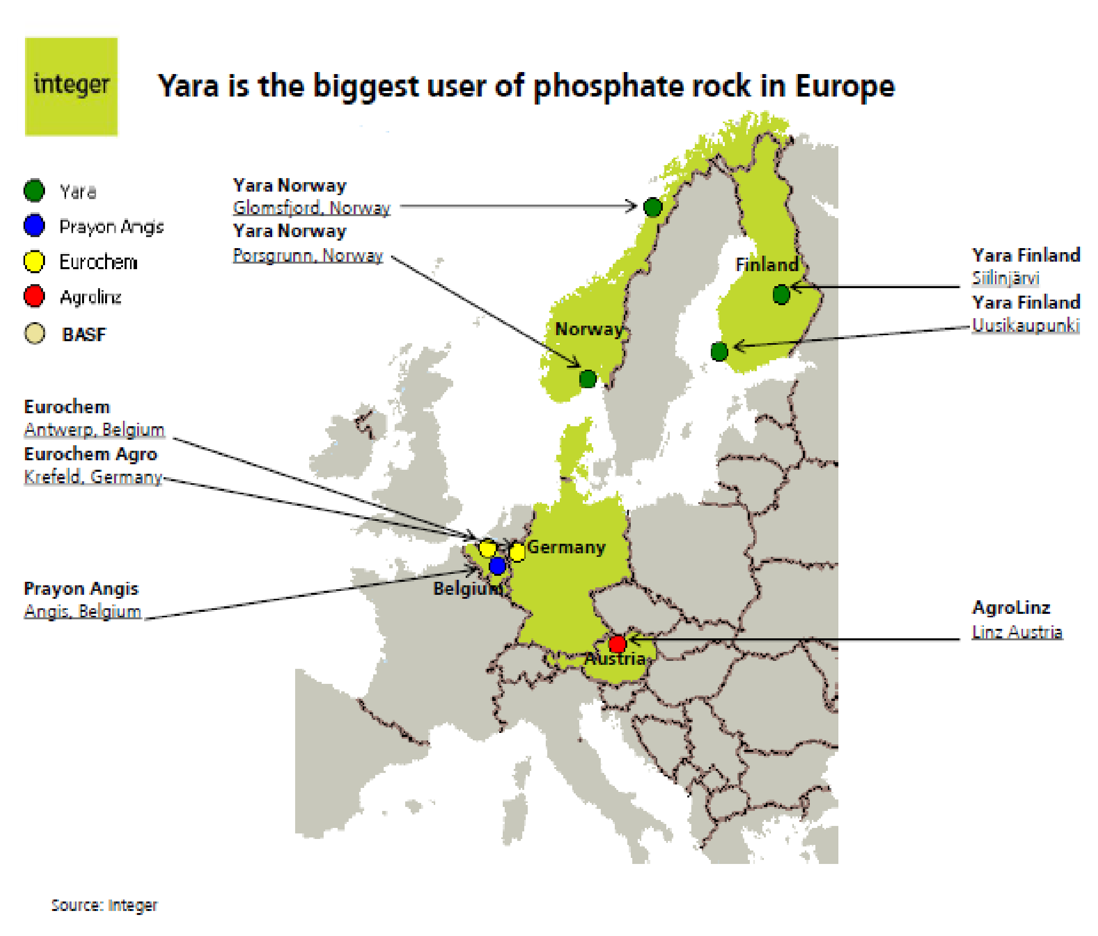


Figure 19.1.2 Geographical Location of Phosphate Potential Buyers in Europe

19.1.3 Latin America

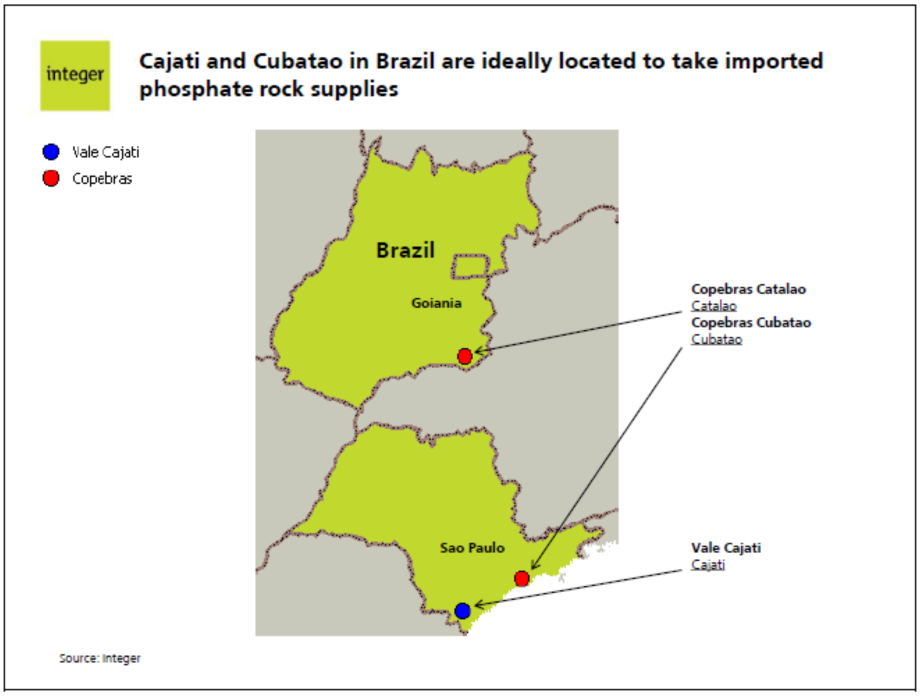
Latin America phosphate rock consumption is on a rising trend. Regional demand is now around 10.5 million tpy, up from 8 million tpy in the early 2000s. CRU expects it to reach 12 million tpy by 2015 or shortly thereafter. Almost all of this is in Mexico (around 2.5 million tpy) and Brazil (7 million tpy). Brazil is growing much faster than Mexico. Both countries have domestic rock supply but, at the margin, are net importers. These imports are currently running at 1.5 million tpy in the case of Brazil and 0.8 million tpy in the case of Mexico. In both cases, supply is contested between Peru and Morocco.

Brazil has ambitious plans to reduce its current dependence on imported MAP by an expansion in domestic production. CRU in their market study report has identified four key projects in this regards:

- **Vale** completed a brownfield expansion project at its Uberaba plant in Q3 2012.

- Vale also plans to build a greenfield development at Salitre, Minas Gerais, which includes a 2.0 million tonnes/year rock mine as well as MAP and TSP facilities. Although Vale has recently pushed back the commissioning of the R$2 billion project to 2016. Once the project is completed it is expected to have a total phosphoric acid capacity of 0.6 million tonnes/year P_2O_5, in addition to 0.8 million tonnes/year of MAP and 0.3 million tonnes/year of TSP.
- **Copebras** is planning to revamp production at its Catalao plant, which will be completed through a series of debottlenecking measures, specifically on the phosphoric acid and phosphate rock sides. The project, listed as probable, is forecast to come on-stream by 2015 and will increase capacities at the facility to a total of 0.2 million tonnes/year P_2O_5 phosphoric acid and 0.3 million tonnes of MAP.
- Copebras is also planning a brownfield expansion of its Catalao plant, with the aim to increase rock capacity to 2.6 million tonnes rock by 2013. Although the company is still unclear about what products it will produce, the likelihood is it will focus production on MAP, TSP and/or DCP. If this is the case, and if capacities are increased in their entirety, the project will see phosphoric acid capacity increase to 0.4 million tonnes P_2O_5 in addition to 0.5 million tonnes of MAP and 0.3 million tonnes of TSP.

These increases in Brazilian acid production will be met by parallel increases in phosphate rock mine production. Indeed there is the likelihood that Brazil will raise mine production by more than acid production so the current net import rate is forecast by CRU to decline. Consequently, the prospects of placing Lac a Paul product in this region are not considered to be particularly promising.



Source: Integer

Figure 19.1.3 Geographical Location of Phosphate Potential Buyers in Latin America

19.1.4 Market Forecasts

The Integer market report discusses market demand in terms of compound average growth rate (CAGR) of the global phosphate rock market was 2.0% between 2000 --2011, measured by production which grew by 35.7 million tonnes. Looking forward, phosphate demand fundamentals appear to be robust.

- The global population is expected to grow by approximately 300--400 million every five years.
- Income growth in developing countries tends to stimulate a change toward more varied and meat based, more crop intensive diets.
- Despite weak growth prospects in developed countries, incomes of developing countries will continue to rise and diets will change and become more crop intensive.
- Phosphate rock prices eased during H2 2012 and continued to fall in early 2013, down 25% year--on--year in June 2013. However, prices remain high by historical standards and supportive of robust demand for agricultural inputs like phosphate fertilizers.

In order to produce more food, crop production must intensify and yields must increase. Arable land area is flat in absolute terms and falling per capita, and opportunities to boost crop production by increasing arable area are limited. Fertilizers are essential to raising crop yields where application rates are below optimal or imbalanced, and insufficient use of phosphate fertilizer is frequently a yield constraint. As such, Integer expects to see a continued phosphate rock demand growth looking forward.

The integer report goes on to discuss new phosphate rock production capacity will be required in order to meet demand growth in the long term. There are large phosphate rock expansion projects being developed or under consideration by established producers in China, Morocco, Jordan, Tunisia and Brazil. In addition, high phosphate rock prices have encouraged a number of exploration companies to develop phosphate rock projects around the world.

There are also a large number of more speculative greenfield projects that are mainly being developed by junior mining companies. The most advanced projects include Sunkar Resources (Chilisai), GB Minerals (Farim), Minbos Resources (Cacata/Kanzi), Stonegate Agricom (Paris Hills), Cominco Resources (Hinda), MBAC Fertilizer (Santana), Vale (Nampula), Minemakers (Wonarah), Celamin Holdings (Chaketma) and B&A Mineracao (Bonito). The timing of completion of many of the greenfield projects is likely to be highly sensitive to market conditions, how prices and industry profits develop and the availability of finance. It is also important to note that greenfield projects will take a number of years to reach their full operational capacity.

19.1.5 Arianne Phosphate Inc. Marketing Plan

The CRU and Integer marketing study reports both identify possible geographical markets into which Arianne could sell their product. The Arianne product will be expected to compete as previously mentioned with the likes of material from the Apatit in Kola Peninsula in Russia and Foskor in South Africa for high purity phosphate rock.

Arianne in deriving a market plan has targeted two market segments namely high purity rock sales and fertilizer manufacture sales. The location of the targeted markets for the high purity sales is Brazil, North West Europe and the SE United States and Gulf. The geographical regions for the sale of material into the fertilizer manufacturing sector are Western Canada (Vancouver) and the United States gulf region.

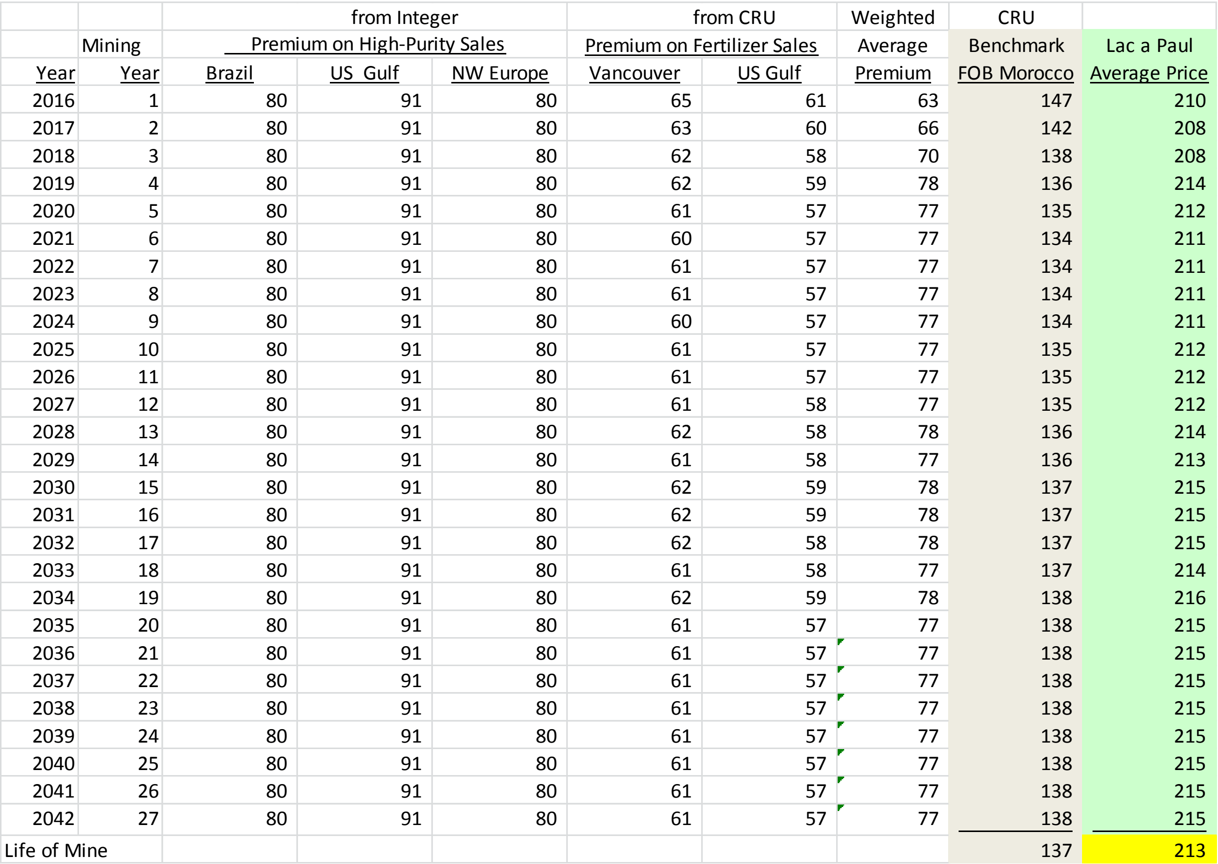
19.1.6 Sales Price Forecast

The sales price forecast has been developed by Arianne based on credible data contained in the two third party marketing study reports. The marketing study reports have been prepared by CRU International and Integer Research.

The data from CRU indicated a forecast sales price for the Arianne product in a range of US$185 per ton to US$200 per ton. The Integer report forecasts a high-purity premium of between $80 and $91/t based on their assessment of the existing market for Arianne's high-grade (39% P_2O_5) concentrate.

The Arianne base case concentrate price model has been derived by Arianne and is based on credible cost input data from marketing studies by CRU International (Price forecast base date May 2013) and Integer Research Limited (forecast base date July 2013).

Arianne has used the CRU “Benchmark FOB Morocco US$/t” as a basis to calculate the Lac a Paul Average price of US$213 per ton.



		from Integer			from CRU		Weighted	CRU	
	Mining	Premium on High-Purity Sales			Premium on Fertilizer Sales		Average	Benchmark	Lac a Paul
Year	Year	Brazil	US Gulf	NW Europe	Vancouver	US Gulf	Premium	FOB Morocco	Average Price
2016	1	80	91	80	65	61	63	147	210
2017	2	80	91	80	63	60	66	142	208
2018	3	80	91	80	62	58	70	138	208
2019	4	80	91	80	62	59	78	136	214
2020	5	80	91	80	61	57	77	135	212
2021	6	80	91	80	60	57	77	134	211
2022	7	80	91	80	61	57	77	134	211
2023	8	80	91	80	61	57	77	134	211
2024	9	80	91	80	60	57	77	134	211
2025	10	80	91	80	61	57	77	135	212
2026	11	80	91	80	61	57	77	135	212
2027	12	80	91	80	61	58	77	135	212
2028	13	80	91	80	62	58	78	136	214
2029	14	80	91	80	61	58	77	136	213
2030	15	80	91	80	62	59	78	137	215
2031	16	80	91	80	62	59	78	137	215
2032	17	80	91	80	62	58	78	137	215
2033	18	80	91	80	61	58	77	137	214
2034	19	80	91	80	62	59	78	138	216
2035	20	80	91	80	61	57	77	138	215
2036	21	80	91	80	61	57	77	138	215
2037	22	80	91	80	61	57	77	138	215
2038	23	80	91	80	61	57	77	138	215
2039	24	80	91	80	61	57	77	138	215
2040	25	80	91	80	61	57	77	138	215
2041	26	80	91	80	61	57	77	138	215
2042	27	80	91	80	61	57	77	138	215
Life of Mine								137	213

Note 1 - *The Lac a Paul Phosphate Project: Market outlook and competitive position – CRU International, 21 June 2013, CS Reference number: 430571*

Note 2 - *Study in support of FS for Arianne's Lac a Paul phosphate rock deposit in Canada, Integer Research Limited, July 2013,*

Table 19.1.2 Selling Price Forecast Analysis by Arianne

The Lac a Paul Average Price (US$/t) is derived from the CRU Benchmark FOB Moroccan price (US$/t) plus a weighted average premium. The weighted average premium (US$/t) is based on the Arianne predicted sales tonnage by location (and sales type – High Purity rock customer or Fertilizer customer) multiplied by the premium for the two customer groups. The premium data by location for the high purity sales was derived from the Integer market study and the premium data for the fertilizer sales was derived from the CRU market study.

The Lac a Paul Average price in US$/t over a 25.75 year life of mine is calculated by Arianne to be US$ 213/t.

19.2 Contracts

No sales contract and no letter of intent have been secured at this stage of the project.

20. ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

20.1 Description of the Biophysical Components

20.1.1 Physical Components

20.1.1.1 Substrates

The Lac a Paul mining site, located in the Canadian Shield's Grenville geological province, contains an Anorthositic suite of the Lac-Saint-Jean Group, and is characterized by apatite-rich facies (gabbronorites, norites and leuconorites). There are regional shear planes to the east and west, sometimes corresponding to geological contacts.

The maximum altitude is 540 m, the Lac a Paul site being at an elevation of 401 m while the Manouane River is at an elevation of between 370 and 400 m. Surface materials are mostly made up of variable thicknesses of glacial and glaciofluvial deposits.

20.1.1.2 Water

20.1.1.2.1 Hydrology

The study area's hydrographic network shows a large density of lakes and watercourses draining into Lac a Paul to the south and west, and into the Manouane River to the north-east.

20.1.1.2.2 Surface Water and Sediment

The results from the September 2011 and July 2012 sampling surveys show that the quality of surface water for both lotic and lentic environments is qualified as good, and the aquatic environment protection criteria are generally respected. These results are what would be expected under current conditions, which are virgin and wild without human activity except for the outfitter.

In the case of sediment, concentrations are below recommended regulatory thresholds.

20.1.1.2.3 Groundwater

The water table at the surficial deposits level is relatively shallow (2 to 3 m deep) and the underground flow follows the surface topography's flow. The hydrogeology study shows that the groundwater drawdown is significant in the bedrock aquifer but not significant in the surficial deposit aquifer. The degree of fracturing in the bedrock is relatively low, and the hydraulic conductivity is typical of the Saguenay–Lac-Saint-Jean region (order of magnitude between 1E-07 and 1E-06 m/min).

20.1.1.3 Air

Lac a Paul is located in an isolated area, without industrial activity. The only source of dust is the passage of vehicles using the forest road to reach the mine site.

The air emissions and dispersion generated by the Lac a Paul mining operations are currently being modelled.

20.1.2 Biological Components & Species at Risk

The local study area consists in large part of forest stands (~75% of the study area's total surface) and has dry barren areas (~3%), a burnt area, numerous wetlands (~7%; mainly peat bogs and riparian areas), lakes and watercourses (~15%). There is therefore some diversity in the habitats. According to the literature and the field survey results, besides the vegetation species (including the possible presence of 17 special-status species), there are:

- 5 confirmed species of fish, of which only brook trout and northern pikes are of interest for sports fishing.
- 12 species of amphibians and reptiles, none of which have any special status.
- 83 confirmed species of birds, including 4 endangered nesting species: the olive-sided flycatcher, the rusty blackbird, the common nighthawk and the bald eagle.
- 4 large wildlife species, one of which has double endangered species status: the woodland caribou.
- 22 small wildlife species.
- 18 small mammal species.

The biological environment's main components of interest are: vegetation, aquatic fauna and the woodland caribou.

20.1.2.1 Vegetation

The wetland surface area loss is estimated to be 76.6 ha, which corresponds to 18.5 % of the surface covered by all wetlands within the study area (0.6 % of the study area). Wetlands are protected under Article 22 of the EQA (R.S.Q.., Chapter Q-2).

There are all or parts of five biological refuges in the western portion of the study area. These total 433 ha, of which 278 ha are located within the local study area.

There are 80-year-old jack pine stands, stemming from a fire in 1931; they are of phytosociological interest, and located along the eastern edge of the study area.

20.1.2.2 Aquatic Fauna

The lakes and watercourses cover 2,074 ha of the study area (16.3% of the study area's total surface). While there is little diversity in the aquatic fauna in the local study area's lakes and watercourses, the study area's tributaries show a good diversity in their habitats. Numerous potential spawning grounds were observed in the tributaries and numerous grass beds bordering watercourses provide important aquatic fauna habitat.

20.1.2.3 Caribou

The 1999 inventories confirmed the presence of woodland caribou near the local study area.

Many Authors recognize that the woodland caribou favours peat bogs, mature softwood stands with lichen and other lichen-rich sites when selecting its habitat. It is also recognized that it avoids areas that have recently been disturbed.

In the local study area, the conditions most favourable to woodland caribou in terms of habitat seem to be found in the north-eastern portion of the territory, east of the Lac-Paul Outfitter and north of Lac du Portage. However, there were no caribou sightings in this area during the field surveys. This sector is being targeted by the government, over the next five years (2013-2018), for logging and work to restore forest productivity (scarification, reforestation). It is thus likely that, in the short term, these disturbances will create conditions such that the woodland caribou will avoid the sector.

The federal recovery program's contents, as well as those of Quebec's woodland caribou recovery plan, suggest that it is unlikely that the current conditions in the Lac a Paul Mining Project's local study area will allow for a self-sustaining population.

20.2 Description of the Social Environment

20.2.1 Mine Site Local Study Area

Arianne's mining Project is located within the Fjord-du-Saguenay Regional County Municipality (RCM), more specifically in the Unorganized Territory (UT) of Mont-Valin. The RCM is responsible for managing the territory, which is part of the forestry land use under which the exploitation of natural resources, primary and secondary processing of natural resources, and the extractive industry are Authorized. According to the RCM's UT zoning regulation (N° 04-200), the study area overlaps the 20-2F zone, which Authorizes industrial mining extraction uses.

The 126.6-km^2 local study area is located on Crown land and straddles FMU 024-52, whose land has been certified to the Forest Stewardship Council Canada's (FSC Canada) standard since 2011, and to the Sustainable Forestry Initiative's (SFI) standard since 2007. This land has five beneficiaries of a timber supply and forest management agreement (TSFMA), Arbec Forest Products G.P. being the main holder (nearly 95%) of the volume of timber attributed by the TSFMA.

The local study area consists entirely of Crown land. According to the outfitter's lease, the State is the landowner and the outfitter is the leaseholder. Arianne holds a lease from the Ministère des Ressources naturelles (MRN) for the operation of an outfitter. Thus, almost all of the local study area is dedicated to the outfitter's activities, mainly used for fishing. Other users also frequent this territory which is mainly accessed via Forest Road R0251, including vacationers who have cottages in the area, two forest companies and two Innu communities. There is only one temporary shelter which is the subject of a lease with the MRN within the local study area, but located outside the outfitter's area of operation.

The project site includes the territory straddling the Pekuakamiulnuatsh's (Mashteuiatsh) and Pessamit's (Betsiamites) ancestral Nitassinan. Innu families frequent the project's local study area to hunt, trap, fish and gather berries and plants. Indeed, they have three permanent camps and eight former camp sites along Route R0251 and along the Manouane River. Moreover, the local study area has some archaeological potential, most notably around Arianne's projected permanent workers' camp.

20.2.2 Truck Route Study Area

Trucks transporting apatite concentrate will cross only one RCM territory, which is the RCM of Fjord-du-Saguenay. The truck route study area consists of a 237-km long and 600-m wide corridor on either side of the existing road that will be used to transport the apatite concentrate from the mine to the future Port in Saint-Fulgence, located on the north shore of the Saguenay River. Arianne will study in details this new truck route. The existing road will be improved in some places (curves, slopes) and some bridges will have to be repaired.

The apatite concentrate will be transported by trucks from the mine to Saint-Fulgence (in a former sawmill site) via non-standard routes used by many commercial users. Numerous secondary forest roads have been developed throughout this portion of the study area.

Within the truck route study area, there are no permanent residents, but there are many vacation leases and some Controlled Harvesting Zones (ZEC) and outfitters. The proposed truck route also crosses the Monts-Valin National Park.

The closest cottage to the planned pit is located slightly less than 5 km north-west of the Chute-des-Passes Road at Kilometer 165. The cottage is found outside the local study area limits, but near its limits.

There are two power lines crossing the territory on the west side of the mine local study area. A 345 kV line owned by Hydro-Québec is powered by the Péribonka generating station, while a 161 kV line runs from the Chute-des-Passes dam towards the south and is owned by Rio Tinto Alcan (RTA). The mining site source of energy will be provided by the Chute-des-Passes generating station.

Trucking will end in a former sawmill facility (Saint-Fulgence) and the apatite concentrate will be unloaded in storage facilities. From there, an external operator (Arrimage Saint-Laurent) will operate and maintain equipment used to handle, store and load phosphate rock concentrate in sea vessels. Handling and shipping facilities will have to be built at the unloading area (former sawmill) and at the port. The port infrastructure will also have to be constructed. The port will consist of standard facilities (boats moored to dolphins), suitable to handle this type of concentrate.

20.3 Stakeholder Information & Consultation Process

In a spirit of transparency and so as to provide a better understanding of the Lac a Paul open-pit mine project and of its potential impacts, Arianne is very committed to maintaining good relations with any and all that are affected by the development of its project. Through this information and consultation process, the company was able to incorporate the regional community's sensitive issues and concerns while developing the project.

20.3.1 Community Meetings

A total of 12 community meetings were organized over the last 3 years: four meetings were held in 2011, three in 2012, including one in the community of Mashteuiatsh, and five so far in 2013.

The overriding issues brought up during the first phase of meetings (2011, in Dolbeau-Mistassini and Saguenay) were:

- The expectation of transparency regarding information from Arianne.
- The issue of transportation.
- Maximizing local spinoffs (jobs, training, contracts for local companies); and
- The continuity of commitments in the event that the company were to be sold.

The second phase of meetings, also held in Dolbeau-Mistassini and Saguenay, dealt with the following issues:

- The transportation of apatite concentrate from the mine to the rail network.
- Jobs and economic spinoffs for the region; and
- Environmental impacts.

The issues of greatest priority for the public during these consultations included:

- Maximizing the economic spinoffs for local contractors and recruiting regional personnel.
- Health-safety and training; apprenticeship and mentoring.
- Transparency, dialogue and cohabitation on the territory.
- Local processing of the mine production.
- Transportation over five days a week.
- Protection of the water and soil.

The third phase of meetings (July 2012) took place in Saint-Ludger-de-Milot and Saguenay. The project's progress was presented and the 2011 meetings reviewed. Issues stemming from these additional meetings were mostly related to economic aspects (local spinoffs and jobs), but also environmental ones (respecting the environment, site Closure, etc.) and social concerns (company transparency, respect for the Aboriginal communities and the quality of life of tourists).

During a fourth phase of consultation, Arianne held five meetings regarding transportation. During these meetings the transportation option to Alma was presented. This option was afterwards replaced by the transportation option to Saint-Fulgence. The main concerns involved health and safety (noise, dust, transportation schedules, etc.), cohabitation with other users (tourists, Aboriginals, forestry operators) and economics.

Noteworthy, amongst the improvement ideas proposed by the public during these meetings (Alma option), are:

- Promoting road safety.
- Considering using train transportation from L'Ascension-de-Notre-Seigneur to Alma.
- Improving modes of communication on the Chute-des-Passes Road.
- Setting realistic transportation schedules to avoid peak traffic periods and re-examining the transportation scenarios.
- Further study of the project's economic impact.
- Favouring small local companies during construction and operation of the project.

Applicable proposed recommendations will be taken into account during the development of the Saint-Fulgence option. To this purpose, a community meeting is planned in November 2013 with people from Saint-Fulgence and with other interested parties from the surrounding area of Saint-Fulgence.

20.3.2 Meetings with the First Nations

The Lac a Paul Project is on the Nitassinan[1] of three First Nations: the Innu Nation from Pessamit, Mashteuiatsh and Essipit. Arianne has had an ongoing relationship with the Mashteuiatsh nation since 2008 and with the Pessamit nation since 2010. Discussions with the Essipit nation are planned.

20.3.2.1 Mashteuiatsh

In 2008, a meeting was organized in Mashteuiatsh with representatives from Arianne, the Conseil des Montagnais du Lac-Saint-Jean's (now Pekuakamiulnuatsh Takuhikan) assistant director for external affairs, and members of the Band Council.

On November 9, 2011, representatives from Pekuakamiulnuatsh Takuhikan made a site visit to Lac a Paul. Members of the Innu family, guardians of the land, also took part.

At the beginning of 2012, Arianne sent a first preliminary agreement proposal to the Mashteuiatsh Band Council, who in turn made a counterproposal. A negotiations group made up of representatives from Arianne and Mashteuiatsh was created. Since December 2012, this negotiations committee has been meeting regularly. Arianne would like to reach an agreement on the repercussions and advantages (ARA) with the community. Mashteuiatsh (Pekuakamiulnuatsh Takuhikan) also wishes to enter into an agreement.

In June 2012, representatives from Arianne held a public meeting in Mashteuiatsh. The meeting took place in two parts, a first part with the families affected by the project and a second one with members of the community.

They are preoccupied by the potential effects that dust will have on hunting, trapping and fishing activities, as well as the safety of the facility and road safety. They expressed the desire for immediate economic spinoffs in the form of contracts for local companies and long-term jobs. There was a lot of interest from the community regarding non-specialized jobs that would be available (security, cafeteria, etc.). Concerns regarding the project's impact on water and fish were expressed. Arianne reassured them that ancestral hunting and fishing rights would be respected within the outfitter. The community was interested in the establishment of a training subsidy program. It is expected that an agreement will be reached within the next year between Arianne, Mashteuiatsh and the competent Authorities on the form and level of compensation.

In July 2013, a meeting was held in the City of Saguenay between the Community's Grand Chief and Arianne's CEO. Thereafter, the latter was invited to a cultural visit in the Mashteuiatsh Community in September 2013.

A new public meeting with the Community of Mashteuiatsh and a discussion meeting are scheduled for November 2013; its objective will be to update them regarding the project's progress, discuss transportation and present the impact assessment results.

Arianne has noted that Pekuakamiulnuatsh Takuhikan is open to collaborating on the analysis of the mining projects. It assesses these projects with the specific objective of protecting ancestral rights and ensuring the preservation and practice of traditional activities. The projects must also meet the socioeconomic, cultural and environmental needs of the community and of future generations.

20.3.2.2 Pessamit

Communications with the community of Pessamit began in October 2010. Arianne presented its project to the community's Grand Chief in November 2011.

In January 2012, Arianne presented the same preliminary agreement proposal to Pessamit as was presented to Mashteuiatsh.

In June 2012, representatives from Arianne accompanied the Pessamit Innu Council's Vice-Chief and members of the guardian family of one of the Lac a Paul traplines for a visit of the project site.

A first meeting with the Pessamit Council took place in December 2012. Numerous Band Council members, including the Grand Chief, attended. The purpose of the meeting was to present the project and record the community's concerns and needs. These needs are mainly socioeconomic: jobs and training for young people and financing for territorial agents.

A second meeting with the Pessamit Innu Council took place on April 24, 2013. In addition to the participants of the previous meeting, the chief negotiators from both organizations also attended. Questions were mainly pertaining to jobs, the mine's environmental impact and the management of water throughout the process.

A third meeting took place on October 22, 2013. There were talks regarding the transportation scenario and the Pessamit Innu Council took the opportunity to share their understanding and vision of the Project. A public meeting to present the project to the community of Pessamit is currently being organized.

20.3.3 Meetings with Local Elected Officials

There have been numerous meetings with various officials in Saguenay-Lac Saint-Jean. The purpose has been to both provide information on the project and to gather information regarding local issues and the concerns of local officials.

Since November 2012, biweekly meetings have been taking place between Arianne and the City of Alma's economic development advisor (former alternative for transportation). The subjects that have been discussed are land and rail transportation, existing and to be constructed infrastructures, environmental impacts, the social acceptability of the route, maximizing economic spinoffs, etc. Arianne is working with the Fjord-du-Saguenay RCM to develop its final transportation plan (Saint-Fulgence).

The City of Saguenay and Promotion Saguenay (Saguenay's economic and tourist development organization) were present at all three meetings that were held in the City of Saguenay.

Several information meetings were held with the Fjord-du-Saguenay RCM, where the Lac a Paul Project will be located, and the mayors of the RCM. The mayor of Saint-Ludger-de-Milot, as well as many elected officials from the municipality, attended the meetings which also took place in this village.

Arianne is working closely with governmental Authorities to develop its project. At the provincial (Québec) level, the project was presented to and discussed with officials from the MRN, the MTQ, the MDDEFP and the Secrétariat aux Affaires autochtones (ministère du Conseil exécutif). At the federal level, the Canadian Environmental Assessment Agency (CEAA), Fisheries and Oceans Canada (DFO), Environment Canada (EC) and Transport Canada (TC) have been consulted. In May 2012, a helicopter fly-over was organized for representatives from the MDDEFP, the MRN, the CEAA and the DFO to provide an overview of the area where the future mining site is located.

20.3.4 Other Communications and Visibility Initiatives

In order to make the information regarding the Lac a Paul Project more accessible to the public, the project’s section on the company’s website has been constantly updated. In addition, Arianne prepares on a monthly basis, an advertisement column which is published in local newspapers. Arianne has collaborated on a number of articles and advertisements on the project’s development. Since 2010, the company has published a quarterly newsletter in both English and French. Arianne is a member of the Quebec Mineral Exploration Association (AEMQ) and has been a member of the Quebec Mining Association (QMA) since 2012. Finally, Arianne has also been a member of the International Fertilizer Industry Association (IFA) since 2010.

20.3.5 Press Analysis

An analysis by an external communication consultant of the press regarding the Project shows that it is expected and desired in the region. However, there are still some concerns regarding transportation of phosphate rock concentrate and the mining complex’s potential environmental impact.

20.3.6 Planned Communications Activities and Community Relations

Arianne plans on continuing its meetings in 2013 and 2014 on the following themes: infrastructure, protection of the environment and maximizing the economic spinoffs according to the demands from area citizens and representatives.

20.4 Environmental & Social Impact Assessment

The significance of residual anticipated impacts on the physical, biological and the social environment is assessed by considering that mitigation measures will be applied (see Section 20.4.2).

20.4.1 Environmental and Social Impact Identification

20.4.1.1 Physical Environment

The main components of the physical environment affected by the Lac a Paul Mine construction, operation or closure are: ambient air quality, soil quality, groundwater quality and regime, as well as surface water and sediment quality. The main anticipated impacts are:

- Increased dust levels in the ambient air and greenhouse gas (GHG) emissions.
- Soil quality degradation.
- Modifications to watercourse flow regimes.
- Groundwater quality degradation.
- The degradation on quality of surface water, of the aquatic environment and of sediment.

While the potential residual impacts on the physical environment are largely deemed to be very low to low, some have the potential to be long lasting, such as those on air quality or the hydrological regime during exploitation

Following the mine's closure and restoration phase, the ambient air and surface water should return to a similar quality as the baseline state.

20.4.1.2 Biological Environment

Regarding the biological environment, the main components potentially impacted are: vegetation and wetlands, aquatic fauna, benthic fauna, herpetofauna, avifauna, mammals, woodland caribou and wildlife habitats. The main potential impacts are:

- The loss of vegetated areas.
- The disturbance of plant groupings.
- The loss of fish habitat.
- Changes to the quality of wildlife habitats.
- The disturbance of wildlife due to noise.

The impact assessment, including the applied mitigation measures, leads to the conclusion that it is not expected that the project would have any significant impact on the components of the biological environment, either during construction or production. However, the following residual impacts of medium importance are expected:

- The disturbance of avifauna by noise during construction.
- The loss of habitat, the death of less-mobile individuals, the disturbance of mammals by noise during construction.
- The loss and fragmentation of caribou habitat, its disturbance by noise and modifications of the environment favouring its predation during construction. During the operational phase, the temporary loss of caribou habitat, as well as its disturbance due to noise, constitutes negative impacts of medium importance.

20.4.1.3 Human Environment

The main issues for the Lac a Paul Project are related to the components of the human environment. Some components could be significantly affected, either positively or negatively, including the local and regional economy, infrastructure and services, ambient noise, quality of life and the Aboriginal presence. The use of land and natural resources, archaeological and cultural heritage, navigation, as well as landscape will also be issues, but to a lesser degree.

The expected residual negative impacts which are of high to very high importance are:

- Traffic related to the transportation of concentrate from the mine to St-Fulgence.
- Increased noise especially associated with transportation on the non-standard route used from the mine to St-Fulgence.

- Crossing Road 172 by trucks.

Significant positive residual impacts are expected, especially:

- The creation and/or preservation of jobs.
- Economic spinoffs.

20.4.2 Mitigation Measures

In order to minimize or eliminate impacts from its project, Arianne has consistently performed work and conducted studies to optimize all of their aspects. The objective is to preserve the natural environment and promote social acceptability, while maintaining the profitability of the project.

The optimization process, still ongoing, has so far focused on the following key elements:

- Pit design: in order to optimize operations and keep a compact general development plan, Arianne decided to operate only the Paul pit, and create one larger and deeper pit instead of two small ones.
- Process water recycling: minimize the volume of water pumped from Lac a Paul, maximize process water recycling, maximize the recovery of tailings water and minimize final effluent discharge; this will be achieved through a tailings thickening approach: in order to reduce the project footprint, Arianne has decided to provide a densification plant to minimize the volume of water pumped to the tailings storage facility (TSF).
- Apatite concentrate transportation: attempt to reduce the number of trucks on the road, by specifying larger-capacity and lighter trailers, in order to maximize unit loads.
- The new truck route option (Saint-Fulgence option) is under further analysis. This option is located in an area mostly inhabited but there are several recreational leases found within the study area. The proposed truck route avoids towns and villages.
- TSF location: Arianne has decided to use an area located 1.8 km south of the process plant, which is already impacted by logging and forest fires. This area is located near a steep drop in the terrain, thereby reducing the amount of dike construction as well as the visual impact of the facility.
- Avoidance of lakes and perennial streams: efforts have been made to avoid lakes and permanent streams in the implementation of project's components; Arianne strongly wishes to allow the continuation of outfitting activities and minimize the impacts on the territory.
- The electrification of installations and machinery: electricity will be used wherever possible in order to reduce fossil fuel consumption.

- The optimization of roads and conveyors: roads have been shortened and conveyors lengthened to reduce the distance traveled by trucks and other equipment, providing better energy efficiency and reducing the project's environmental footprint.
- Implementation of ponds around the waste rock stockpiles to reduce (by at least 80%) the concentration of total suspended solids in the run-off.

20.4.3 Compensation Program

The preservation of fish habitats is covered, at the federal level, by the Fisheries Act; the Act was modified, in 2012, in order to ensure the sustainability and continued productivity of Canada's commercial, recreational and Aboriginal fisheries.

Sustainable development concerns and the need to meet the provisions of the Fisheries Act resulted in site optimization efforts intended to avoid, as much as possible, sensitive elements of the environment such as the study area's watercourses and water bodies. Despite these efforts, some project components will affect some watercourses. However, the project's impacts will not affect the continued durability and productivity of sport or Aboriginal fishing in the local study area. It was established that the current lakes used for fishing activities on the study area, will not be impacted by the project.

Nonetheless, Arianne will implement compensation measures in order to maintain the productivity of fishing in the Lac a Paul watershed. A detailed compensation plan will be submitted at a later date to Authorities, during the project's Authorization process.

20.4.3.1 Loss of Fish Habitat

Losses in fish habitat will mainly be generated by excavation, backfilling or drainage activities during the excavation of the pit and the development of the tailings facility and basins. The total area of fish habitat loss within the study area is evaluated at nearly 17,052 m^2. Most fish habitat encroachment will be directly linked to the operation of the pit, which cannot be moved or optimized, given the location of the deposit; this represents nearly 62% of the entire fish habitat encroachment.

No fish habitat was identified in the waste rock dump area.

20.4.3.2 Compensation Options

New habitats created following the development of watercourses, as well as those optimized by the establishment of a series of sills and pools, deflectors and spawning sites, will provide a choice of feeding, breeding and rest sites for the fish species frequenting the area's lakes and watercourses.

Compensation plans for lost fish habitat and also for the loss of wetlands will be presented to government agencies for approval.

Table 20.4.1 lists the proposed compensation options.

Habitat	Type of Measure	Length (m)	Approximate Average Width (m)[1]	Developed Surface (m^2)
Lac du Coyote Outlet	Creation of a new watercourse	63	3.5	221
Lac de l'Ours Polaire outlet	Creation of a new watercourse	421	3.4	1,431
Lac H tributary	Creation of a new watercourse from the Lac I outlet	484	2.0	968
Lac du Kodiak outlet	Development of the existing watercourse	1,268	2.7	3,424
Lac Siamois tributary	Creation of a new watercourse	974	3.3	3,214
Lac a Paul tributary (Naja River)	Development of spawning grounds (3 x 50 m^2)			150
Total		**3,210**		**9,408**

1 *Approximate average width estimated according to the average width of the watercourse under natural conditions. The definite width of the watercourses will be calculated during the design stage.*

Table 20.4.1 Proposed Compensation Plans for Fish Habitat

20.5 Environmental Permitting & Applicable Regulations

20.5.1 Legal Context

The preparation of the Lac a Paul Project's environmental impact assessment (EIA) is guided by a series of provincial and federal laws, regulations and administrative procedures presented below. The Project Notice has been filed with the Government in May 2011 and the EIA submitted in June of 2013.

20.5.2 Provincial Permitting Process

20.5.2.1 Environment Quality Act (EQA)

20.5.2.1.1 Environmental Impact Assessment (EIA)

Under Subsection 31.1 of Quebec's *Environment Quality Act*, (R.S.Q., c. Q-2):

> *"No person may undertake any construction, work, activity or operation, or carry out work according to a plan or program, in the cases provided for by regulation of the Government without following the environmental impact assessment and review procedure and obtaining an Authorization certificate from the Government (1978, c. 64, s. 10)."*

20.5.2.1.2 Projects Subject to the EIA Procedure

The list of projects subject to the Environmental Impact Assessment and Review Procedure is presented in the Regulation Respecting Environmental Impact Assessment and Review.

Its Division II - Projects Subject to the Environmental Impact Assessment and Review Procedure, under paragraph (p), specifies the projects subjected to the assessment and review process, in the case of opening and operation of a mine.

The Lac a Paul Project falls within this category since the intended daily production will exceed 500 metric tons, for a non-metal mine.

It should be noted that, as stated in the same regulation, projects involving several elements subject to an EIA require a single EIA statement and a single application for a Certificate of Authorization (CoA).

20.5.2.1.3 Administrative Procedure

In order to reach the decision stage for the Authorization of the Project by a Government decree, there is a total of eight (8) phases to complete the environmental impact assessment process as described hereafter.

1. **Issuing of an Instruction by the ministère du Développement durable, de l'Environnement, de la Faune et des Parcs (MDDEFP)**

   Any person wishing to undertake projects contemplated in Section 31.1 of the EQA must file a written notice with the Minister, describing the general nature of his project. The Minister, in turn, will indicate, through an instruction to the proponent of the project, the nature, scope and extent of the environmental impact assessment statement to be prepared ((ss. 31.2) 1978, c. 64, s. 10).

   The Ministry issued, in April 2005, a general instruction specific to mining activities called Directive 19. This document mainly covers the general environmental baseline and the operational aspects of the mining activities, as well as requirements for the preparation of requests for a Certificate of Authorization. However, some of its content will have to be considered in the EIA for the Lac a Paul Project, namely the standards fixed for water effluents, groundwater, noise and vibrations.

   More recently, on September 2010, the Ministry produced a specific instruction detailing the requirements for conducting an EIA for mining projects triggering article 31.1 of the EQA[1]. This document was the baseline for the EIA of the Lac a Paul Project.

2. **Environmental Impact Assessment**

   In broad terms, there are four key steps to an environmental impact assessment:

   - Describe the project in detail.
   - Describe the biophysical and human environment.

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[1] Obligation of following the environmental impact assessment and review procedure and obtaining an Authorization certificate from the Government.

- Assess the negative environmental effects.
- Determine ways (mitigation measures) to eliminate or reduce the negative effects on the environment.

The specific steps in the process can vary depending upon the scope of the project, the anticipated level of the impact on the environment and several other factors.

3. Public Consultation

Public Participation (Bureau d’audiences publiques sur l’environnement [BAPE])

After confirming acceptance of the environmental impact assessment statement, the Minister will make the document public, and public information and consultation process as required by law will then be initiated.

4. Public Hearing

Any person, group or a municipality may, within the timeframe prescribed by law, apply to the Minister to hold a public hearing for the project.

5. Report

Unless he or she considers such an application to be unfounded, the Minister shall require the Environment Public Hearing Board (the Board or as commonly known in French, the BAPE) to hold a public hearing and report its findings and its analysis thereof to him ((ss. 31.3) 1978, c. 64, s. 10; 1999, c. 40, s. 239).

6. Analysis by the MDDEFP

In order to study certain matters more thoroughly, or to research elements which he or she considers necessary to fully assess the impact of the proposed project on the environment, the Minister may, at any time, request that the proponent of the project provide additional information ((ss. 3.4) 1978, c. 64, s. 10).

7. Decision

Once the environmental impact assessment statement is considered satisfactory by the Minister, it is submitted to the Government, along with an application for Authorization. The Government may or may not issue the decree authorizing the project, with or without amendments, and on such conditions as it may determine. That decision may be made by any committee of ministers of which the Minister is a member and to which the Government has delegated that power (ss. 3.4).

8. Control

The MDDEFP reserves the right to conduct site inspections during the various work phases of the project to ensure that the terms of the decree and certificates of Authorization emitted are respected.

20.5.2.2 Other Laws, Regulations and Guidelines

Once the required environmental impact assessment and review procedure for the Lac a Paul Project has been completed, and the decree obtained from the provincial Government, the project's detailed engineering will be finalized. This step shall take into account the environmental mitigation measures associated with the mining equipment and infrastructure as presented in the EIA and incorporated by the Government in the decree. It shall also consider all applicable environmental standards included in other relevant provincial laws and regulations. These include:

- The Mining Act (R.S.Q., c. M-13.1)

  This Act was under review by the provincial government (Project Bill 43[2]) and was rejected on October 30, 2013. Several important changes were under review and their inclusion would have rendered any exploration work and the opening and exploitation of a new mining site more complicated. Amongst the main potential new requirements, there were:

  - The need to obtain Authorization from private land owners before gaining access to their Property.
  - The exclusion of some land area from mining exploration and operations, including those within an urbanization perimeter, and any area dedicated to vacationing. To do any work on these excluded claims, holders would have to obtain the consent of the local municipality.
  - The future evolution of this review of the mining act will have to be carefully monitored as it progresses and evolves.
- MDDEFP Directive 019 on the mining industry (2012).
- The Forest Act (R.S.Q., c. F-4.1).
- The Watercourses Act (R.S.Q., c. R-13).
- The Dam Safety Act (R.S.Q., c. S-3.1.01).
- The Transportation of Dangerous Substances Regulation (R.R.Q. c. Q-2, r.32.).
- The Petroleum Products Act (R.S.Q., c. P-30.01, r.1).
- The Groundwater Catchment Regulation (R.R.Q., c. Q - 2, r.6).
- The Regulation Respecting Pits and Quarries (R.R.Q., c. Q-2, r.7).

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[2] Bill N°43: An Act respecting the development of mineral resources in keeping with the principles of sustainable development.

- The Regulation Respecting Waste Water Disposal Systems for Isolated Dwellings (R.R.Q., c. Q-2, r.8).
- The Act Respecting Threatened or Vulnerable Species, (R.S.Q, c. E-12.01).

20.5.3 Federal Permitting Process

20.5.3.1 Canadian Environmental Assessment Act (CEAA)

The *Canadian Environmental Assessment Act* (2012) (CEAA 2012) and its regulations establish the legislative basis for federal environmental assessments in most regions of Canada.

The CEAA 2012 applies to projects designated by the *Regulations Designating Physical Activities*. A project may also be designated by the Minister of the Environment if he or she believes that the implementation of the project may cause significant environmental effects or public concern about these effects.

Based on a federal communication to Arianne dated August 8, 2013, Arianne's Project is not subject to a federal environmental assessment under the CEAA (2012) and the *Regulations Designating Physical Activities*. In addition, considering the non-metal nature of the ore mined, the project is not subject to *Metal Mining Effluent Regulations* (MMER).

However, Arianne must obtain permits from the federal Authorities in pursuance to the following acts:

20.5.3.1.1 The Explosives Act (Sch. I, P.I, It.5)

The Explosives Act governs the manufacture, testing, sale, storage and importation of explosives in Canada. Under Section 7(1) (a), an approval is required from the Minister of Natural Resources for an explosives magazine (storage).

20.5.3.1.2 The Fisheries Act (Sch. I, P.I, It.6 and Sch. II, It. 5)

The Fisheries Act deals with the proper management and control of the fisheries, the conservation and protection of fish and the protection of fish habitat, and prevention of pollution. It involves the following authorizations, requirements and orders:

- Section 22(1): At every obstruction, where the Minister determines it to be necessary, the owner or occupier thereof shall, when required by the Minister, provide a sufficient flow of water over the spillway or crest, with connecting sluices into the river below, to permit the safe and unimpeded descent of fish.
- Section 22(2): The owner or occupier of any obstruction shall make such provision as the Minister determines to be necessary for the free passage of both ascending and descending migratory fish during the period of construction thereof.
- Section 22(3): The owner or occupier of any obstruction shall permit the escape into the river-bed below the obstruction of such quantity of water, at all times, as will, in the opinion of the Minister, be sufficient for the safety of fish and for the flooding of the spawning grounds to such depth as will, in the opinion of the Minister, be necessary for the safety of the ova deposited thereon.
- Section 32: No person shall kill fish by any means other than fishing.
- 35. (1) No person shall carry on any work, undertaking or activity that results in the harmful alteration or disruption, or the destruction, of fish habitat.

Exception

- 35(2) A person may carry on a work, undertaking or activity without contravening subsection (1) if:
  - (*a*) the work, undertaking or activity is a prescribed work, undertaking or activity, or is carried on in or around prescribed Canadian fisheries waters, and the work, undertaking or activity is carried on in accordance with the prescribed conditions.
  - (*b*) the carrying on of the work, undertaking or activity is Authorized by the Minister and the work, undertaking or activity is carried on in accordance with the conditions established by the Minister.
  - (*c*) the carrying on of the work, undertaking or activity is Authorized by a prescribed person or entity and the work, undertaking or activity is carried on in accordance with the prescribed conditions.
  - (*d*) the harmful alteration or disruption, or the destruction, of fish habitat is produced as a result of doing anything that is Authorized, otherwise permitted or required under this Act; or
  - (*e*) the work, undertaking or activity is carried on in accordance with the regulations.
- Section 36(5) (a to e): Site-specific regulations by the Governor in Council Authorizing the deposit of deleterious substances. Deleterious substances are defined as substances that, if added to water, would alter or degrade the quality of that water so that it is deleterious to fish.

- Section 37(2): Ministerial order requiring modifications, additions or restrictions to, or the closing of work that does or could result in the harmful alteration, disruption or destruction of fish habitat, or the deposit of deleterious substances.

Normally, most projects are only submitted to Section 35(2) requirements.

20.5.3.1.3 The Migratory Birds Convention Act (Sch. I, P.I, It.7.1)

The Migratory Birds Convention Act, 1994 provides for the implementation in Canada of the 1916 Convention between the United Kingdom and the United States of America for the Protection of Migratory Birds in Canada and the United States. The Convention may be amended from time to time. Under Section 5.1 (1) of the Act:

> *“No person or vessel shall deposit a substance that is harmful to migratory birds, or permit such a substance to be deposited, in waters or an area frequented by migratory birds or in a place from which the substance may enter such waters or such an area.”*

20.5.3.1.4 The Species at Risk Act (S.C. 2002, c. 29)

The Species at Risk Act (SARA) was created to prevent wildlife species from becoming extinct. The Act protects species at risk and their critical habitats. SARA also contains provisions to help manage species of special concern to prevent them from becoming endangered or extinct.

Once a species is listed under the Species at Risk Act, it becomes illegal to kill, harass, capture or harm it in any way. Critical habitats are also protected from destruction. The Act also requires that recovery strategies, action plans and management plans be developed by the competent minister for all listed species. Under Section 33:

> *“No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species, or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada.”*

20.5.4 Permitting Timeline

Major Milestones	Anticipated (Actual) Time Frame
Project notice submission	May 2011 – Completed
Federal and provincial instructions	June 2011 – Completed
Submission of the EIA	June 2013 – Completed
Public hearing process kick-off	February 2014
Decision of council of Minister (governmental decree)	September 2014
CoA delivery	October 2014

Table 20.5.1 Permitting Timeline

20.6 Environmental Geochemistry Program

The following observations can be drawn from the geochemical characterization and the preliminary results of the long-term (kinetic) test performed by the Université du Québec en Abitibi-Témiscamingue’s Unité de recherche et de service en technologie minérale (URSTM):

- Waste rock is richer in aluminium and potassium, while the Nelsonite unit (ore) is richer in calcium and iron, but contains less potassium and aluminium. Tailings have an intermediate chemical composition, between waste rock and Nelsonite.
- Some samples exceed criterion A of the Soil Protection and Contaminated Sites Rehabilitation Policy in Ba, Co, Cr, Cu, Mo, Ni, Se. All samples have at least one concentration exceeding criterion B: two waste rock samples exceed in Cr and Ni, the Nelsonite exceed in Co, Mn, Ni and Se and the tailings exceed in Co and Mn.
- Elements identified as exceeding criterion A presented no excess in the leachate produced during the leaching test (TCLP 1311 method), therefore, the samples tested are considered "low-risk tailings".
- According to the static test results, the waste rock tested is not acid generating. The Nelsonite and tailings samples are classified as uncertain. However, the partial results of the column tests via the oxidation / neutralization curve (graphical interpretation) indicate that the Nelsonite and tailings will not generate acid mine drainage in the long term. This hypothesis will be reassessed once the results of all column tests are available.
- Sulfide minerals are present in trace amounts in the four samples studied. They are mainly pyrrhotite with traces of pyrite and horomanite and chalcopyrite. Nickel is mainly present as horomanite, whose concentration varies from 18 to 37% (mass), as well as in traces in the pyrite and the pyrrhotite.
- The kinetic test monitoring shows that geochemical parameters presented are stable approximately since the 50th day of the test, suggesting stable geochemical behavior in the long term.
- The concentrations of As, Cu, Fe, Ni, Pb and Zn obtained in the leachate columns are low and well below the limits stated in Directive 019. Only tailing # 1 exceeded the RESIE criterion in Cu and Zn.
- Concentrations in P are stable approximately to 0.02 mg/liter for all columns.
- The tailings column leachates contain more Ca than the waste rock, and the nelsonite column leachates have the lowest concentrations.
- The concentrations in Mg are lower in the waste rock column leachate, with values of approximately 1 mg/liter, while the nelsonite column presents values of approximately 10 mg / liter. Tailings columns have similar concentrations between 20 and 30 mg / liter.

- Sulphate concentrations are lower for the waste rock columns (4-8 mg / L) and the highest values are observed in the tailings columns (150 mg / L). The nelsonite column is in between, approximately 25 mg / L.
- The two tailings columns maintain their degree of saturation values favouring the oxidation of sulfides, thus the test may represent favourable conditions to the oxidation of the sulphide minerals which is usually the source of contamination of drainage water. Despite this, no AMD or NDC generation was observed.

An additional testing program is required to confirm the preliminary results described above. However, the preliminary assumptions are:

- MDDEP directive 019 Low risk residues classification based on leachate results for waste rock, tailings and ore materials.
- No potential acid generation (PAG) for waste rock.
- Uncertain PAG for tailings and ore material: long term test will confirm the classification of these materials.

20.7 Water Management

From the preliminary results, the assumption used is that the leachate from the mining residues should only require treatment for suspended solids. Water management of the project site therefore will consist in the construction of drainage ditches surrounding the facilities, and sedimentation ponds will be used for water treatment. All these works will be designed in accordance with MDDEFP Directive 019 and to ensure that the quality of water discharged into the environment meets the requirements of MDDEFP Directive 019 and if possible, the MDDEFP's site specific environmental discharge objectives (OER).

Water management will be implemented by sector. Thus, each of the following areas will have a system of ditches draining into sedimentation ponds:

- Waste rock dump sector, pit explosives storage areas, crusher, mining complex, the camp, the water intake and tailings storage facility.
- A sanitary water treatment plant will also be built near the camp.
- According to the information currently available, 10 water discharge points into the receiving environment are planned. This number, however, is being revised so as to try and reduce the number of discharge points.

20.8 Closure Plan

Despite the recent conclusion of the Bill 43 described in Section 20.5.2.2, a preliminary closure plan was nonetheless developed. As mentioned in the Mining Act (L.R.Q., Chapter M-13.1) and Regulation respecting mineral substances other than petroleum, natural gas and brine (M-13.1, r.2), a redevelopment and restoration plan must be submitted before the beginning of mining activities. The rehabilitation and restoration plan will have to be developed in accordance with the provincial Guidelines for Preparing a Mining Site Rehabilitation Plan and General Mining Site Rehabilitation Requirements.

The closure plan shall include, among other things:

- A description of the mining site and the activities that will be carried out there.
- A description of the restoration work to be completed to return the mining site to a satisfactory state.
- A monitoring program as well as an estimation of the rehabilitation costs.

The Lac a Paul Project's closure plan will focus mainly on the following elements:

- The secondary roads and pathways will be scarified.
- The buildings and surface infrastructure will be dismantled. The surfaces will then be covered with topsoil and revegetated.
- The pit will naturally fill with surface water and groundwater.
- The tailings and waste rock are classified as being low risk with the preliminary results described in Section 20.6. Considering this assumption, the restoration of the tailings management facility and the waste rock dump will thus consist of simply profiling, adding an organic topsoil cover and revegetating these accumulation areas.
- The overburden and low-grade ore accumulation areas will be leveled and scarified, if necessary, then planted.
- The sedimentation and retention basins will be demolished. The basins will be backfilled with material used for the construction of the dykes. The surfaces will be covered with topsoil and revegetated.
- The landfill will be covered over and vegetated.
- Measures will be put in place to secure the area as per regulatory obligations.

Production at the apatite deposit is planned over a 25 year period. Progressive restoration of the waste rock dump and tailings management facility will begin in the project's 10th year of production.

The restoration costs are estimated in 2013 US dollars with a degree of accuracy of ± 30%. The unit rates used come from suppliers, contractors and projects conducted in similar contexts. They are summarized in the Table 20.8.1.

The cost associated with topsoil includes loading as well as transportation and placing. These costs were evaluated according to the transport distance. Thus, the unit rates associated with this activity vary depending on the sector where it will be conducted. It was assumed that the amount of organic earth accumulated during the exploitation period is sufficient to meet the needs of the restoration work.

It is considered that the electrical station's dismantling costs will be covered by the resale of the electronic equipment. The profits from the sale of all other specialized equipment have not been calculated.

The rates for the dismantling of related buildings and infrastructure assume that these elements to be dismantled will be clean and will not be contaminated, and that the contractor is responsible for managing and recycling the materials along with the associated profits.

The engineering and management costs for the work have been estimated at 10% of the direct costs.

The following rates were used:

Restoration Activity	Unit	Value
Placement of topsoil over 15 cm	$ / m²	1.00
Revegetation (hydraulic seeding)	$ / m²	1.00
Dismantling of the basin (demolition of dykes, levelling, placement of topsoil and revegetation)	$ / m²	3.80
Levelling and revegetation	$ / m²	2.40
Dismantling of conduits	$ /lin. m	29.50
Scarification of gravel road	$ / m²	0.75
Dismantling – complex buildings	$ / m²	87.60
Dismantling – less-complex buildings	$ / m²	57.15
Dismantling – light buildings	$ / m²	43.80
Dismantling – modular camp	$ / m²	23.80
Dismantling – 100, 000 l oil reservoir	$ / reservoir	6,190

Table 20.8.1 Cost Factors for Site Restoration Work (USD$)

The cost of this restoration work is estimated at USD$44,800,000, with a 30% contingency, given the limited information available on the nature of the industrial buildings; restoration costs are summarized as follows:

Activity	Cost (USD$)
Restoration of accumulation areas	36,263,517
Restoration of the plant and related infrastructure	7,274,109
Other restoration activities	1,262,374
Total	**44,800,000**

Table 20.8.2 Closure Costs for the Accumulation Areas and Environmental Monitoring

The amount of the financial guarantee corresponds to 100% of the estimated closure cost. The Regulation respecting mineral substances other than petroleum, natural gas and brine provides for a schedule of annual payments depending on the duration of the mining project. In the case of the Lac a Paul Project, the financial guarantee payments shall be as follows:

Year	Payment Breakdown (%)	Amount Paid (USD$)
1	50	22,400,000
2	25	11,200,000
3	25	11,200,000
Total	**100**	**44,800,000**

Table 20.8.3 Calendar of Financial Guarantee Payments

21. Capital and Operating Costs

21.1 Capital Cost

21.1.1 Capital Cost Estimate Introduction

This capital cost estimate covers the Arianne's Lac a Paul Project for apatite concentrate production based on a milling rate of 55,000 tonnes per day. The estimate is based on CegertecWorleyParsons' standard methods applicable for a feasibility study.

The open pit mine development, the ore processing facilities and all on-site infrastructure and services necessary to support the mine operation have an estimate accuracy of +/- 15%.

The off-site concentrate “Mine-to-Port” transportation, port storage and transfer system facilities have an estimate accuracy of ±25%.

All duties and taxes are excluded from the capital cost, but are considered in the economic analysis. Escalation and interests incurred during construction are excluded from the Capital Cost.

The effective date for the project cost estimate is October 2013 but September 5, 2013 was used for the currency exchange rate. The estimate is expressed in US dollars.

The pre-production initial capital cost for the mine and ore processing facility is USD $982.5M, of which USD $612.9M is direct cost (General plus third-party Sub-Contract costs) USD $295.7M is indirect cost and USD $73.9M is contingency.

The pre-production initial capital cost for the mine-to-port transportation scope is USD $232.2M, of which US$ 167.9 M is direct cost, USD $46.2M is indirect cost and USD $18.1M is contingency.

The sustaining capital requirement is shown with OPEX costs in Section 21.2.

The CAPEX costs are summarized in Tables 21.1.1 and 21.1.2. Details are provided in the Feasibility Study report.

« Open Pit Mine » and « Ore Processing Facility » Item Descriptions			General Capital Directs US$ M	Sub Contract Directs & Indirects US$ M	In-Direct Costs US$ M	Total Costs US$ M
WBS						
0000	Mill general (all areas in Mill)		42.3		11.6	53.9
0110	crusher area		43.1		6.0	49.2
0120	coarse ore stockpile & reclaim		22.3		7.0	29.3
0130	grinding & classification area		106.1		20.4	126.5
0140	magnetic separation area		23.4		8.8	32.2
0150	flotation area		49.6		10.3	59.9
0160	concentrate thickening & drying area		36.3		4.6	40.9
0170	tailings & reclaim area		9.6		2.5	12.1
0180	reagents area		15.5		5.3	20.8
0190	concentrate stockpile area		35.1		10.9	46.0
0000	**Sub-Total Mill**		**383.4**	**0.0**	**87,4**	**470.8**
1100	Open Pit Mine		29.7	42.5	0.0	72.2
1200	Tailings and water Management		16.9	12.1	7.4	36.3
3100	General Services		20.1		6.8	27.0
3200	Infrastructures		29.9	6.7	6.6	43.2
3300	Power and Communication		33.0	30.6	3.8	67.4
‘4000	Off-Site Concentrate Transportation			0.04		0.04
‘5100	Temporary Facilities (temp camp)		7.5		0.4	7.9
‘6000	Commissioning Support		0.5		0.6	1.1
	Sub-Total Contractors’ Directs and Contractors’ Indirects for WBS 0000 to 6000		**521.0**	**91.9**	**113.0**	**725.9**
‘5101	Camp operating costs up to year 1				15.2	15.2
‘6000	Initial site mobilization				1.9	1.9
‘6000	Temporary power				16.2	16.2
‘6000	Vendor Reps				1.7	1.7
‘6000	General Project Indirects				22.6	22.6
‘6000	Heavy Cranes > 150 ton				14.3	14.3
	Sub-Total Third-Party Indirects for WBS 5101 to 6000		**0.0**	**0.0**	**71.9**	**71.9**
‘7100	EPCM				61.7	61.7
‘9000	Owner’s Cost				49.1	49.1
‘9500	Escalation (excluded)		0.0	0.0	0.0	0.0
‘-----	Financial Costs (excluded)		0.0	0.0	0.0	0.0
‘-----	Mine Closure Costs (excluded)		0.0	0.0	0.0	0.0
	Sub-Total Project Indirects for WBS 7100 to 9500		**0.0**	**0.0**	**110.8**	**110.8**
	Sub-Total Capital Cost		**521.0**	**91.9**	**295.7**	**908.6**
‘8000	Contingency				73.9	73.9
	Total Capital Cost		**521.0**	**91.9**	**369.6**	**982.5**

Note: Sub-Contract column shows third-party costs with combined Directs & Contractors’ In-Directs.

Table 21.1.1 Summary of CAPEX for ““±15% Open Pit Mine and Ore Processing Facilities”

« Mine-to-Port » Transportation Item Descriptions		Sub Contract Directs & Indirects US$ M	In-Direct Costs US$ M	Total Costs US$ M
WBS	**St. Fulgence Option :**			
4000	Off-site Facilities and Infrastructure	167.9		167.9
	Sub-Total Contractors' Directs and Contractors' Indirects for WBS 4310 to 4340	**167.9**	**0.0**	**167.9**
'5000	Temp Construction Facilities & Services (room & board for 450,000 hrs)		7.7	7.7
'6000	Construction Support/Equipment Consumables		3.3	3.3
	Sub-Total Third-Party Indirects for WBS 5000 to 6000	**0.0**	**11.0**	**11.0**
'7100	Project Management (EPCM)		20.9	20.9
'9000	Owner's Cost		14.3	14.3
'9500	Escalation (excluded)		0.0	0.0
"-----"	Salvage Value		0.0	0.0
	Sub-Total Project Indirects for WBS 7000 to 9500	**0.0**	**35.2**	**35.2**
	Sub-Total Capital Cost	**167.9**	**46.2**	**214.1**
'8000	Contingency (including freight and Vendor Cost allowances)		18.1	18.1
	Total Capital Cost	**167.9**	**64.3**	**232.2**

Note: Sub-Contract column shows third-party costs with combined Directs & Contractors' In-Directs.

Table 21.1.2 Summary of CAPEX for ““±25% Mine-to-Port” Transportation

CAPEX Direct Costs					Labour Hours	Direct Labour Cost USD M	Contractors' Distributable Direct Costs USD M	Process Equipment Direct Costs USD M	Bulk Material Direct Costs USD M	Total Direct Cost USD M
Comm Code	**WBS**	**General Directs**	**QTY**	**Unit**						
A	---	Site Prep	1	Lot	14,262	1.2	1.7	-	1.3	4.2
B	---	Earthwork (576,000 CM of excavation and 1,845,000 CM of backfill)	2.42 M	CM	118,475	9.0	12.3	-	0.1	21.4
C	---	Concrete	47,584	CM	403,768	32.1	28.0	-	20.3	80.4
D	---	Steel members quantified by tonnes	5,700	t	87,825	6.8	7.8	-	15.4	30.0
D	---	Steel quantified by SM and LM for deck plate, chequer plate, stairs, handrail, etc.	1	Lot	43,300	3.4	3.8	-	7.8	15.0
F	---	Buildings (excl temp camp)	24,817	SM	137,974	11.1	10.4	-	27.1	48.5
G	---	General Infrastructure	1	Lot	19,212	1.4	0.8	-	-	2.2
L	---	Insulation	1	Lot	2,144	0.2	0.1	-	0.1	0.4
M	---	Process Equipment	1	Lot	269,104	21.7	19.1	173.1	5.1	219.1
P	---	Piping	43,733	LM	188,460	15.4	14.4	0.1	17.1	46.8
U	---	Electrical Equipment	1	Lot	48,357	3.9	2.9	-	32.8	39.6
V	---	Instrumentation Eqpt	1	Lot	31,794	2.6	2.0	-	15.2	19.7
W	---	Electrical Bulks	1	Lot	116,162	9.4	7.0	-	14.0	30.3
X	---	Instrumentation Bulks	1	Lot	24,223	2.0	1.5	-	0.6	4.0
Z	---	Spares and First Fills				-	-	-	15.1	15.1
		Sub-Total General Directs			**1,505,060**	**120.0**	**111.7**	**173.1**	**172.0**	**576.8**

CAPEX Direct Costs (continued)					Labour Hours	Direct Labour Cost USD M	Contractors' Distributable Direct Costs USD M	Process Equipment Direct Costs USD M	Bulk Material Direct Costs USD M	Total Direct Cost USD M
Comm Code	**WBS**	**Other (sub-contract) Directs**	**QTY**	**Unit**						
M	1130	Mine Primary Eqpt	1	Lot	-	-	-	10.0	-	10.0
M	1130	Mine Secondary Eqpt	1	Lot	-	-	-	5.0	-	5.0
M	1130	Mine Auxilliary Eqpt	1	Lot	-	-	-	11.7	-	11.7
M	1130	Additional Mining Eqpt	1	Lot	-	-	-	2.9	-	2.9
Z	1106	Mine pre-stripping	1	Lot	82,600	16.0	24.3	-	2.1	42.5
B	3200	Env - Waste Rock Stockpile	1	Lot	8,263	1.6	2.4	-	0.7	4.8
Z	3200	Env - fish habitat - compensation	1	Lot	994	0.2	0.3	0.1	0.1	0.6
B	1210	TAILINGS Storage (Dessau)	1	Lot	19,738	3.8	5.8	-	2.4	12.1
W	3315	161 KV Line from Chute des Passes, 45km	1	Lot	21,734	4.2	6.4	3.5	3.5	17.7
W	3315	345 kV Transformer, 161 kV 2000 MVA Client outpost	1	Lot	3,040	0.6	0.9	4.5	1.5	7.4
W	3315	161 kV Start of Line, Client outpost	1	Lot	3,367	0.7	1.0	2.7	1.1	5.5
F,G	3240	Glycol heating system	1	Lot	1,321	0.3	0.4	0.2	0.2	1.1
		Sub-Total Other (sub-contract) Directs			**141,056**	**27.4**	**41.6**	**40.7**	**11.7**	**121.3**
		Total General and Other Directs			**1,646,116**	**147.4**	**155.0**	**213.8**	**168.5**	**698.1**
	---	Freight for process equipment and bulk materials	1	Lot						18.3
		Total Direct Cost								**716.4**

Table 21.1.3 Breakout of CAPEX « Direct » Costs for "Open Pit Mine and Ore Processing Facilities"

Construction Indirect Costs					Labour Hours	Direct Labour Cost USD M	Contractors' Distributable Direct Costs USD M	Process Equipment Direct Costs USD M	Bulk Material Direct Costs USD M	Total Direct Cost USD M
Comm Code	**WBS**	**Construction Services**	**QTY**	**Unit**						
F	5100	temp camp moved from Directs	1	Lot	5174	0.4	0.3	-	6.5	7.3
Z	5101	catering	1	Lot		-	15.8	-	-	15.8
Z	6000	initial mobilization	1	Lot		-	1.9	-	-	1.9
Z	6000	temp power	1	Lot		-	16.2	-	-	16.2
Z	6000	commissioning	1	Lot	6,781	0.5	0.6	-	-	1.1
Z	6000	general project indirects	1	Lot		-	22.6	-	-	22.6
		Sub-Total Construction Service Indirects	1	Lot	**11,955**	**1.0**	**57.4**	**-**	**6.5**	**64.9**
		Other Indirects								
Z	6000	Vendor Reps	1	Lot						2.2
Z	6000	Heavy Cranes	1	Lot						14.3
		Total Indirects	**1**	**Lot**						**81.4**

Table 21.1.4 Breakout of CAPEX « Indirect » Costs for "Open Pit Mine and Ore Processing Facilities"

21.1.2 Direct Costs

a) Direct Costs

Direct costs in Tables 21.1.1 and 21.1.2 include General Directs and Sub-Contract Costs.

General Directs include separate calculations for labour, equipment and bulk material. Note that Contractors' Indirects are separated and shown with Sub-Contract Distributables in Quest estimating software summary reports (included in the FS engineering report).

Sub-Contract costs denote third-party costs with combined Directs and Contractors' Indirects. Sub-Contract costs include combined calculations for labour, equipment, bulk material and Contractors' indirects. Note that Sub-Contract Costs are also shown with Sub-Contract Distributables in Quest estimating software summary reports (included in the FS engineering report).

b) Currencies

The exchange rates used when quotations were received in foreign currencies are 1.00 CAD /0.9524 USD and 1.00 CAD/5.8275 CNY. No allowances for escalation or currency fluctuation are included throughout the detailed engineering and construction phase.

c) Construction Direct Labour

Industrial direct craft rates for trades-people on site (considering a craft mix of foremen, experienced Journeymen and Apprentice helpers) include for base pay, social fringe benefits and government burdens per hour per craft (e.g., iron workers, pipefitters, etc.), CSST health and safety (La Commission de la santé et de la sécurité du travail du Québec), direct supervision and overtime for a 28 day work cycle.

The individual craft/trade (pipefitter, electrician, etc,) labour rates for Foremen, Journeymen and Apprentices are then blended to form a combined overall rate for each particular craft/trade.

The average industrial non-weighted direct hourly rate for all crafts is CAD$81.

The weighted average direct hourly rate for all crafts is USD$79.75 (USD $120,983,663 for 1,517,415 direct hours).

Refer to Section 21.1.3 for a discussion of indirect labour charges per direct hour of field work and the all-inclusive wage rate per direct hour.

The construction direct crew rates for various disciplines considers a mix of different crafts people, working together to install a particular commodity (steel, concrete, piping, etc.). The individual craft wage rates for each crew worker are then blended to show a combined overall crew rate per hour.

Each construction work crew shall use a 179 hours per month work cycle spanning 28 days. Each work cycle consists of 19 consecutive work days, 2 paid travel days and 7 un-paid vacation days. Each work day (Monday – Friday) is 10 hours. Saturdays and Sundays that are worked vary generally from 5 to 8 hours in duration

General direct labour to develop the mine and the ore processing facility is estimated to be in the order of 1.5 million direct field hours.

Contractors' Indirects are worked into the all-inclusive wage rate for each field crew. This includes the Construction Equipment Rental (and hourly fuel) rates per hour.

It is assumed that 20% of the 179 hour work cycle will be used by night shift workers, with an uplift of $1.50 per hour.

The CAPEX estimate is based on lump sum construction contracts with competitive bidding amongst qualified contractors. It is also expected that the Contractors' construction management would include site management, contract administration, quality control and adequate safety requirements.

Considering the working calendar, the type of project and availability of the workforce, a compounded labour productivity factor varying by discipline from 1.0 to 1.3 was applied to the man hours to account for productivity loss with respect to specific conditions related to Vendor drawing interpretations, temperature conditions, work schedule, continuity of work flow, availability of skilled workers, etc.

d) Freight, Duties and Taxes

Equipment freight for the mine and ore processing facility has been estimated at an average of 7% of the purchase price. Bulk material freight (excluding civil and structural accounts) has been estimated at an average of 5% of the purchase price. Total freight is estimated at USD $18.3M. This approximates to 2.98% of Total Direct Cost.

All duties and taxes are excluded from the capital cost estimate, but are considered for the economic analysis.

e) « Ore Processing » Direct Costs

Mill Ore Processing Direct Costs are all costs associated with the WBS codes 0000 – 0190 as shown in the CAPEX Table 21.1.1. These costs are separated and sub-totaled for reference.

f) « General » Capital Direct Costs

General Direct Costs are broken out in the CAPEX Tables 21.1.1 and 21.1.2. These direct costs include:

- WBS 0000-0190 for the Ore Processing scope
- WBS 1100 for the Open pit mine
- WBS 1200 FOR Tailings and water management
- WBS 3100 for General Services
- WBS 3200 for Infrastructures
- WBS 3300 for Power and Communications
- WBS 4000 for off-site E&I tasks associated with Concentrate material handling and transportation
- WBS 5100 for Temporary Facilities
- WBS 6000 for Commissioning Support

g) « Sub-Contract » Costs

Sub-Contract Direct and Indirect Costs are separated from General Directs in the CAPEX Tables 21.1.1 and 21.1.2.

Sub-Contract costs, as mentioned earlier are self contained third-party cost estimates (including directs and Contractors' indirects). Sub-Contract costs in Tables 21.1.1 and 21.1.2 are deemed to be direct costs.

As mentioned earlier, these all-inclusive "Sub-Contracts" are shown with Sub-Contract Distributable costs in Quest CAPEX estimate reports (included in the FS engineering report).

Sub-Contract costs account for approximately 15% of total directs in Table 21.1.1.

Sub-Contract costs for the mine and ore processing facilities are highlighted here as an introduction:

- WBS 1106 open pit mine pre-stripping quotation (as coordinated by the WorleyParsons Vancouver mining group),
- WBS 1210 tailings storage (from Dessau Consultants),
- WBS 3200 Environmental fish habitat compensation (from Genivar Consultants),
- WBS 3200 Environmental west extension waste rock stockpile estimate (from Genivar Consultants),
- WBS3240 Glycol heating system estimate
- WBS 3315 high voltage electrical transformer associated with the 161KV main power line

- WBS 3315 high voltage “start of line” Client Outpost associated with the 161KV main power line
- WBS 3315 161KV main power line from Chute de Passes (45 km on wooden poles).

All of the “mine-to-port” Transportation CAPEX costs are estimated as “lump sum” Sub-Contract costs. Sub-Contract costs include both directs and Contractors’ in-directs and are shown in the Quest estimating summary reports as Sub-Contract Distributables (included in the FS engineering report). The Contractors’ indirects, if broken out from directs, would account for roughly 13% to 18% of the total Sub-Contract costs.

Note that Contractors’ Indirects are specific indirect costs to cover construction expenses to support and deploy Direct Labour. As a distinction, note that third-party Indirects are “other” indirects provided for the field Contractors by third-party groups (other Contractors or Owner’s forces). These are grouped separately in the CAPEX Tables 21.1.1 and 21.1.2.

h) Total Direct Costs

The mine and ore processing facility total directs amount to 521.0 plus 91.9 = USD $612.9M in Table 21.1.1.

The “mine-to-port” transportation total directs amount to USD $167.9M in Table 21.1.1.

i) Mining

The mine CAPEX costs in Table 21.1.1 show the mine pre-stripping (in Sub-Contract Directs) and the mobile equipment (in General Capital Directs) required for the first year of operation. The detailed CAPEX mining Basis of Estimate document 207090-19468-1100-MG-DSP-0001 outlines the planned pre-stripping activities and assumptions related to the mobile equipment selection.

j) Ore Processing (Mill)

The various ore processing facilities in the Mill are shown in Table 21.1.1 (WBS 0000 – 0190).

The cost of start-up and commissioning spares as well as commissioning first fills of lubricants and/or chemicals at a combined cost of USD $15.1M is included with the direct costs.

WBS 0190 includes for the final product being stored in a monolithic reinforced concrete dome and being transferred to a truck load-out facility.

k) Tailings and Water Management

Tailings general construction direct costs by all disciplines are shown as Mill related activities (WBS 0170).

Specific tailings storage facilities were designed and estimated by Dessau Consultants. The Dessau cost is shown with Sub-Contact Directs in Table 21.1.1.

l) General Services

This includes items from all construction disciplines pertaining to WBS 3100 for mostly process water, potable water and waste water for equipment and bulk material supply and installation.

m) Infrastructure

This includes items from all construction disciplines pertaining to WBS 3200 for permanent process and non-process buildings, generally.

Pre-assembled modules are estimated for permanent lodging for Operations staff. The permanent camp is also used throughout construction as needed for construction staff lodging.

Note for WBS 3200 – this includes the Sub-Contract cost entries for environmental compensation for fish habitat (USD $0.6M), environmental waste rock stockpile (USD $4.7M) and the Glycol Heating System (USD $1.3M). These costs “roll-up” to USD $6.7M.

n) Power and Communications

Site power and communication directs are shown in the General Capital Directs.

Note for WBS 3300 – this includes the Sub-Contract cost entries (WBS 3315) for the 345 KV transformer (USD $7.4M), the 161KV “start of line” Outpost (USD $5.5M) and the 161KV main power line itself (USD $17.7M). These costs “roll-up” to USD $30.6M.

o) Off-Site Concentrate Transportation

WBS 4000 entries allow for off-site scope for Concentrate transportation and material handling.

p) Temporary Facilities

WBS 5100 allows for the direct material and labour costs to purchase and erect temporary construction camp prefabricated modules.

Note that all camp operating costs for food and maintenance throughout the construction period are shown with WBS 5101 as indirects.

The “mine-to-port” transportation “room and board” cost has been grouped as one item in WBS 5000.

q) Commissioning Support

WBS 6000 includes Construction support for pre-commissioning and commissioning.

Pre-Commissioning and Commissioning are shown as direct labour in the Quest estimating summary reports.

Pre-commissioning and Commissioning is generally estimated at 1% of mechanical, piping, electrical and instrumentation labour.

21.1.3 Indirect Costs

r) Sub-Total Contractors' Indirects in Table 21.1.1.

Contractors' Indirects are estimated to be USD $113.0M as per Table 21.1.1 for the mine and ore processing facility.

The cost of Contractors' Indirects includes field labour and bulk material and is found in the Indirect Cost column in Tables 21.1.1 and 21.1.2.

As mentioned earlier, Contractors' Indirects are specific indirect costs to support and deploy Direct Labour.

As a distinction, note that third-party Indirects are "other" indirects provided for the field Contractors by third-party groups (other Contractors or Owner's forces). These are grouped separately in the CAPEX Tables 21.1.1 and 21.1.2.

Contractors' Indirects are shown with Sub-Contract Distributable costs in Quest estimating software reports for the mine and ore processing facility (included in the FS engineering report).

As mentioned in Section 21.1.2, the weighted average direct hourly rate for all crafts is USD$79.75 (calculated from total labour of USD $120,983,663 for 1,517,415 direct hours) per each direct field hour.

The weighted average indirect hourly charge for all crafts is USD$74.50 (USD $113,000,000 for 1,517,415 direct hours) per each direct field hour.

Therefore, the total weighted average "all-inclusive" rate for field labour averages to USD $154.25 per each direct field hour.

For purposes of bed availability, we assume that the extra field hours associated with the indirect labour is 25% of the total direct hours = .25x 1,517,015= approx. 380,000 field hours.

We can then deduce that the total direct and indirect field hours would be 1,517,415 + 380,000 = 1,896,000 total field hours for the mine and ore processing facility. For a rough analysis, if we assume a 10 hour average work day, this would be 189,600 man days.

For purposes of camp operation cost, we assumed 200,000 man-days x CAD $50 per man day for meals and CAD $30 per man day for camp maintenance.

As mentioned earlier with Sub-Contracts, Contractors' indirect cover construction expenses to support and deploy installation labour. These indirect costs have been developed as a percentage of the direct labour costs or by a flat rate in dollars per hour. Contractors' Indirects are displayed in the FS engineering report.

Cost components covered by Contractors' indirect charge rates include:

- Mobilization and demobilization;
- Supply and maintenance of temporary site facilities;
- General purpose scaffolding, cribbing and dunnage;
- Small tools and consumables;
- Site office operation, including staff and supervision;
- Construction equipment rental (including fuel costs);
- Home office costs;
- Contractors' fees and overhead.

Note that the other Project Indirects, namely third-party indirects and specific Project Indirects for EPCM and Owner's Cost are shown elsewhere (below).

s) Sub-Total Contractors' Indirects in Table 21.1.2

Contractors' Indirects for "mine-to-port" Transportation are included along with the Sub-Contract costs in Table 21.1.2.

Sub-Contract costs denote third-party costs with combined Directs and Contractors' Indirects.

Note that with items in the Sub-Contracts column of Tables 21.1.1 and 21.1.2, the Contractors' indirects, if broken out from directs, would account for roughly 13% to 18% of the total Sub-Contract costs.

The total direct and indirect hours for the transportation scope is roughly 450,000 hours, as shown in Quest summary reports by Commodity for WBS 5000.

t) Sub-Total Third-Party Indirects in Tables 21.1.1 and 21.1.2

Third-party Indirects are "other" indirects provided for the field Contractors (by third-party groups or Owner's forces). These are shown separately in the CAPEX Tables 21.1.1 and 21.1.2.

Third party Indirects include for camp operating costs, initial site mobilization, temporary power, Vendor Reps, General Project Indirects and Heavy Cranes > 150 tons.

u) Camp Operating Costs

Construction camp on-site operating costs allow for meals and camp maintenance for 200,000 man days of direct and indirect construction labour personnel during the construction period for developing the open pit mine and the ore processing facilities.

Construction camp off-site operating costs allow for “room and board” combined costs for meals and lodging. for construction labour personnel for the “mine-to-port” Transportation portion. This appears as Temporary Construction Facilities.

v) Initial Site Mobilization

Initial site mobilization is an allowance to cover the cost of preliminary activities and site lodging of personnel who first arrive on site.

w) Temporary Power

Temporary power is estimated using diesel powered generators supplying power to selected locations on site via pole mounted overhead wires.

The emergency generators purchased for permanent use will replace rental units as soon as they are procured and delivered to the Lac-a-Paul site.

The High Voltage electrical MTO quantity narrative in the CAPEX Basis of Estimate briefly explains this scope of work.

x) Vendor Representatives

Vendor Representatives are included for site supervision and Commissioning of detailed process equipment items.

Vendor Reps for the ore processing facility are shown with WBS 6000 at USD $1.7M.

This is factored at 1% of the purchased process equipment cost of USD $173.1M.

A further 0.3% for Vendor Reps is included with the process equipment direct costs for the Mill area.

Vendor Representative costs (at USD $0.5M) are grouped with Contingency for the “mine-to-port” Transportation scope.

y) General Project Indirects

General Project Indirects on site for WBS 6000 are indirects assessed on a Project-wide basis and supplied by the Owner or a third-party. These indirects include, but are not limited to, the following:

- Specific construction facilities supply and/or maintenance (roads, walks, parking areas, trailers, temporary buildings and temporary utilities/power);
- Construction support, general and final clean-up, welder testing, on-site services (e.g. cleaning), operation and maintenance of construction support facilities and pre-operational testing support – manual labour);
- Material handling for Owner purchased equipment and materials;
- General project expenses that are not included with Contractors indirects.

z) Heavy Cranes

An allowance for heavy cranes > 150 tons has been carried for heavy equipment lifts and long reach lifts. This is based on the experience of Nardella Construction Management Consultants on previous mining projects completed in northern Quebec.

Cranes are shown with Construction Support in Table 21.1.2 for the Transportation scope.

aa) Sub-Total Project Indirects in Tables 21.1.1 and 21.1.2

"Project" Indirects are specific Project indirects that include EPCM, Owner's cost, Escalation, Financial costs and Mine Closure.

bb) EPCM

Site wide engineering, procurement and construction management is factored at 10% of the total direct cost for the mine and ore processing facility.

Engineering, Procurement and Construction Management (EPCM) costs include construction site security and safety cost allowances (at USD $ 3.8M) for the "mine-to-port" transportation scope.

cc) Owner's Cost

Owner's costs from Arianne Phosphate for the open pit mine and the ore processing facility amount to USD $49,1M from Table 21.1.1. This includes for the following:

- Historical expenditure on any aspect of the Project (including engineering, procurement and construction) as of the estimate base date of the estimate;
- Owner's staff, specialist consultants and contractors (such as operations, maintenance, engineering and administrative personnel) including salaries, benefits, travel, and accommodation, office rental and running costs;

- Marketing and sales costs;
- Land purchase, compensation or leasing costs, right-of-way establishment;
- Cultural heritage, community relations, security and environmental management costs;
- Owner's systems, plans, processes and procedures for: health, safety, environment, cultural heritage, operations, drilling, government/compliance, engineering / QA, etc.;
- Royalties, fees and levies, including management, technology, external/internal consultants, legal fees and expenses and transportable long service levy;
- Foreign exchange variation and hedging costs;
- Force majeure costs and delays, including severe weather (but the estimate allows for a normal degree of inclement weather);
- Owner's insurances, including those during construction (including public liability, contractor's all-risks, marine and inland freight, workers compensation), motor vehicle, public and professional liability;
- Commissioning handover and close-out costs, including staff salaries and benefits, supplies and communications, travel and accommodation, plant modification costs, pre-production operating costs (e.g. utility, raw materials, chemicals, shut-down/start-up costs of existing plant, tie-ins, production / sales losses impacted by commissioning etc.);
- Project finance / working capital / payroll costs;
- Owner's local and corporate overheads generally.

Owner's cost for the "mine-to-port" Transportation scope amount to USD $14.3M in Table 21.1.2.

dd) Escalation

Escalation costs incurred during detailed engineering and construction are excluded from the CAPEX estimate.

ee) Financial Costs

Working capital, financing interest incurred during the project, taxes and duties are the responsibility of the Owner.

ff) Mine Closure and Rehabilitation of the site

Closure Cost and Rehabilitation/remediation of the site are excluded from the Capital Cost. These costs have been developed by others and shown with the Economic Analysis.

21.1.4 Contingency

Contingency for the open pit mine and ore processing facility was determined at approximately 10% of Total Direct Cost. This considered the level of engineering development of the project as well as area risks.

Contingency for the "mine-to-port Transportation scope (USD $17.1) is combined with freight (USD $0.5M) and Vendor Representatives (USD $0.5M).

21.1.5 Sustaining Capital Expenditures

Sustaining Capital estimates are established for the Mining Equipment (additional equipment and replacement over time), environmental remediation, the Ore Processing Facility requirements over time, the Tailings Management Facilities (costs to reach final design elevation) and the Concentrate Transportation scope (additional equipment and replacement over time). These costs are shown with OPEX in Section 21.2.

21.2 Operating Costs

21.2.1 Operating Costs Summary

This section contains the operating cost estimate for the Lac a Paul Project, processing plant and related infrastructure. The report outlines the philosophy and basis on which the estimate was developed.

These Costs were developed in close collaboration between Arianne, Cegertec WorleyParsons in Quebec offices as well as other WorleyParsons entities in Melbourne, Vancouver, and Toronto in addition to other private consultants. These contributions were compiled to produce a total project operating cost estimate.

Data were drawn from a Microsoft Excel based model, which was developed and modified to suit the requirements of this project. Pre-production costs were not included because they were treated as capital expenditures and were included in mining capital costs for the E&Y financial model.

The methodology and data collection strategies applied during the development of the operating cost estimate are sufficient to support a ±15% level of accuracy.

The operating costs are summarized in Table 21.2.1.

Area	CWP Average Operating Cost		
	US$/Year	US$/t Ore	(US$/tonne of concentrate)
Mining	79,580,064	4.35	27.33
Ore Processing :	140,078,766	7.71	48.11
- *Labour (non-mining)*	*18,843,299*	*1.04*	*6.47*
- *Operating Consumables*	*70,982,065*	*3.91*	*24.38*
- *Maintenance Equipment*	*11,324,739*	*0.62*	*3.89*
- *Power*	*38,928,664*	*2.14*	*13.37*
Plant Administration, Infrastructure & Tech. Serv.	12,430,079	0.68	4.27
S/Total Operating Costs	**232,088,908**	**12.75**	**79.71**
Transportation (Mine to Port)	40,651,333	2.24	13.96
Total Operating Cost	**272,740,241**	**14.99**	**93.68**

Table 21.2.1 Total Operating Cost

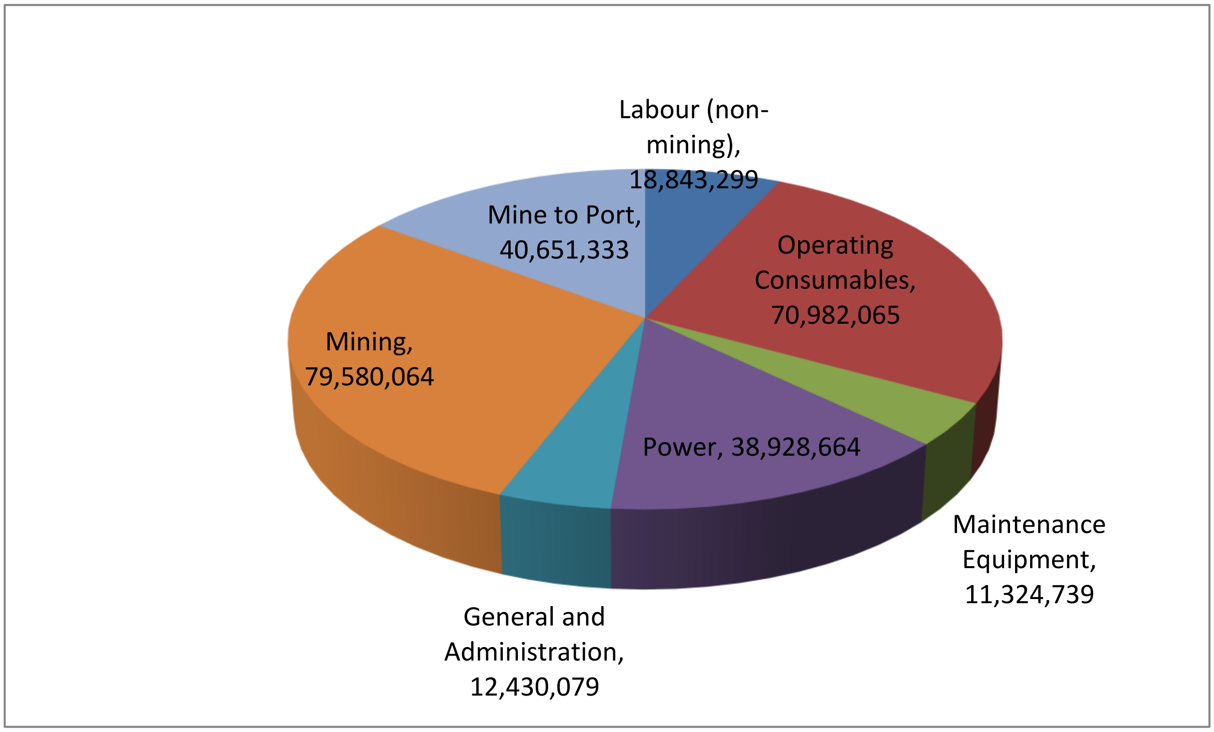

Figure 21.2.1 Total Operating Cost

21.2.1.1 Inputs and assumptions

- Annual Ore Throughput of 55,000 tpd.
- Production number of days is 339 per year.
- Power station facilities are Hydro-Quebec.
- The operating costs exclude cost of capital and amortization. These will be addressed in the Financial Model.
- Accommodation, cleaning, flight admin, rubbish collection and disposal will be provided by a third party.
- Light vehicles and mobile equipment for the plant will be purchased by the owner.
- External communication of voice and data will be via microwave; and
- Fuel Prices are as per the Input table.
- There is no provision for product transportation costs (truck, rail and port).
- There are no export duties or import duties included.
- The project ramp up to design capacity is first 3 months = 35%, next 6 months = 80%, year 2 = 100%.
- The normal operating year achieves nameplate capacity at the design availabilities; and
- The operating costs do not fluctuate significantly.
- The employees status will be First In First Out (FIFO).
- On site accommodation will be provided near the mine site with bus transport to the workplaces.
- Working 12 hour shifts, 7/7 and 4/3 rosters.
- The unit prices for various consumables have been obtained from reputable vendors.

21.2.1.2 Exclusions

These figures exclude:

- Product marketing.
- Cost of capital and financing charges.
- Depreciation.
- Royalties and taxation.
- Escalation.
- Contingency.

21.2.1.3 Fixed and Variable Costs assumptions

- Labour Costs as well as the general and administration costs are considered to be fixed costs.
- Operating consumables excluding fuel and reagents are considered to be mostly Variable (80%) whereas only 20% of these costs are considered to be fixed.
- Fuel and reagents are considered to be variable costs.
- Power consumption is considered to be fixed at 38% of the total costs based on the power consumption model.
- 50% of the Equipment's maintenance is considered to be variable and 50% fixed.
- 25% of the mining costs are assumed to be fixed and the remaining are variable.

21.2.1.4 Labour

These expenses account for the annual costs of all personnel required to facilitate the operation and management of Lac a Paul Project. They include direct payments and all required on costs.

Arianne provided a labour manning chart which indicated the anticipated personnel requirements, role and shift roster details under functional area headings. They also provided a remuneration scale which allocates a total annual labor cost against each position. The total annual labor cost of an employee is comprised of the employee remuneration package including salaries, wages and bonuses.

Table 21.2.2 summarizes the overall requirement for labour as well as the average annual cost by area.

Area	Number	Average Yearly Cost US$/Y	(US$/t Ore)	(US$/t Concentrate)
Management and Administration	60	7,621,985	0.42	2.62
Hourly Personnel - Mine	175	15,649,093	0.86	5.37
Employed Personnel - Mine	30	3,329,089	0.18	1.14
Hourly Personnel - Process	82	7,952,192	0.44	2.73
Employed Personnel - Process	28	3,269,122	0.18	1.12
Total Manpower	**375**	**37,821,482**	**2.08**	**12.99**

Table 21.2.2 Yearly average manpower requirement for the operations

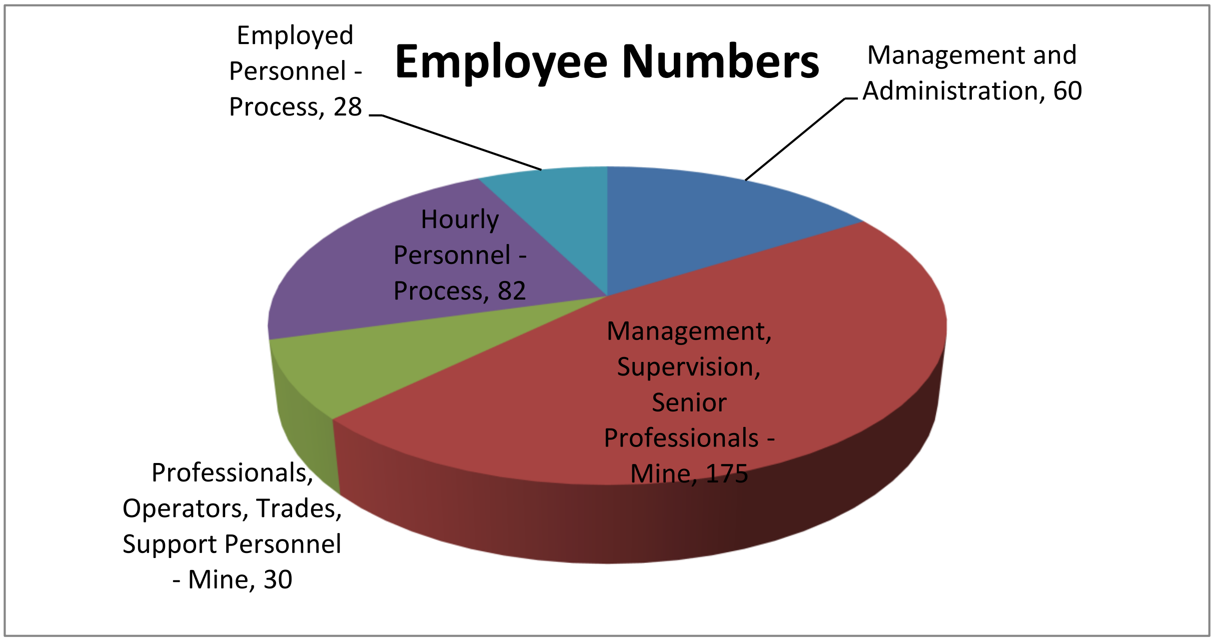

Figure 21.2.2 Yearly average manpower breakdown by area

21.2.2 Mining Cost

21.2.2.1 Cost Summary

The mine operating cost estimate was prepared by the WorleyParsons office in Vancouver using spreadsheets that have been developed and refined on a range of open pit projects and is used to estimate mining costs from first principles.

The spreadsheet is adapted to each project according to the project requirements, specifications and assumptions, however, the logic of the main processes within the system are generally kept constant.

The open pit activities assessed include:

- Drill, blast, excavate, load, haul and dump of ore to the primary crusher and waste to the waste dump.
- Auxiliary operations such as haul road construction and maintenance and bench, dump and drainage maintenance, waste dump batter pushing to final slope angle.
- Pit dewatering.
- Mining department management and supervision up to and including the Mining Director, including technical services personnel such as mining engineers and geologists etc.
- Operating and maintenance manpower requirements.
- Consumables including fuel, parts, explosives, reagents, etc.

Mine	Average Operating Cost		
	US$/Year	US$/t Ore	(US$/tonne of concentrate)
Mining Labour	18,978,182	1.05	6.52
Equipment Maintenance	22,760,575	1.25	7.82
Equipment Fuel Consumption	19,922,844	1.10	6.84
Equipment Electric Power Consumption	813,466	0.04	0.28
Equipment Consumables	2,401,544	0.13	0.82
Blasting	14,279,016	0.79	4.90
Clearing, Grubbing, other Costs	424,436	0.02	0.15
Total	**79,580,064**	**4.38**	**27.33**

Table 21.2.3 Summary of the mining operating cost

21.2.2.2 Equipment Operating Cost

The equipment operating costs are divided in terms of equipment maintenance, fuel required for equipment, electrical energy required, and equipment consumables. Labor is excluded from the equipment calculations and is included under the Personnel subsection.

Equipment being run on diesel fuel includes the mine trucks, drills, loaders, dozers and other mine equipment. Section 16 of this Report gives an overview of the fuel consumptions that were estimated on a yearly basis of operation. The fuel consumptions for each year are then multiplied by the standard supply rate in the region, which is $0.877 per liter and includes the cost of transportation to the site, which is 200km north of the town of Alma.

Electrical power is used for the hydraulic shovels and mine dewatering pumps. The cheaper and available electric power in Quebec provides cost benefits for running one of the major equipment items of the Mine. Power consumptions were calculated for each year, and took into account the equipment mechanical availability, utilization and utility. The rated price of electricity is the “L Rate” of Hydro Quebec. As well, a power factor has been applied for the calculations in the mine. The power factor used is 93% except the crushers for which the power factor is 75%.

Equipment	Average Qty. pa
Primary equipment	
PC2000BH -15.5cubic yards	1
HD785-7 100T Class	4
Shovel (PC5500)- Electric	2
Wheel Loader (L-1850)	1
Mining Truck (CAT 793)	12
Secondary Equipment	
Wheel Dozer (Caterpillar 844H)	2
Track Dozer (D10)	2
Motor Grader (Caterpillar 16M)	2

Equipment	Average Qty. pa
Water/ Sander Truck (777G)	2
Auxiliary Equipment	
Hydraulic Crane (P&H truck mounted 100 tonnes)	1
Air Track Drill (200 HP 80 to 100mm)	1
Wheel Loader (Reeler) (Caterpillar 980K)	1
Articulated Dumper (Caterpillar 735)	1
Skid-steer (CAT 242B3)	1
Tow Truck (789D)	1
Utility Excavator (Caterpillar 320E)	1
Fuel/ Lube Truck (CT660)	2
Prime Mover For Low Bed	1
Service Truck (CT 660) (250 HP 22,000 GVW)	1
Tire Changer (attachment for 99H)	1
Mini Bus (12 passenger Ford E series)	1
Pick Up Truck (4x4 crew cab Chevrolet 2500)	4
Pick Up Truck (4x4 single cab Chevrolet 2500)	4
Light Tower MLT3060K (1000 w. diesel generator)	5
Dewatering Pump (250 HP electric submersible)	5
Tow Low Boy LPM (120-48-20)	1
Tire Handler (Kalmar DCD200-12lb)	1
Total Mobile Equipment	**62**

Table 21.2.4 Details of the Average Mobile Equipment Quantity

Table 21.2.5 below details the requirement for the maintenance, fuel consumption and other consumables.

Equipment Operating Cost	Average Operating Cost Per Year		
	US$/Year	US$/t Ore	(US$/tonne of concentrate)
Equipment Maintenance	22,760,575	1.25	7.82
Equipment Fuel Consumption	19,922,844	1.10	6.84
Equipment Electric Power Consumption	813,466	0.04	0.28
Equipment Consumables	2,401,544	0.13	0.82
Total	**45,898,429**	**2.53**	**15.76**

Table 21.2.5 Breakdown of average equipment operating cost

21.2.2.3 Blasting

The blasting operating costs were provided by an Explosive's Supplier, who divided costs by bulk emulsion, accessories costs, operating service fees, MMU, MMU Operators, Blasters and Supervisors, Transport, etc.

All of the blasting design parameters are presented in Section 16 of this Report. The unit blasting costs are dependent on the powder factors, which are also shown in Section 16 of the Report. The unit costs for ore and waste rock are $0.33/t mined for and $0.31/t mined, respectively.

The accessories and emulsion costs are shown below:

Blasting Accessories	Cost	Unit
Exel MS 12m	7.34	$/hole
Pentex D454	5.63	$/hole
Cordex 18	0.33	$/M
MS Connector	5.11	Un
Total Accessories	**18.41**	**$/hole**
Emulsion	1.01	$/kg

Table 21.2.6 Explosives Costs

21.2.2.4 Labor

Manpower is divided into hourly operations personnel, hourly maintenance personnel and salaried personnel.

Hourly operators are calculated based on four crews working on 12 hour shifts (i.e. two crews per rotation, one crew per shift).

Section 16 contains details on the calculations and total numbers of personnel over the life of the mine.

The salaries of the mine are based on competitive pricing for the region, on an internal database, and on expertise. Fringe, benefits were calculated at 25% of employees salaries.

21.2.2.5 Services and Miscellaneous

Additional operating costs not mentioned above, include clearing, grubbing, additional dewatering costs, etc. The clearing is being done with a cost of $2000/HA, whereas topsoil removal is based on 0.5m thick topsoil, with a unit cost of $6/m^3. Yearly costs are dependent on the surface areas being cleared in any given year.

21.2.3 Ore Processing

21.2.3.1 Summary

The Ore processing operating costs are summarized in Table 21.2.7. These costs are subdivided into four main categories which are Labour, Power Consumables (including Operating consumables, reagents and fuel) and the maintenance of non-mining equipment. These prices were derived from suppliers' information as well as WorleyParsons and Arianne internal data.

Description	Average Operating Cost		
	US$/Year	(US$/t Ore)	(US$/tonne of concentrate)
Labour	18,843,299	1.04	6.47
Power	38,928,664	2.14	13.37
Operating Consumables (Reagents Excl.)	30,361,013	1.67	10.43
Reagents	40,621,051	2.24	13.95
Maintenance of non-mining Equipment	11,324,739	0.62	3.89
Total	**140,078,766**	**7.71**	**48.11**

Table 21.2.7 Summary of the Ore processing operating costs

21.2.3.2 Consumables

The process Plant operating cost for consumables represents the major portion of the total mine development operating costs. It includes Operating Consumables of Equipment, Dryer Fuel, Reagents and Grinding Media. Al the prices of consumables were sourced from reputable suppliers.

21.2.3.2.1 Operating consumables (Excluding Grinding Media)

Operating consumables are treated separately to maintenance consumables and spares. These items are not considered as a requirement for equipment repair but are materials that are consumed during production. The requirement for the various operating consumables has been based predominantly on vendor or original equipment supplier recommendations.

Description	Annual Consumption rate per unit	Average Operating Cost	
		US$/Year	(US$/tonne Concentrate)
Primary Crusher		1,095,568	
- *Mantle set – std lower diameter*	*3 sets*		
- *Mantle set – oversize lower diameter*	*3 sets*		
- *Alloy Concaves*	*3 sets*		
- *Set of Spider Shields*	*3 sets*		
- *Set of top Shell Wear Plates*	*3 sets*		
- *Set of Bottom Shell Liners*	*3 sets*		
- *Set of Liner attachment Disks*	*3 sets*		

Description	Annual Consumption rate per unit	Average Operating Cost	
		US$/Year	(US$/tonne Concentrate)
SAG Liners		3,514,686	
- *FE Throat, Inner, Outer*	*18 ea.*		
- *FE Shell Liners*	*30 ea.*		
- *Filler ring segment*	*36 ea.*		
- *Center Shell Liner*	*30 ea.*		
- *DE Shell Liner*	*30 ea.*		
- *Filler Block*	*18 ea.*		
- *Pulp lifter*	*36 ea.*		
- *Grate*	*36 ea.*		
- *Pulp discharge*	*18 ea.*		
- *Pulp discharger plate*	*18 ea.*		
- *Retaining ring*	*1 ea.*		
- *Rubber Wedge*	*170 ea.*		
- *Fastners*	*1040 ea.*		
- *Rubber Plugs*	*456 ea.*		
Ball mill liners (x2)	Qty for each mill	1,347,706	
- *Inner end Liner*	*16 ea.*		
- *Outer End Liner*	*48 ea.*		
- *Filler Ring Segment*	*46 ea.*		
- *FE Shell Liner*	*23 ea.*		
- *Center Shell Liner*	*92 ea.*		
- *DE Shell Liner*	*23 ea.*		
- *Rubber Wedge Filler Strip*	*138 ea.*		
- *Fastners*	*815 ea.*		
- *Expandable Rubber Plug*	*213 ea.*		
Mill Cyclones		633,266	
- *Cover plate liner, gum rubber (x3)*	*18 ea.*		
- *Inlet head liner, gum rubber (x3)*	*18 ea.*		
- *Upper cone liner, gum rubber (x3)*	*18 ea.*		
- *Middle cone liner, gum rubber (x3)*	*18 ea.*		
- *Lower cone liner, gum rubber (x3)*	*36 ea.*		
- *Apex insert, gum rubber (x8)*	*36 ea.*		
- *Vortex finder, gum rubber lined (x3)*	*18 ea.*		

Description	**Annual Consumption rate per unit**	**Average Operating Cost**	
		US$/Year	(US$/tonne Concentrate)
Dewatering Cyclones		766,803	
Stages 1			
- *Cover Plate Liner, gum rubber (x2)*	*14 ea.*		
- *Inlet head liner, gum rubber (x6)*	*14 ea.*		
- *Upper cone liner, gum rubber (x2)*	*14 ea.*		
- *Middle cone liner, gum rubber (x2)*	*14 ea.*		
- *Lower cone liner, gum rubber (x2)*	*28 ea.*		
- *Apex insert, gum rubber (x8)*	*28 ea.*		
- *Vortex finder, gum rubber lined (x2)*	*14 ea.*		
Stages 2			
- *Cover Plate Liner, gum rubber (x2)*	*34 ea.*		
- *Inlet head liner, gum rubber (x6)*	*34 ea.*		
- *Upper cone liner, gum rubber (x2)*	*34 ea.*		
- *Middle cone liner, gum rubber (x2)*	*34 ea.*		
- *Lower cone liner, gum rubber (x2)*	*68 ea.*		
- *Apex insert, gum rubber (x8)*	*68 ea.*		
- *Vortex finder, gum rubber lined (x2)*	*34 ea.*		
Flash Dryer		76,116	
- *Filter bags*	*100 bags*		
- *Refractory*	*1058 kg*		
Other Consumables		305,058	
- *General supplies*			
- *Sewage Water Treatment*			
- *Potable Water treatment*			
- *Operator supplies*			
Total		**7,739,203**	**2.66**

Table 21.2.8 Summary of the Ore processing operating cost

21.2.3.2.2 Fuel

Diesel for non-mining mobile equipment is considered for a yearly consumption of 525,000 Liters. These were estimated based on the equipment identified. Table 21.2.9 below summarizes the fuel consumption for the process operations. Diesel price is negotiated by Arianne and is considered to be 0.835 US$/liter (0.877 CA$/liter) including transportation.

Description	**Average Operating fuel Cost**			
	Unit	**US$/Year**	**US$/t Ore**	**US$/t Concentrate**
Diesel for non-mining Mobile Equipment	525 (**)	438,509	0.02	0.15

(**) Annual consumption: (x1000) liters

Table 21.2.9 Fuel cost for non-mining equipment

21.2.3.2.3 Reagents

Unit consumption rates for reagents and chemicals were derived from the Process Design Criteria and the nominal mass balance flow data. Consumption rates are predominantly expressed in tonnes of Ore.

There are six groups of reagents and chemicals used in the process plant as shown in Table 21.2.10.

The majority of reagent and chemical prices were sourced through sound suppliers.

Reagent	Average yearly Operating Cost			
	Tonne	US$/Year	US$/t Ore	US$/t Concentrate
Flocculant (emulsion)	200	742,872	0.04	0.27
Phosphate collector	5,963	12,505,513	0.69	4.51
Wheat starch	11,528	9,881,340	0.54	3.56
Sulfuric acid	5,883	980,520	0.06	0.35
Sodium Silicate	3,800	2,334,332	0.13	0.84
Sodium Hydroxide	11,450	14,176,474	0.78	5.11
Total		**40,621,051**	**2.24**	**13.95**

Table 21.2.10 Average Yearly Reagents Costs

21.2.3.2.4 Grinding media

The grinding mills will need a regular addition of balls to replace the worn media and exercise the proper grinding action on the material. Media consumption has been estimated from the power input into the material based on steel consumption observed in similar operations. Balls will have to be added every day to maintain the steel load in the mills. The grinding media consumption for each mill is detailed in Table 21.2.11.

Consumables	Average Operating Cost		
	Kg media/t Ore	Average Yearly Cost US$/Y	US$/t Ore
SAG Mill Grinding Media	0.280	6,582,989	0.36
Ball Mills #1	0.360	7,800,156	0.43
Ball Mills #2	0.360	7,800,156	0.43
Total		**22,183,301**	**1.22**

Table 21.2.11 Media consumption for grinding mills

21.2.3.2.5 Power

Energy expenses comprise the costs associated with purchasing electrical power for the project.

The annual power consumption for the Process Plant is obtained from the installed power as per Table 21.2.12 below, assuming a 24 hpd operation through 365 days a year and represents the total annual energy (kWh/y) consumed. This power consumption was derived by calculating the required absorbed power and annual operating time for all electrically connected pieces of mechanical equipment assuming a 93% service factor for all equipment.

The following table gives the detailed power cost per area.

Area	Average Operating Cost			
	Installed Power (kW)	Average Yearly Cost US$/Y	US$/t Ore	US$/t Concentrate
MILL AREA - EROOM Services and Compressors	3,917	1,363,592	0.08	0.47
CRUSHER AREA	2,381	828,960	0.05	0.28
COARSE ORE STOCKPILE	772	268,675	0.01	0.09
GRINDING AND CLASSIFICATION	37,130	12,926,637	0.71	4.44
MAGNETIC SEPARATION	1,653	575,446	0.03	0.20
FLOTATION	6,005	2,090,732	0.12	0.72
CONCENTRATE & THIKENING, FILTRATION, DRYING, LOAD-OUT	43,365	15,097,170	0.83	5.19
COMBINED TAILING PUMP BOX	1,376	479,050	0.03	0.16
REAGENTS	374	130,117	0.01	0.04
PHOSPHATE ROCK CONCENTRATE STOCKPILE AND LOAD-OUT	1,115	388,038	0.02	0.13
OPEN PIT MINE	5,349	1,862,221	0.10	0.64
TAILINGS AND WATER MANEGEMENT FACILITIES	3,397	1,182,614	0.07	0.41
GENERAL SERVICE MINE SITE	2,578	897,579	0.05	0.31
INFRASTRUCTURE MINE SITE	2,106	733,327	0.04	0.25
PUMPING STATION (Dessau) - Not in CWP contract	300	104,506	0.01	0.04
Mill AREA - EROOM Services and Compressors	3,917	1,363,592	0.08	0.47
Total	**111,817**	**38,928,664**	**2.14**	**13.37**

Table 21.2.12 Detailed power cost per area

21.2.3.2.6 Maintenance of Equipment

Maintenance supplies will be required for routine replacement and/or change out of parts for capital items of plant and equipment and for general site maintenance, in order to fully maintain the operating plant and related infrastructure. These expenditures generally comprise maintenance spares, stores and consumables allowances that differ in nature from those in the consumables area, such as mill liners and filter cloths etc.

Maintenance cost estimates have been calculated based on a percentage of the delivered cost of materials and equipment to site (taken from the project Capital Cost estimate), according to the categories and factors shown in Table 21.2.13. These factors are typical for new plant of a similar scale and level of complexity to that proposed for the Lac a Paul Project and were developed by WorleyParsons.

The maintenance cost estimates do not include labour. This is accounted for under the Labour Expense Item.

Area	Total FIS Capital Cost US$	FIS Maint. Factor	Average Operating Cost	
			Average Yearly Cost US$/Y	US$/t Concentrate
0100 - Mill	31,092,388	3.0%	932,772	
0110 - Crusher area	37,747,031	4.0%	1,509,881	
0120 - Coarse Ore stockpile and reclaim	14,245,556	3.0%	427,367	
0130 - Grinding and classification	79,243,918	3.5%	2,773,537	
0140 - Magnetic Separation	13,699,283	2.0%	273,986	
0150 - Flotation	36,459,811	3.0%	1,093,794	
0160 - Concentrate thickening, filtration, drying, storage and load-out	36,248,622	3.0%	1,087,459	
0170 - Instrumentation	5,127,809	1.0%	51,278	
0180 - Reagents	6,775,075	1.5%	101,626	
0190 - Phosphate rock concentrate stockpile and load-out	28,393,382	2.0%	567,868	
1100 - Open pit mine (Already in life of mine)				
1110 - Mine development (Already in life of mine)				
1130 - Mining Equipment (Already in life of mine)				
1200 - Tailings and water management facilities	905,151	0.5%	4,526	
1220 - Tailings pipelines and outlet structure	24,515	0.5%	123	
1240 - Reclaim water Pumping and Pipeline	612,838	2.0%	12,257	
1260 - Tailings Pipelines - Drainage Basins	7,102,250	1.0%	71,022	
3110 - Fuels	852,163	1.5%	12,782	
3130 - Fresh Process Water Underground network	8,909,414	2.0%	178,188	
3140 - Sanitary Waste Water U/G Network	1,840,223	2.0%	36,804	
3160 - Fire protection underground network	605,601	2.0%	12,112	
3180 - potable water underground network	1,349,549	1.5%	20,243	
3220 - Ancillary buildings and facilities	23,969,029	2.0%	479,381	
3230 - Storm water collection and Management	1,030,863	3.0%	30,926	
3310 - Main Power	13,196,192	2.0%	263,924	
3320 - Site power distribution	1,317,580	1.5%	19,764	
3330 - Emergency Power	3,685,167	1.5%	55,278	
3360 - Process Automation System	3,584,037	1.5%	53,761	
3370 - Access Control	215,846	1.5%	3,238	
S/Total Eq. Maintenance	**358,233,293**		**10,073,895**	**3.46**
Offsite infrastructure and main access roads			380,960	
Contract major shut down Labor			447,113	
Maintenance general allowance (Software, training, manuals)			285,720	
Power line Maintenance			137,050	
Total Maintenance			**11,324,739**	**3.84**

Table 21.2.13 Summary of equipment maintenance costs

21.2.4 General and Administration

These expenses include a range of miscellaneous costs associated with providing services to the project.

In general, these expenses were determined on a dollar allowance basis and include items such as:

- Costs related to travel associated with personnel rosters.
- Communication expenses (telephone, post and internet).
- Medical, safety and clothing supplies.
- Training and development.
- Office and general supplies.
- Various consultancies and laboratory testing.
- Emergency freight.
- Recruitment, relocation, advertising and other similar employee related expenses.
- Recreation and entertainment expenses.
- Community relations expenses.
- Insurance.
- Government, commercial, auditing and legal fees, and
- Other overhead costs.

Item	Unit Rate	Units	Total Cost US$/year	US$/t Concentrate
Operations				
Telecommunications			2,043,302	
Stationery	3,000	$/month	34,286	
Postage, Courier and Light Freight	65	$/package	25,753	
Computer Supplies & Upgrades	3,000	$/computer	42,858	
Insurances				
General			2,381,000	
Financial				
Banking Charges	Excluded			
Legal Fees	Excluded			
Auditing Costs	Excluded			
Royalties	Excluded			
Fees				
Tenement Fees	325,000	$/year	309,530	
Environmental License	25,000	$/year	23,810	
Local Government Fees	1,000	$/month	11,429	
Community Relations Expenses	15,000	$/month	171,432	
Consultants				
Environmental Consultants	250,000	$/year	357,150	
Safety Consultants	80,000	$/year	76,192	
Engineering	300,000	$/year	285,720	
Payroll Consultants	230,000	$/year	72,287	
Environmental Compliance Testing	500,000	$/year	476,200	
Personnel				
First Aid and Medical Costs	125	$/employee/year	44,644	
Medicals & on-boarding	185	$/new employee/year	66,073	
Entertainment	8	$/employee/month	34,286	
Safety Clothing	400	$/employee/year	142,860	
Travel & Accommodation	Excluded			
Recruiting/Relocation	Excluded			
Training	2,000	$/employee/year	714,300	
Worker Transport (FIFO / bus)	25	$/trip	238,290	
Contracts				
Medical Contract	3,000	$/month	34,286	
Community Health Contract	N/A	$/month		
Security Contract	395,000		376,198	
Camp, Catering and Cleaning Contract	50.03	$/employee/day	3,565,444	
General				
Site Laboratory			569,409	
Administration Light Vehicles	5,0000		47,620	
Services	100,000	$	95,240	
Miscellaneous	200,000	$	190,480	
TOTAL			**12,430,079**	**4.27**

Table 21.2.14 Summary of G&A Costs

21.2.5 Transport of Concentrate (Mine to Port)

Phosphate rock concentrate will be transported by trucks from Mine to Port using 120 tonnes custom designed trailers; travel distance will be 237 km on out of norms road to Saint-Fulgence, a village located on the North shore of the Saguenay River. New phosphate handling/storage equipment and wharf will be built at Saint-Fulgence. Trailers will be emptied in a pit and phosphate rock concentrate will be air lifted to two (2) 100 Kt silos; one 50 Kt silo will feed the ship loader which will be used to load Handymax (35 to 50 Kt) or Supramax (60 Kt) type ships. OPEX costs cover the following requirements: phosphate transportation, trailers maintenance, road maintenance, electricity, equipment maintenance and operation at the wharf in Saint-Fulgence.

Description	Average yearly Operating Cost US$/t Concentrate
Shipping by 120t trucks (237 km) from Mine to Port (St-Fulgence)	9.93
Out of norm road maintenance	1.67
Phosphate rock concentrate loading at Port (including Port utilization costs)	2.13
Power costs	0.23
Total Transportation cost	**13.96**

Table 21.2.15 Summary of Shipping Cost

21.2.6 Sustaining Capital

This Expense Item covers the requirement for either the replacement or purchase and installation of plant and equipment, or outlay of costs associated with the building of infrastructure sometime throughout the life of the project. The sustaining capital estimated amount totals to US$384.8M (CAD$404M). Table 21.2.16 below gives further details.

The mine sustaining capital comprises the equipment purchasing and replacements from the start of production (i.e. Period 1) until the end of the LOM. The pre-production equipment purchases are considered within the initial capital estimate.

All sustaining capital was calculated on a yearly basis, and was broken down by individual equipment types. Design assumptions are provided within Section 16: Mining Methods. The initial budgetary pricing was provided by equipment Suppliers and was divided into assembly, commissioning, freight, etc. The sustaining mining capital is divided into equipment purchasing and replacements over the LOM. The respective purchasing/replacement schedule can be found in Appendix 3: Mining Equipment Fleet.

The mine sustaining capital for the Lac a Paul FS totals to US$252.04 (CAD$264.64M) and represents approximately 66% of the total sustaining capital estimated. The majority of the equipment purchasing occurs within the first production period and amounts to US$55.19 (CAD$57.95M).

Cost Centre	Total Cost				
	Cost in US$	US$/year	% of Total	US$/t ore	US$/t Concentrate
Tailings	54,034,630	2,001,283	14	0.11	0.66
Mine equipment	252,043,532	9,334,946	66	0.50	3.06
Waste Rock Stockpile	6,503,331	240,864	2	0.01	0.08
Plant, building and infrastructure	53,810,600	1,992,985	14	0.11	0.65
Trailers	14,571,720	539,693	4	0.03	0.18
Handling (Port)	3,809,600	141,096	1	0.01	0.05
Total	**384,773,414**	**14,250,867**		**0.76**	**4.67**

Table 21.2.16 Sustaining Capital Cost Details

22. ECONOMIC ANALYSIS

22.1 General

A preliminary economic analysis of the project (apatite concentrate production based on a milling rate of 55,000 tonnes per day) has been carried out using a cash flow model prepared in Microsoft Excel. The model is constructed using monthly cash flows during the construction period and annual cash flows during the operating period, both in constant money terms (5th of September 2013). No provision is made for the effects of inflation. As required in the financial assessment of investment projects, the evaluation is carried out on a 100% equity basis, i.e. the debt and equity sources of capital funds are ignored. Results are presented before and after taxation (an additional dashboard is shown in Appendix 10).

The model reflects the base case financial and technical assumptions given in this report on the basis that the owner will own and operate the mining equipment.

22.2 Assumptions

22.2.1 Key Assumptions

The key assumptions used in the base case are given in Table 22.2.1.

The average phosphate price of 213 US$/tonne of concentrate is based on economic studies performed by CRU and Integer as outlined in Section 19.

The sensitivity analysis examines a range of phosphate prices 40% above and below the base case price in 5% increments.

Item	Unit	Base Case Value
Phosphate Rock Concentrate Price	US$/tonne	213
Exchange Rate	CAD$/US$	0.9524
Life of Mine (Paul Zone)	years	25.75
Discount Rate	% per year	8.0%

Table 22.2.1 Key Assumptions

The current Canadian tax system applicable to mining income is used to assess the Project's overall annual tax liability. This consists of federal and provincial corporate taxes as well as provincial mining taxes. The federal and provincial corporate tax rates currently applicable over the project's operating life are 15.0% and 11.9% of taxable income, respectively. The rate applicable for the purpose of assessing mining taxes is 16%.

The discount rate variants used to determine the net present value of the project is assumed to represent the weighted-average cost of capital.

22.2.2 Technical Assumptions

The main technical assumptions used in the base case are given in Table 22.2.2.

Item	Before-Tax	After-Tax
Total Ore Mined (Life Of Mine)	Million tonnes	472.1
Average Ore Grade to Mill	% P_2O_5	6.89
Concentrate Grade	% P_2O_5	38.60
Total Tonnes of Concentrate Produced	M tonnes	75.7
Processing Design Rate	Tonnes/day	55,000
Average Process Recovery over Mine Life	%	90.00
Average Extraction Cost	(US$ / tonne concentrate)	27.33
Average Processing Cost	(US$ / tonne concentrate)	48.11
Average General and Administrative Cost	(US$ / tonne concentrate)	4.27
Average Shipping Cost	(US$ / tonne concentrate)	13.96
Total Operating Cost	(US$ / tonne concentrate)	93.68

Table 22.2.2 Technical Assumptions

On average,18.6 Mt of run of mine ore will be supplied per year to the process plant when full production is reached. The amount of concentrate produced is a function of head grade and recovery and thus varies from 2.7 Mt to 3.4 Mt per year.

22.3 Financial Model and Results

A summary of the key financial results are given in Table 22.3.1 and base case cash flow results are given in Table 22.3.2 The cash flow statement for the base case is given in Figure 22.3.1; it is also included in Appendix 11 for easier reference.

Item	Before-Tax	After-Tax
NPV @ 8%	1,910.1 $	1,065.9 $
IRR	20.7%	16.7%
Payback Period (years)	4.4	4.8

Table 22.3.1 Financial Results

The summary below indicates that the total pre-production capital expenditure was evaluated at US$ 1,214.7 M and the sustaining capital requirement was evaluated at US$ 384.8 M for a total project capital expenditure over the project life of US$ 1,599.5 M.

For taxation purposes, all contingencies as well as owner's and contractors' indirect costs were allocated on a pro-rata basis to the other components of the construction costs for the calculation of the tax liability. The cash flow statement shows a capital cost breakdown by area and provides a preliminary capital spending schedule over a two-year pre-production period.

A working capital equivalent of 30 days of accounts receivable, 30 days of inventory and 30 days of accounts payable is maintained throughout the production period.

A total of US$ 44.8 M was added for mine reclamation purposes. The total operating cost was estimated at US$ 7,091.5 M for the life of the mine.

Base Case 55,000 tpd Owner Operated (million US$)	
Initial Capital Cost	$1,214.7
Sustaining Capital Cost	$ 384.8
Total Direct Capital Cost	$ 1,599.5
Mine Closure and Rehabilitation	$ 44.8
Total Mining Operating Cost	$ 2,069.1
Total Process Operating Cost	$ 3,642.3
Total General & Administration Operating Cost	$ 323.2
Total Concentrate Transport Operating Cost	$ 1,057.0
Total Operating Cost	$ 7,091.5
Before-Tax NPV @ 8%	$ 1,910.1
Before-Tax IRR (%)	20.7%
Before-Tax Payback Period (years)	4.4
After-Tax NPV @ 8%	$1,065.9
After-Tax IRR (%)	16.7%
After-Tax Payback Period (years)	4.8

Table 22.3.2 Project Evaluation Summary

	IRR	NPV	Total		30-Apr-16	30-Apr-17	30-Apr-18	30-Apr-19	30-Apr-20	30-Apr-21	30-Apr-22	30-Apr-23	30-Apr-24	30-Apr-25
Production			*Total*											
Tonnes mined			**472,091**	*kt*	165	330	9,089	18,648	18,648	18,648	18,648	18,648	18,648	18,725
Waste			**527,306**	*kt*	2,602	5,205	15,159	9,504	11,703	16,734	23,965	38,748	55,306	70,804
Overburden			**1,008,452**	*kt*	3,067	6,135	26,023	29,848	30,739	35,382	43,638	60,453	74,170	89,530
Ore processed			**472,091**	*kt*	-	-	9,089	18,648	18,648	18,648	18,648	18,648	18,648	18,725
Concentrate produced			**75,703**	*kt*	-	-	1,505	3,081	3,055	3,094	2,781	2,904	3,139	2,917
			Average											
Extraction ratio			**16.1 %**		na	na	16.6 %	16.5 %	16.4 %	16.6 %	14.9 %	15.6 %	16.8 %	15.6 %
Phosphate price					**-**	**-**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**
Operations		*NPV*	*Total*											
Revenue		6,065,456	**16,124,825**	*$ '000's*	-	-	320,652	656,265	650,761	659,080	592,266	618,602	668,688	621,384
Extraction costs		(810,998)	**(2,069,082)**	*$ '000's*	-	-	(51,945)	(62,210)	(64,333)	(80,513)	(85,940)	(96,454)	(112,442)	(124,485)
Process costs		(1,380,207)	**(3,642,299)**	*$ '000's*	-	-	(96,204)	(141,957)	(141,971)	(142,569)	(141,799)	(140,450)	(141,955)	(141,955)
Shipping costs		(397,592)	**(1,056,985)**	*$ '000's*	-	-	(21,019)	(43,018)	(42,658)	(43,203)	(38,823)	(40,549)	(43,833)	(40,732)
SG&A		(124,358)	**(323,182)**	*$ '000's*	-	-	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)
Cash flow from operations		**3,352,303**	**9,033,278**	*$ '000's*	**-**	**-**	**139,055**	**396,650**	**389,371**	**380,366**	**313,274**	**328,719**	**358,028**	**301,782**
Capital costs		*NPV*	*Total*											
Construction		(1,163,956)	**(1,214,682)**	*$ '000's*	(529,879)	(684,803)	-	-	-	-	-	-	-	-
Land royalties		(463)	**(500)**	*$ '000's*	-	(500)	-	-	-	-	-	-	-	-
Financing royalty buy-outs		(8,333)	**(9,000)**	*$ '000's*	-	(9,000)	-	-	-	-	-	-	-	-
Investment in working capital		(36,930)	**-**	*$ '000's*	-	-	(26,355)	(27,585)	599	(830)	5,492	(2,165)	(3,966)	3,738
Sustaining capital expenditure		(193,325)	**(384,773)**	*$ '000's*	-	-	(68,202)	(2,714)	(3,583)	(40,731)	(6,466)	(29,228)	(33,832)	(22,523)
Site restoration costs		(39,201)	**(44,763)**	*$ '000's*	-	(22,381)	(11,191)	(11,191)	-	-	-	-	-	-
	IRR	*NPV*	*Total*											
Before-tax cash flow	**20.7 %**	1,910,094	**7,379,559**	*$ '000's*	**(529,879)**	**(716,685)**	**33,307**	**355,161**	**386,387**	**338,805**	**312,300**	**297,326**	**320,230**	**282,998**
Mining tax		(324,878)	**(1,056,609)**	*$ '000's*	-	-	-	-	(11,721)	(29,768)	(26,419)	(32,967)	(40,290)	(33,677)
Federal tax		(289,603)	**(950,381)**	*$ '000's*	-	-	-	-	-	-	(36,493)	(40,049)	(43,187)	(36,037)
Provincial tax (Quebec)		(229,752)	**(753,969)**	*$ '000's*	-	-	-	-	-	-	(28,951)	(31,772)	(34,262)	(28,589)
	IRR	*NPV*	*Total*											
Net cash flow	**16.7 %**	**1,065,861**	**4,618,601**	*$ '000's*	**(529,879)**	**(716,685)**	**33,307**	**355,161**	**374,665**	**309,038**	**220,437**	**192,538**	**202,491**	**184,694**
Costs per ton mined			*Average*											
Extraction costs			**2.26**	*$ / t*	na	na	2.00	2.08	2.09	2.28	1.97	1.60	1.52	1.39
Process costs			**4.29**	*$ / t*	na	na	3.70	4.76	4.62	4.03	3.25	2.32	1.91	1.59
SG&A			**0.38**	*$ / t*	na	na	0.48	0.42	0.40	0.35	0.28	0.21	0.17	0.14
Shipping costs			**1.25**	*$ / t*	na	na	0.81	1.44	1.39	1.22	0.89	0.67	0.59	0.45
Total			**8.17**	***$ / t***	**-**	**-**	**6.98**	**8.70**	**8.50**	**7.88**	**6.39**	**4.80**	**4.19**	**3.57**
Costs per ton of ore milled			*Average*											
Extraction costs			**4.38**	*$ / t*	na	na	5.71	3.34	3.45	4.32	4.61	5.17	6.03	6.65
Process costs			**7.72**	*$ / t*	na	na	10.58	7.61	7.61	7.65	7.60	7.53	7.61	7.58
SG&A			**0.68**	*$ / t*	na	na	1.37	0.67	0.67	0.67	0.67	0.67	0.67	0.66
Shipping costs			**2.24**	*$ / t*	na	na	2.31	2.31	2.29	2.32	2.08	2.17	2.35	2.18
Total			**15.02**	***$ / t***	**-**	**-**	**19.98**	**13.92**	**14.02**	**14.95**	**14.96**	**15.54**	**16.66**	**17.07**
Costs per ton of concentrate			*Average*											
Extraction costs			**27.33**	*$ / t*	na	na	34.51	20.19	21.06	26.02	30.91	33.21	35.82	42.67
Process costs			**48.11**	*$ / t*	na	na	63.91	46.07	46.47	46.07	51.00	48.36	45.22	48.66
SG&A			**4.27**	*$ / t*	na	na	8.26	4.03	4.07	4.02	4.47	4.28	3.96	4.26
Shipping costs			**13.96**	*$ / t*	na	na	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96
Total operating cost			**93.68**	***$ / t***	**-**	**-**	**120.63**	**84.26**	**85.56**	**90.07**	**100.34**	**99.81**	**98.96**	**109.55**

	30-Apr-26	30-Apr-27	30-Apr-28	30-Apr-29	30-Apr-30	30-Apr-31	30-Apr-32	30-Apr-33	30-Apr-34	30-Apr-35
Production										
Tonnes mined	18,648	18,648	18,716	18,605	18,648	18,648	18,648	18,648	18,648	18,648
Waste	49,375	20,362	20,311	20,432	19,200	18,200	18,200	18,200	17,700	17,700
Overburden	68,023	39,010	39,027	39,037	37,848	36,848	36,848	36,848	36,348	36,348
Ore processed	18,648	18,648	18,716	18,605	18,648	18,648	18,648	18,648	18,648	18,648
Concentrate produced	2,632	2,905	2,908	3,161	3,245	2,895	2,747	2,968	2,950	3,214
Extraction ratio	14.1 %	15.6 %	15.5 %	17.0 %	17.4 %	15.5 %	14.7 %	15.9 %	15.8 %	17.2 %
Phosphate price	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**
Operations										
Revenue	560,719	618,853	619,377	673,318	691,211	616,716	585,139	632,260	628,394	684,571
Extraction costs	(116,717)	(86,381)	(80,286)	(84,061)	(75,569)	(81,349)	(75,333)	(81,249)	(82,742)	(82,443)
Process costs	(141,955)	(141,955)	(142,051)	(141,955)	(141,955)	(141,955)	(141,776)	(141,951)	(141,972)	(141,953)
Shipping costs	(36,755)	(40,566)	(40,600)	(44,136)	(45,309)	(40,426)	(38,356)	(41,445)	(41,191)	(44,874)
SG&A	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)
Cash flow from operations	**252,862**	**337,522**	**344,010**	**390,736**	**415,948**	**340,557**	**317,244**	**355,185**	**350,058**	**402,872**
Capital costs										
Construction	-	-	-	-	-	-	-	-	-	-
Land royalties	-	-	-	-	-	-	-	-	-	-
Financing royalty buy-outs	-	-	-	-	-	-	-	-	-	-
Investment in working capital	4,986	(4,778)	96	(4,573)	(1,471)	6,123	2,727	(4,004)	318	(4,617)
Sustaining capital expenditure	(9,809)	(13,115)	(8,506)	(17,751)	(8,067)	(17,489)	(19,110)	(5,259)	(15,828)	(5,498)
Site restoration costs	-	-	-	-	-	-	-	-	-	-
Before-tax cash flow	**248,039**	**319,629**	**335,600**	**368,413**	**406,410**	**329,191**	**300,861**	**345,922**	**334,548**	**392,756**
Mining tax	(28,130)	(43,113)	(45,379)	(53,271)	(58,060)	(46,075)	(42,321)	(49,039)	(48,165)	(57,073)
Federal tax	(30,223)	(41,065)	(42,160)	(47,984)	(51,407)	(41,812)	(38,753)	(43,862)	(43,146)	(50,061)
Provincial tax (Quebec)	(23,977)	(32,578)	(33,447)	(38,067)	(40,783)	(33,171)	(30,744)	(34,797)	(34,229)	(39,715)
Net cash flow	**165,710**	**202,873**	**214,613**	**229,091**	**256,160**	**208,134**	**189,043**	**218,224**	**209,007**	**245,907**
Costs per ton mined										
Extraction costs	1.72	2.21	2.06	2.15	2.00	2.21	2.04	2.20	2.28	2.27
Process costs	2.09	3.64	3.64	3.64	3.75	3.85	3.85	3.85	3.91	3.91
SG&A	0.18	0.32	0.32	0.32	0.33	0.34	0.34	0.34	0.34	0.34
Shipping costs	0.54	1.04	1.04	1.13	1.20	1.10	1.04	1.12	1.13	1.23
Total	**4.53**	**7.21**	**7.06**	**7.24**	**7.27**	**7.49**	**7.27**	**7.52**	**7.66**	**7.75**
Costs per ton of ore milled										
Extraction costs	6.26	4.63	4.29	4.52	4.05	4.36	4.04	4.36	4.44	4.42
Process costs	7.61	7.61	7.59	7.63	7.61	7.61	7.60	7.61	7.61	7.61
SG&A	0.67	0.67	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Shipping costs	1.97	2.18	2.17	2.37	2.43	2.17	2.06	2.22	2.21	2.41
Total	**16.51**	**15.09**	**14.71**	**15.19**	**14.76**	**14.81**	**14.37**	**14.86**	**14.93**	**15.11**
Costs per ton of concentrate										
Extraction costs	44.34	29.73	27.61	26.59	23.29	28.10	27.42	27.37	28.05	25.65
Process costs	53.92	48.86	48.85	44.91	43.74	49.03	51.61	47.82	48.12	44.17
SG&A	4.72	4.28	4.27	3.93	3.83	4.29	4.52	4.19	4.21	3.87
Shipping costs	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96
Total operating cost	**116.95**	**96.83**	**94.70**	**89.39**	**84.82**	**95.38**	**97.52**	**93.34**	**94.34**	**87.65**

	30-Apr-36	30-Apr-37	30-Apr-38	30-Apr-39	30-Apr-40	30-Apr-41	30-Apr-42	30-Apr-43	30-Apr-44
Production									
Tonnes mined	18,648	18,648	18,648	18,648	18,648	18,648	18,648	14,848	-
Waste	18,028	19,906	11,339	4,883	2,306	985	292	159	-
Overburden	36,676	38,554	29,987	23,531	20,954	19,633	18,940	15,008	-
Ore processed	18,648	18,648	18,648	18,648	18,648	18,648	18,648	15,343	-
Concentrate produced	3,085	2,748	2,664	2,860	2,934	3,171	3,370	2,768	-
Extraction ratio	16.5 %	14.7 %	14.3 %	15.3 %	15.7 %	17.0 %	18.1 %	18.0 %	na
Phosphate price	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**213.00**	**-**
Operations									
Revenue	657,024	585,220	567,357	609,199	624,966	675,472	717,745	589,584	-
Extraction costs	(80,262)	(82,343)	(76,475)	(68,408)	(62,983)	(61,063)	(58,552)	(54,544)	-
Process costs	(141,954)	(141,956)	(141,952)	(141,957)	(141,948)	(141,962)	(141,955)	(140,281)	-
Shipping costs	(43,068)	(38,361)	(37,190)	(39,933)	(40,967)	(44,277)	(47,048)	(38,647)	-
SG&A	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	-
Cash flow from operations	**379,309**	**310,130**	**299,310**	**346,471**	**366,639**	**415,739**	**457,761**	**343,681**	**-**
Capital costs									
Construction	-	-	-	-	-	-	-	-	-
Land royalties	-	-	-	-	-	-	-	-	-
Financing royalty buy-outs	-	-	-	-	-	-	-	-	-
Investment in working capital	2,412	5,754	1,468	(3,439)	(1,156)	(4,292)	(3,475)	10,534	48,459
Sustaining capital expenditure	(25,236)	(8,851)	(15,579)	(1,764)	(1,762)	(2,333)	(1,540)	-	-
Site restoration costs	-	-	-	-	-	-	-	-	-
Before-tax cash flow	**356,485**	**307,033**	**285,199**	**341,268**	**363,721**	**409,115**	**452,746**	**354,215**	**48,459**
Mining tax	(52,677)	(41,956)	(40,145)	(48,299)	(51,951)	(60,077)	(67,028)	(49,008)	-
Federal tax	(46,692)	(38,168)	(36,747)	(43,064)	(45,891)	(52,278)	(57,748)	(43,555)	-
Provincial tax (Quebec)	(37,043)	(30,280)	(29,152)	(34,164)	(36,407)	(41,474)	(45,814)	(34,554)	-
Net cash flow	**220,073**	**196,630**	**179,154**	**215,741**	**229,473**	**255,286**	**282,156**	**227,098**	**48,459**
Costs per ton mined									
Extraction costs	2.19	2.14	2.55	2.91	3.01	3.11	3.09	3.63	na
Process costs	3.87	3.68	4.73	6.03	6.77	7.23	7.49	9.35	na
SG&A	0.34	0.32	0.41	0.53	0.59	0.63	0.66	0.83	na
Shipping costs	1.17	1.00	1.24	1.70	1.96	2.26	2.48	2.58	na
Total	**7.57**	**7.14**	**8.94**	**11.17**	**12.33**	**13.23**	**13.73**	**16.39**	**-**
Costs per ton of ore milled									
Extraction costs	4.30	4.42	4.10	3.67	3.38	3.27	3.14	3.55	na
Process costs	7.61	7.61	7.61	7.61	7.61	7.61	7.61	9.14	na
SG&A	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.81	na
Shipping costs	2.31	2.06	1.99	2.14	2.20	2.37	2.52	2.52	na
Total	**14.89**	**14.75**	**14.37**	**14.09**	**13.85**	**13.93**	**13.94**	**16.03**	**-**
Costs per ton of concentrate									
Extraction costs	26.02	29.97	28.71	23.92	21.47	19.26	17.38	19.71	na
Process costs	46.02	51.67	53.29	49.63	48.38	44.77	42.13	50.68	na
SG&A	4.03	4.52	4.67	4.35	4.24	3.92	3.69	4.49	na
Shipping costs	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	na
Total operating cost	**90.03**	**100.12**	**100.63**	**91.86**	**88.04**	**81.90**	**77.15**	**88.84**	**-**

Figure 22.3.1 Cash Flow Table

Note: Due to the temporal format imposed by the financial model, there is about 4 months of time schedule discrepancy between this table and the EPCM schedule (Section 24.1); results shown above should be reflected ≈4 months ahead of the above time line.

22.4 Sensitivity Analysis

A sensitivity analysis has been carried out, with the base case described above as a starting point, to assess the impact of changes in phosphate rock concentrate price, total pre-production capital costs and operating costs on the project's NPV (@ 8%) and IRR. Each variable is examined independently. An interval of ±40% with increments of 5% was used for all three variables.

Whereas Figure 22.4.1 and Figure 22.4.3 show a linear relationship between the three variables studied and the before-tax net present value, Figure 22.4.2 shows that there is a non-linear relationship between the key variables and the before-tax IRR. The before-tax NPV and IRR are most influenced by the price, followed by the operating costs and finally the capital costs. As an illustration of this, a 10% increase in the expected sales price results in an increase of US$ 602.9 M in the before-tax net present value at 8%, whereas 10% changes in operating cost and construction cost estimates results in decreases of US$ 271.3 M and US$ 116.4 M, respectively.

As seen in Figure 22.4.1, a reduction of 31.7% in the price forecast (from $213 to $146 per tonne) results in the break-even net present value at 8% on a pre-tax basis.

The before-tax results of the sensitivity analysis, as shown in Figures 22.4.1 to 22.4.3, indicate that the project's before-tax viability is least affected by the under-estimation of capital and operating costs, taken independently. The net present value is more sensitive to variations in operating expenses than it is to variations in capital expenditures, as shown by the steeper curves.

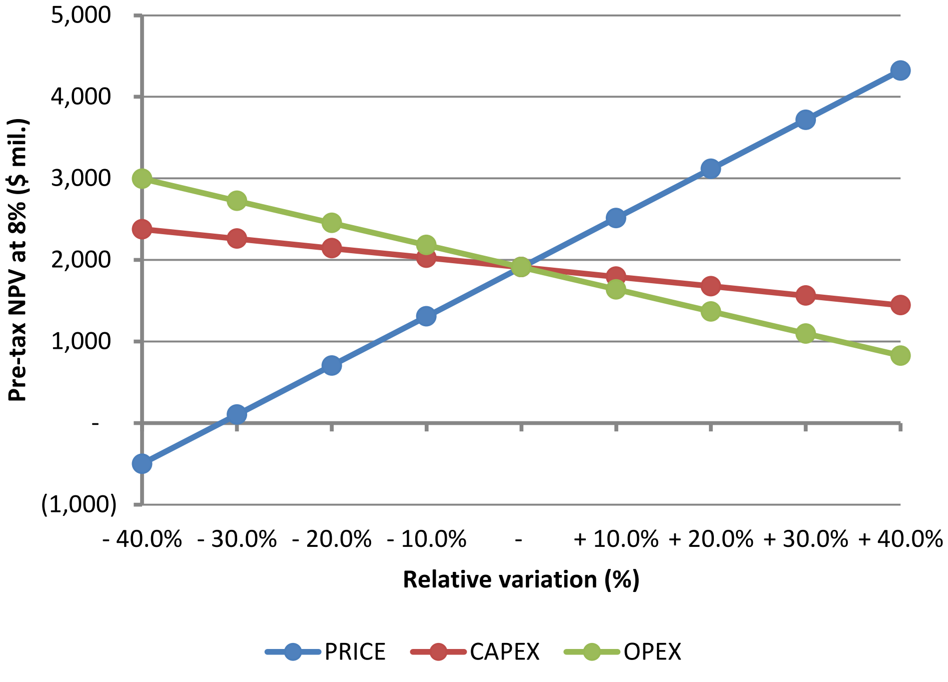

Figure 22.4.1 Before-Tax NPV$_{8\%}$: Sensitivity to Capital Expenditure, Operating Cost and Price

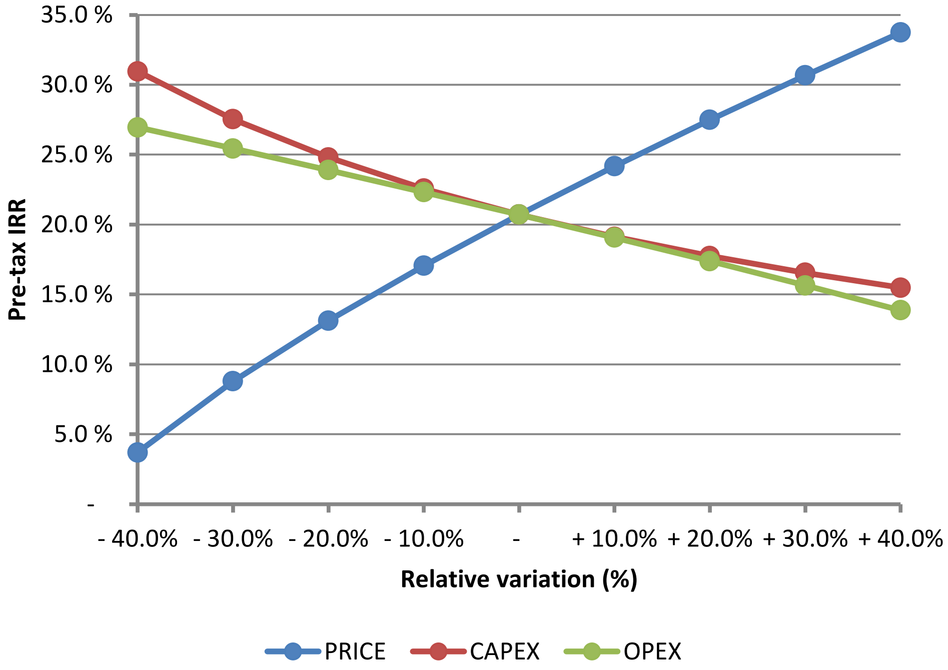

Figure 22.4.2 Before-Tax IRR: Sensitivity to Capital Expenditure, Operating Cost and Price

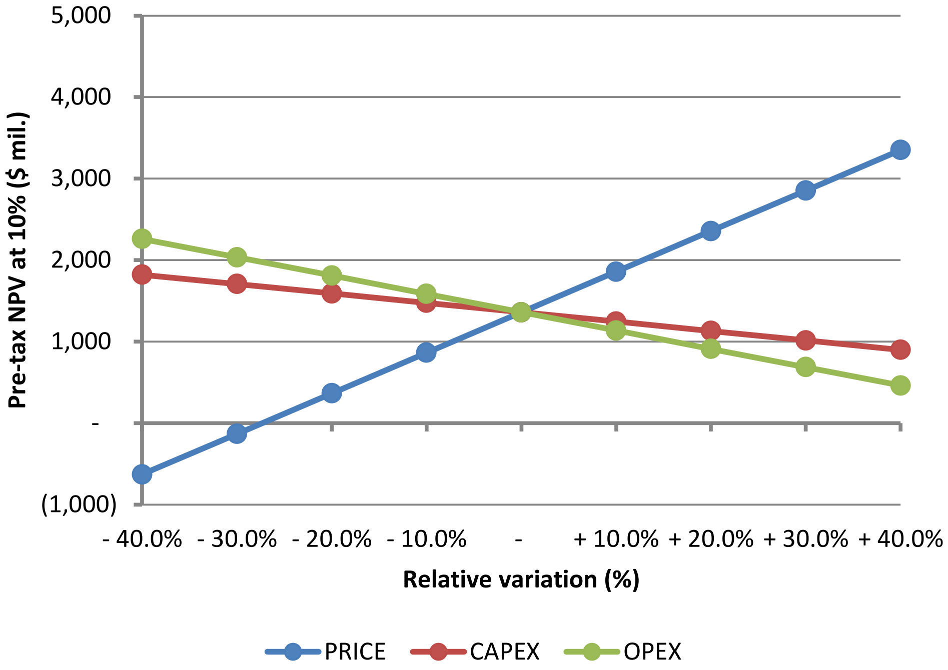

Figure 22.4.3 Before-Tax NPV$_{10\%}$: Sensitivity to Capital Expenditure, Operating Cost and Price

The after-tax results of the sensitivity analysis are shown in Figures 22.4.4 to 22.4.6.

Figures 22.4.4 and 22.4.6 indicate that the project's after-tax viability is most sensitive to a price forecast reduction while being less affected by under-estimation of capital and operating costs. A 27.3% decrease in the price forecast (from $213 to $155 per tonne) results in the break-even net present value at 8% on an after-tax basis. Figure 22.4.5 and Table 22.4.1, which shows variations in internal rate of return, provides the same conclusions.

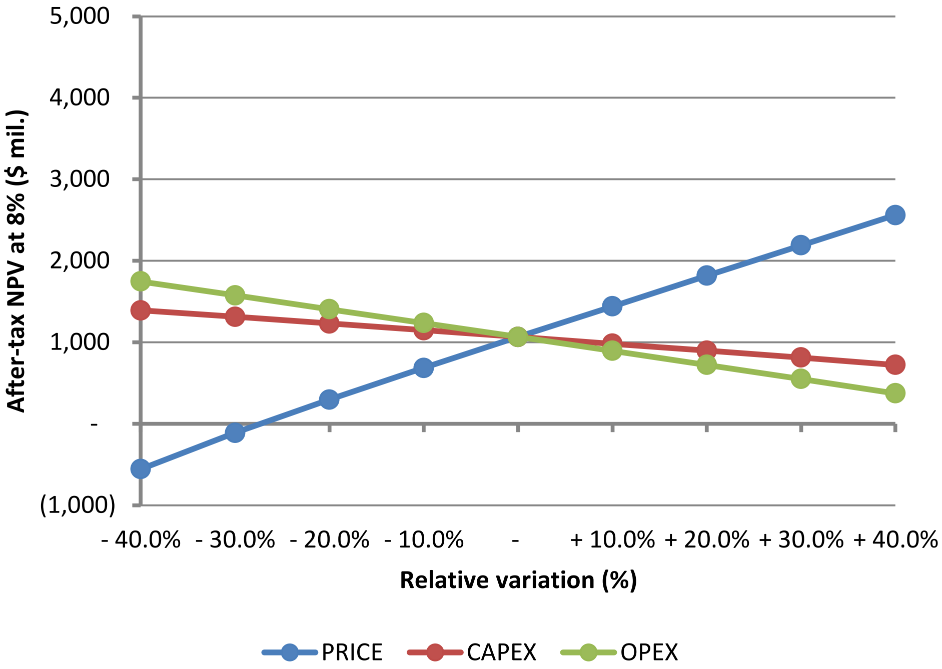

Figure 22.4.4 After-Tax NPV$_{8\%}$: Sensitivity to Capital Expenditure, Operating Cost and Price

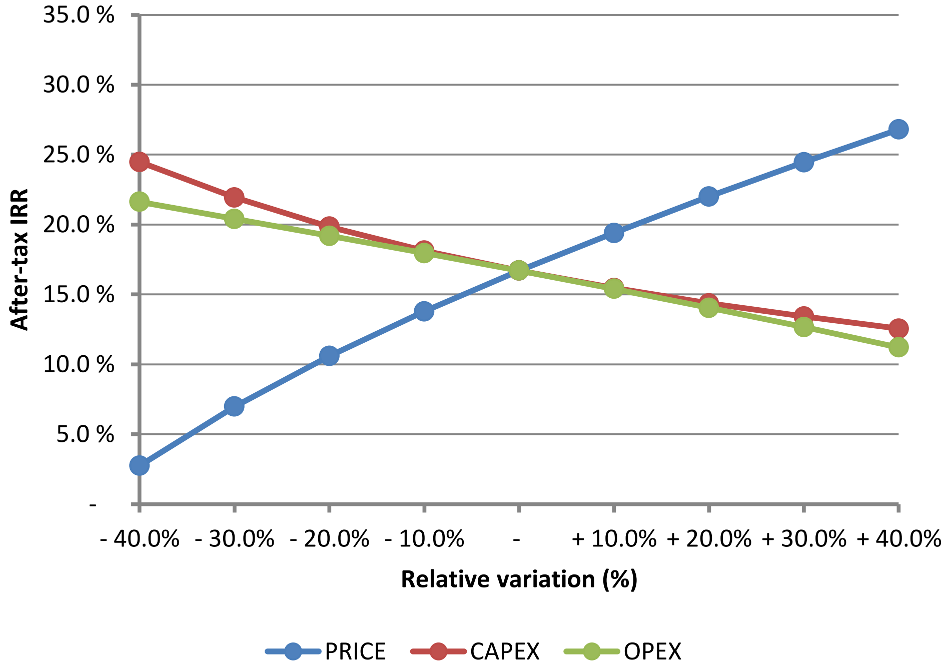

Figure 22.4.5 After-Tax IRR: Sensitivity to Capital Expenditure, Operating Cost and Price

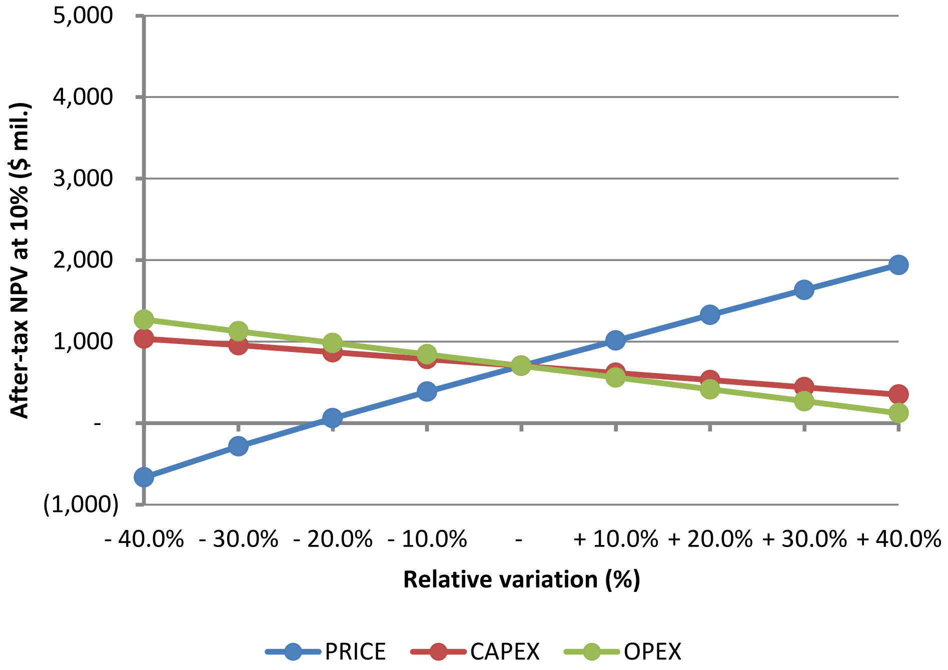

Figure 22.4.6 After-Tax $NPV_{10\%}$: Sensitivity to Capital Expenditure, Operating Cost and Price

Tables 22.4.1 to 22.4.3 show the detail of how changes to the price, operating cost or capital expenditure projections impact the key project viability metrics.

Sensitivity	PRICE ($ / tonne)	Pre-tax NPV at 8% ($ mil.)	After-tax NPV at 8% ($ mil.)	Pre-tax IRR	After-tax IRR
- 40.0%	128	(501)	(558)	3.7 %	2.7 %
- 30.0%	149	102	(112)	8.8 %	7.0 %
- 20.0%	170	704	296	13.1 %	10.6 %
- 10.0%	192	1,307	685	17.0 %	13.8 %
-	213	1,910	1,066	20.7 %	16.7 %
+ 10.0%	234	2,513	1,440	24.2 %	19.4 %
+ 20.0%	256	3,116	1,817	27.5 %	22.0 %
+ 30.0%	277	3,719	2,190	30.7 %	24.5 %
+ 40.0%	298	4,322	2,561	33.7 %	26.8 %

Table 22.4.1 Sensitivity Table: Sensitivity to Price

Sensitivity	OPEX ($ / tonne)	Pre-tax NPV at 8% ($ mil.)	After-tax NPV at 8% ($ mil.)	Pre-tax IRR	After-tax IRR
- 40.0%	56.21	2,995	1,745	26.9 %	21.6 %
- 30.0%	65.57	2,724	1,574	25.4 %	20.4 %
- 20.0%	74.94	2,453	1,404	23.9 %	19.2 %
- 10.0%	84.31	2,181	1,235	22.3 %	18.0 %
-	93.68	1,910	1,066	20.7 %	16.7 %
+ 10.0%	103.04	1,639	895	19.1 %	15.4 %
+ 20.0%	112.41	1,367	721	17.4 %	14.0 %
+ 30.0%	121.78	1,096	549	15.6 %	12.7 %
+ 40.0%	131.15	825	373	13.9 %	11.2 %

Table 22.4.2 Sensitivity Table: Sensitivity to Operating Cost

Sensitivity	CAPEX ($ mil.)	Pre-tax NPV at 8% ($ mil.)	After-tax NPV at 8% ($ mil.)	Pre-tax IRR	After-tax IRR
- 40.0%	729	2,376	1,391	31.0 %	24.5 %
- 30.0%	850	2,259	1,312	27.5 %	21.9 %
- 20.0%	972	2,143	1,230	24.8 %	19.8 %
- 10.0%	1,093	2,026	1,147	22.6 %	18.1 %
-	1,215	1,910	1,066	20.7 %	16.7 %
+ 10.0%	1,336	1,794	982	19.1 %	15.5 %
+ 20.0%	1,458	1,677	896	17.7 %	14.4 %
+ 30.0%	1,579	1,561	811	16.5 %	13.4 %
+ 40.0%	1,701	1,445	723	15.5 %	12.6 %

Table 22.4.3 Sensitivity Table: Sensitivity to Capital Expenditure

23. ADJACENT PROPERTIES

The adjacent properties have been retrieved from GESTIM. The Author is not aware of significant exploration works by the others. Arianne Phosphate is the pioneer in the sector and the others are groups surrounding Arianne's claims.

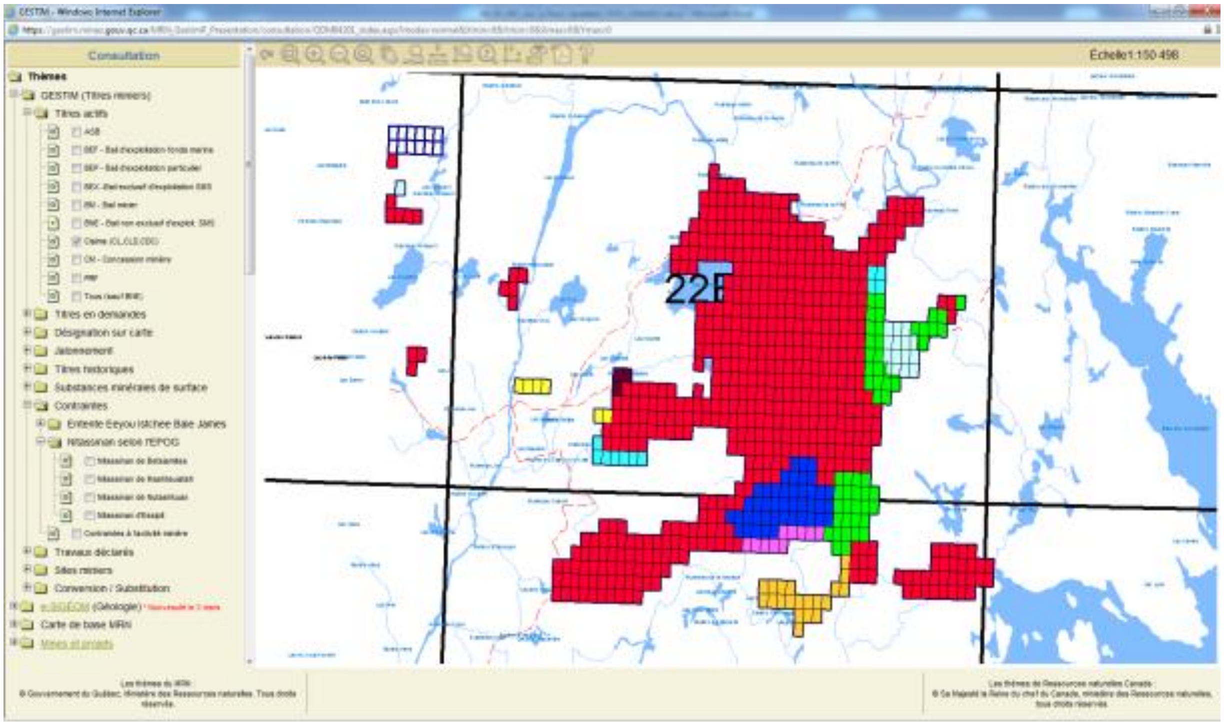

Figure 23.1.1 Arianne Property in Red with adjacent properties with various colours

The legend and ownership is presented below:

Arianne Phosphate (100%)	+Red
Bertrand Brassard (100%)	+Green
Jean-Louis Tremblay (100%)	+Blue
Ghislaine Savard (100%)	+Cyan
JV SOQUEM (50%) & Virginia Mines (50%)	+Pale Blue
Monique Delisle (100%)	+Pink
Pirzada Afzaal (100%)	+Orange
Yacoub Fayz (100%)	+Yellow
Real Gauthier (100%)	+Brown

24. OTHER RELEVANT DATA AND INFORMATION

24.1 Project EPCM Schedule – Basis of Schedule

24.1.1 Overview

The EPCM Project Implementation Schedule is intended to provide a timeline for all efforts required to design, procure, build and commission the Phosphate processing plant at Lac a Paul.

The EPCM is presumed to start in January 2014 with some early work (using bridging funds). This strategy results in an expected project completion by March 2017, an overall project duration of 39 months. The 12-month Early Works period (January 2014 to January 2015) includes critical engineering design for long lead time items and design, procurement and construction work for deforestation, clearing and grubbing and temporary road work and services, and other work permitted prior to obtaining the full environmental approval, expected in October 2014 .

If bridging funds were not made available until overall project financing is obtained, the early works would be delayed until such time. With this eventuality, EPCM project duration would remain at 39 months from its start date.

The first Request For Quotation (RFQ) for long delivery equipment is planned for March 2014 and the remaining will follow in the second and third quarters of 2014. It should be noted that the Floatation cells and tanks, the Hydro cyclone, the Magnetic Separator, the Sag Mill and Ball Mills as well the Mill structural steel are on the critical path; a delay in their procurement would have a direct effect on the project completion date.

The level 1 summary schedule is presented below and is also included in Appendix 12 for easy reference:

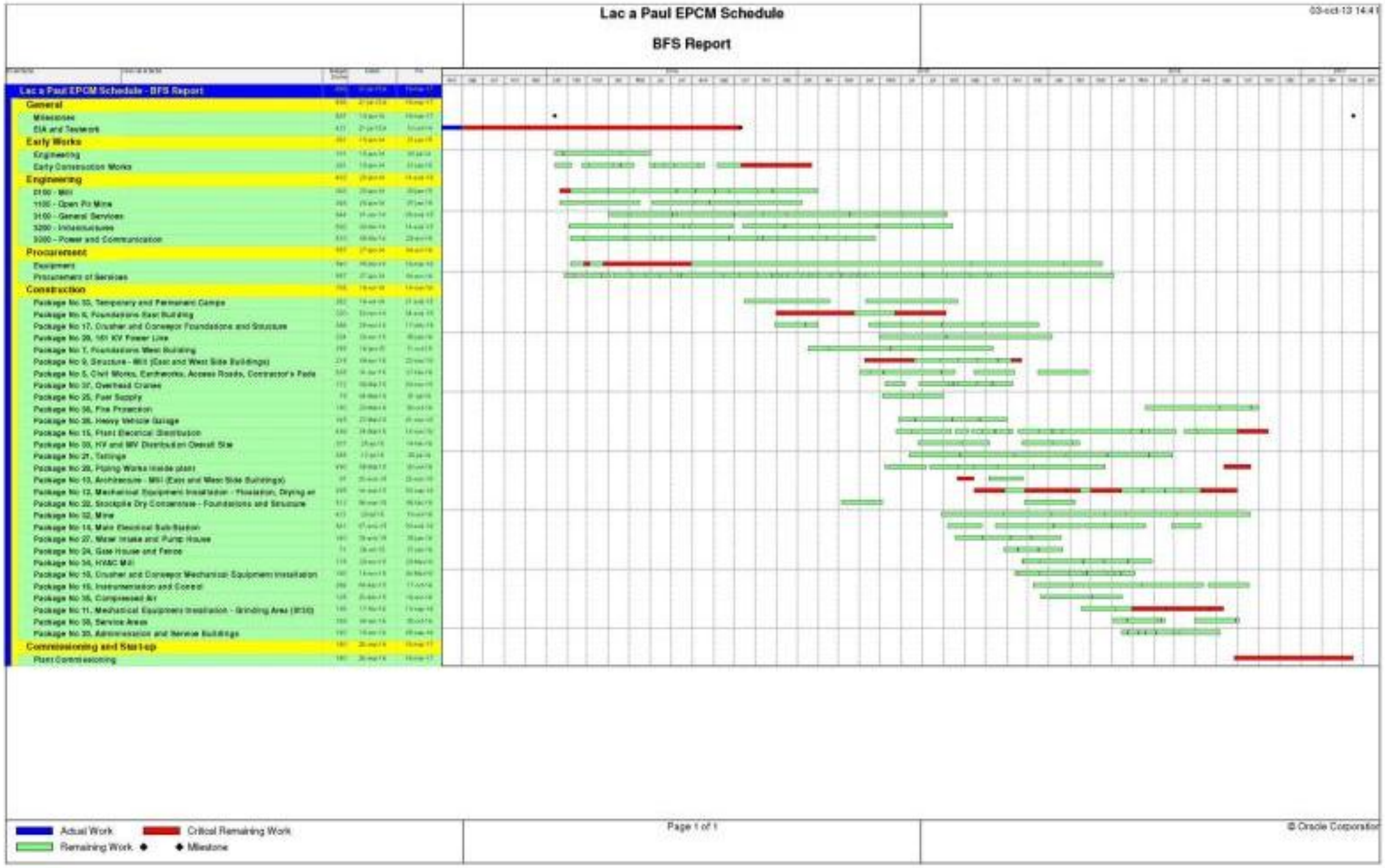

Figure 24.1.1 EPCM level 1 Schedule

24.1.2 Purpose of the Schedule

The purpose for preparing the EPCM schedule is as follows:

- To derive and validate the duration and completion date.
- To obtain a construction labor curve to confirm construction period accommodation requirements.
- To validate the constructability assumptions and strategies, for conformity to project end date requirements.
- To provide information regarding permitting requirements.

24.1.3 EPCM Schedule Principal Activities Duration

Activity	Start	Finish
Early Works	January 2014	January 2015
Engineering	January 2014	August 2015
Procurement	January 2014	April 2016
Construction	October 2014	November 2016
Commissioning and ramp up	September 2016	March 2017

Table 24.1.1 EPCM Schedule Principal Activities Duration

24.1.4 Milestones Dates

The project EPCM schedule has been prepared assuming the following milestone dates:

- Approval of the 161 KV line by the Client: January, 2014.
- Detailed Geotechnical Investigation for roads and Mill area completed: April, 2014.
- Detailed Geotechnical Investigation for Mine completed: June 2014.
- Complete Site Topographic Surveys completed: May 2014.
- Bulk Sample Preparation complete (test work by Arianne): September 2013.
- Pilot Plant Optimization Report complete: January 2014.
- Start of process validation: January 2014.
- Validation process completion: March 2014.
- PFDs complete: April, 2014.
- Ministerial Decree/CoA Delivery: October 2014.
- Start of Major Earthworks: October 2014.

24.1.5 Procurement Assumptions

The procurement of long lead equipment will start as early as February 2014. It has been assumed that negotiations will be carried-out with the firm quote bidders selected during the Feasibility stage, based on revised equipment specification. This will greatly reduce the procurement process duration and effort for the most critical equipment.

Preparation of Vendor Drawings and approval by the consultant is assumed to be 8 to 14 weeks, depending on the equipment. Transportation to site has been assumed at two (2) months for all major equipment.

The following are planned RFQ dates for the major long lead and/or critical equipment (with supplier confirmed lead times in parentheses):

- Gyratory Crusher: March 2014 (68 week fabrication).
- Sag Mill: May 2014 (70 weeks fabrication).
- Ball Mill: May 2014 (70 weeks fabrication).
- Hydro cyclones: May 2014 (26 weeks fabrication).
- Flash Dryer: July 2014 (34 weeks fabrication).
- Pressure Filters: July 2014 (42 weeks fabrication).
- Magnetic Separator: March 2014 (68 weeks fabrication).
- Thickener: June 2014 (52 weeks fabrication).
- Flotation Cells: June 2014 (60 weeks fabrication).
- Sampling System: August 2014 (24 weeks fabrication).
- HV Transformers: July 2014 (6 months fabrication).
- Gas Insulated Switchgear: July 2014 (6 months fabrication).

24.1.6 Calendar

Two calendars were used to produce the EPCM schedule:

- 7-day work week for the construction work, including a 2-week vacation period in July and December.
- 5-day work week for design and procurement.

24.2 Characterization of Chlorine

Arianne has started characterization of Chlorine levels in the concentrate as per GoldMinds Geoservices Inc's recommendation. A first batch of specific tests to produce concentrate at Metchib Laboratory showed variability in the Chlorine content. These tests were performed on core intervals of specific rock types.

The following information was taken from a work in progress report by Arianne on chlorine behavior.

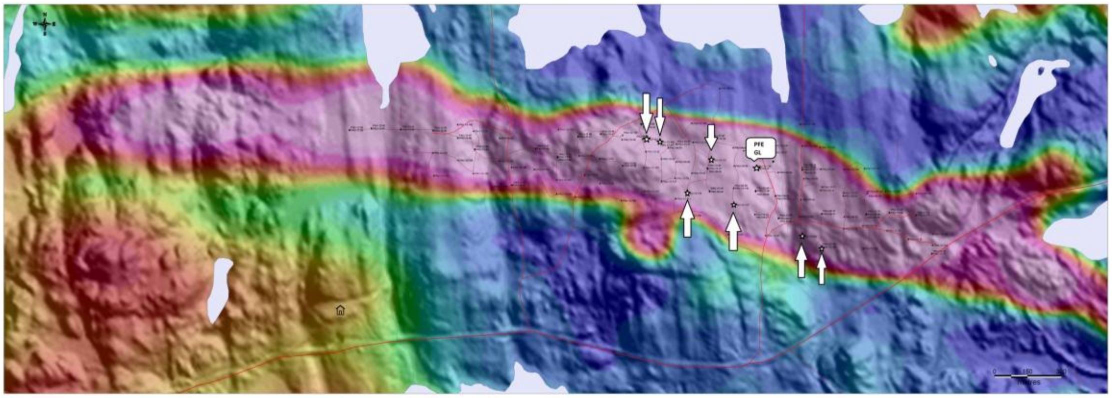

Figure 24.2.1 Sample Localisation for Chlorine Analysis.

	Localisation		ALS Chemex ME-XRF-06			
Échantillons	**No Forage**	**Intervalle (m)**	**#analyse**	**P_2O_5 (%)**	**TiO_2 (%)**	**Fe_2O_3 (%)**
Nel-01	PAU-12-113	246-249	N139759	12.1	9.2	30.1
Nel-02	PAU-12-110	138-141	N139336	5.5	13.9	33.2
Nel-03	PAU-12-142	78-81	P292273	6.5	12.1	32.3
Nel-04	PAU-12-143	75-78	P292323	11	10.2	31.8
Nel-05	PAU-12-115	33-36	N140095	8.2	11.3	36.7
MIX-01	PAU-12-113	107.1-109	N139693	7.5	8.2	24.5
MIX-02	PAU-12-122	168-171	N140949	6.9	7.8	26.4
MIX-03	PAU-12-134	204-207	N142337	5.9	7.9	25.9
MIX-04	PAU-12-117	150-153	N140309	7.1	4.7	15.5
GA-01	PAU-12-113	27-30	N139665	5	3.9	12.7
GA-02	PAU-12-122	12-15	N140888	5	5	20.8
GABB-01	PAU-12-117	48-51	N140268	3.3	2.7	9.3

Table 24.2.1 Sample List with Head.

Analyses du concentré réalisé par MET-CHIB											
Provenance des résultats	**ALS**			**MAXXAM**		**SGS**			**MET-CHIB**		
Éléments	Cl (ppm)	F (ppm)	P2O5 (%)	Cl (ppm)	F (ppm)	Cl (ppm)	F (%)	P2O5 (%)	Cl (ppm)	F (ppm)	P2O5 (%)
Méthodes d'analyse	Cl-IC881	F-IC881	ME-XRF06	B74-2	B20-2						
GA-01	500	17750	40.3	650	9240	730	1.82	40.8			
GA-02	1210	14800	41.3	1050	8830	1160	1.79	41.1			
GABB-01	1240	16600	40.7	1420	9650	1390	1.92	40.8			
MIX-01	680	16800	41.2	740	8820	790	1.96	41.4			
MIX-02	910	15650	41.3	900	10100	860	1.82	41.1			
MIX-03	380	12250	41.4	1130	12600	1150	1.82	41.9	1110	16100	40.92
MIX-04	x	x	x	700	9650	1010	2	41.4			
NEL-01	870	15450	41.8	1030	10600	1370	2.19	41.5			
NEL-02	810	14950	41.1	1040	11100	1880	1.97	41.1			
NEL-03	840	11800	35.9	1190	12700	1340	1.8	36			
NEL-04	600	15050	41.5	820	12100	1070	1.96	41.5			
NEL-05	560	17850	40.8	650	10600	680	2.28	41.1			

Table 24.2.2 Preliminary Summary Table.

As can be seen from these initial results, variability is shown in the Chlorine content for specific rock types and locations within the Paul Zone deposit, in addition to showing significant results differences between laboratories and analytical methods for the same concentrate.

Based on these results, it was decided to take advantage of a planned bulk metallurgical test work program in order to better characterize the chlorine variability within the Paul Zone deposit. This test work program was originally required to finalize and optimize the flotation circuit configuration; it represents six (6) bulk samples of 25 tonnes each.

Results of this investigation will be used to determine if a more extensive analysis of the chorine content within the ore body is necessary.

25. INTERPRETATION AND CONCLUSIONS

25.1 Geology

Arianne's exploration program of 2011-2012 on the Lac a Paul Property focused primarily in the conversion of inferred resources of the Paul Zone to Indicated and Measured resources. The second goal was to explore the zones exhibiting similar geological and geophysical characteristics as Paul and Manouane since they had interesting values in the previous exploration campaign. The zones delineated by this campaign are named Nicole, Traverse, Lise and Lucie. A total of 105 diamond drill holes totaling 30,352 meters were drilled on the Paul Zone.

In 2013, Arianne has 153 diamond drill holes totaling 39,371 meters in the Paul zone and has developed other targets in the Lac a Paul Property.

The drilling at Paul Zone has significantly increased the resources. The increase in the amount of resources is such that it may sustain a whole mining operation on its own without having to touch the Manouane resources. The FS has confirmed it is not necessary to include the Manouane resources to have a 25 year mine life.

25.2 Resource Estimate

For the 2013 Paul model resource update, interpretation of the mineralized structures on cross sections were provided by Arianne's geologists, Hugues Guérin Tremblay and Daniel Boulianne. The nelsonite, transition, mixed zone and low grade zones with enriched Apatite content was interpreted by Arianne's technical team. Cross-sections were simplified by senior QP Claude Duplessis, geological engineer, who created envelopes which were integrated into GENESIS with 3D envelope modelling.

Mineral resources for Paul zone were estimated by using a 4.00% P_2O_5 cut-off grade. This cut-off was applied by the Author to show the robustness of the resource; the Feasibility Study determined the exact cut-off grade at 3.5%.

- Although the cut-off grade is higher than for the PFS, the Measured and Indicated resources of the Paul Zone increased by 221% compared to the last estimate released in 2011.
- The Measured and Indicated mineral resources (M+I) of the Paul Zone amount to 590.24 Mt at 7.13% P_2O_5.
- The mineral resource estimate was calculated according to NI 43-101.

25.3 Mineral Reserve Estimate

The resource block model for the Lac a Paul FS was prepared and provided to CWP by Claude Duplessis of GMG, on February 6, 2013. The model name is "Modelfinal1_06022013.csv" and covers the Paul mineralized Zone.

The surfaces files allowed for coding in specific waste zones, ore zones, topography and overburden. The model coordinate system used is UTM NAD 83 ZONE 19, with no applied model rotation. The block size of the model is 10m (x-coordinate) x 5m (y-coordinate) x 10m (z-coordinate).

The pit optimizations were produced in Dassault Systèmes' Geovia Whittle (4.5.1) software (Whittle). Various pit optimization parameters were used in order to produce the pit optimization shell. These parameters include: selling price, mining, processing and G&A costs, weight recovery (dependent on P_2O_5 grade item and on process information), pit slopes (as recommended by Journeaux) and surface constraints from water bodies. Whittle then produces the pit with the highest discounted cashflow.

From the chosen optimized pit, an economic cut-off grade was calculated. The cut-off grade calculated for this project is 3.5% P_2O_5. A dilution of 2% and an ore loss of 3% were also estimated for the project.

A pit was then designed within the chosen pit optimization. Operational parameters such as a ramp, berms, benching configuration and recommended slopes were applied for the design. The geotechnical pit design parameters were recommended by Journeaux Assoc. (Journeaux) in their report entitled “Report on Pit Slope Design (Report No.L-12-1558)” for the FS.

The Mineral Reserves were derived from the pit design and are presented in Table 25.3.1. The Mineral Resources comprise these Mineral Reserves.

Final Engineered Pit Design In-Pit Reserve Estimate *COG $P_2O_5 \geq 3.5\%$* (Dilution=2%. Ore Loss=3%)		
	Tonnage (Mt)	**P2O5 (%)**
Proven	313.71	6.92
Probable	158.38	6.80
Total Reserve	**472.09**	**6.88**
Inferred	--	
Waste Rock	527.31	
Overburden	9.06	
Total Stripping	**536.36**	
SR	1.14	

Table 25.3.1 Lac a Paul FS Mineral Reserve (Effective October 15, 2013)

25.4 Mining Method

The mine plan for the Lac a Paul Feasibility Study was based on mining operation over 360 days, seven days per week and 24 hour days. The plan assumes that there will be four crews divided among two separate rotations. On each rotation there will be a crew that either works day-shift or night-shift.

The mine life is 25.75 years (excluding the 18 months allocated for preproduction). The mine plan is based on the assumption that the mill requires a throughput of 55 ktpd ROM, operating at a 93% availability (of 365 days). The yearly ore tonnes mined satisfy the yearly requirement of the mill. The mine plan has been developed by sequencing four designed phases.

The complete mine plan consists of a preproduction period in which no ore is milled (only stockpiled). Following the 18-month preproduction (or prestrip) period, there is a processing ramp up that follows the schedule:

- First 3 months of production = 3 months/ 12 months x 35% x (18.645 million tonnes);
- Following 6 months = 6 months/ 12 months x 80% x (18.645 million tonnes).

After the first two shorter periods, each subsequent period (12 months) produces at 100% capacity. Stripping ratios were optimized for the earlier years of the LOM.

Conventional drill, blast, load and haul mining methods will be used for the pit. The equipment fleet was sized based on specific operating parameters of the mine and equipment, and from the haulage profiles. The primary loading and hauling equipment selected for the preproduction period is 1 x Komatsu PC2000 diesel hydraulic shovels with 4 x HD785 haul trucks. These pieces of equipment are kept after preproduction in order to support the production tonnages being mined by the larger equipment.

The primary equipment at the maximum point in production consists of 3 x Komatsu PC5500 electric hydraulic shovels, 19 x CAT 793F haul trucks, 5 x Atlas Copco FlexiRoc D65 bench drills, and 1 x Letourneau L1850 for production support and reclamation activities. A fleet of secondary and auxiliary equipment has also been sized to satisfy the operations' requirements.

It is assumed that the fleet will be owned and operated by Arianne. The blasting will be contracted out to a third party who will supply all explosives, accessories, services and workforce. Blast holes will be single-primed and initiated using non-electric methods. The non-electric detonators will provide the in-hole delays and will provide easy deployment. The explosives contractor will deliver bulk explosives (100% emulsion) to the drillhole.

Manpower requirements have been based on the assumption to operate four production crews. For non-production personnel it is recognized that some positions can be staffed five days per week while others require coverage seven days per week by assigning additional duties. The maximum required staff occurs in Period 9 when there are 249 hourly personnel required (operations and maintenance), and 31 salaried personnel required.

Water inflows for the pit have been estimated by Hydro-Ressource Inc. in 5-year increments. With this information CWP estimated costs associated to the dewatering of the pit.

25.5 Mineral Processing and Metallurgical Testing

FS test programs were conducted by multiple contractors as summarized below:

- Samples of bulk Paul ore and concentrate were shipped to Jenike & Johanson (J&J) to evaluate the material flow characteristics.
- A sample of final concentrate was shipped to FLSmidth for drying tests.
- Jacobs conducted ore characterization testing, preliminary bench scale flotation tests, ore variability testing, and pilot plant testing on core and bulk samples from the Paul deposit. Jacobs

also subcontracted tests to vendors to determine the Bond abrasion index, JK drop weight, Bond ball mill work index, and Qemscan analysis.

- COREM conducted preliminary bench and pilot plant testing of flotation columns. Concentrate and tailings samples generated from pilot plant testing were subsequently tested by Outotec and FLSmidth.

Ore characterization and size reduction tests were performed by Jacobs, Hazen Research Inc., Phillips Enterprises, LLC, SGS Mineral Services, and the Colorado School of Mines. The objective of the test program was to obtain specific data on the ore and determine if a 40% P_2O_5 concentrate grade could be obtained with a high level of P_2O_5 recovery.

The findings from the test program conducted by Jacobs are summarized as follows:

- Provided design data for beneficiation of Lac a Paul ore and completed Paul ore characterization and size reduction test programs.
- Demonstrated that ore from the Paul deposit can achieve a 40% P_2O_5 grade with 87% P_2O_5 recovery with an acceptable MER and CaO/P_2O_5 ratio. This finding is based on bench-scale tests using mechanical flotation cells by Jacobs and pilot-scale column flotation testing by COREM.
- Demonstrated that magnetic separation and desliming are not needed prior to flotation.
- Demonstrated by ore variability tests that the nine ore types with head grades assaying from 3.9% to 12.8% P_2O_5 can consistently achieve a 40% P_2O_5 concentrate grade with P_2O_5 recovery ranging from 63% to 92%.

Jacobs subcontracted the pilot plant test program to COREM. A key component of the pilot plant test program was a 48-hour continuous test run. The flow sheet developed by Jacobs consisted of grinding and LIMS in closed circuit followed by flotation using mechanically agitated cells configured as a rougher/scavenger. The concentrate was sent to the apatite cleaner section where it was cleaned twice. The cleaner tailings were recycled. Overall, the best final concentrate grade from the continuous 48-hour test was 39.4% P_2O_5 at a P_2O_5 recovery of 45.4%. The best P_2O_5 recovery was 78.8% with a corresponding final concentrate grade of 36.4% P_2O_5. The 48-hour continuous test run results were inconclusive because: (1) the pilot plant was not at equilibrium; (2) the grind F_{80} utilized by COREM was possibly too coarse; and (3) the multiple recycle steams likely contributed to the equilibrium issues previously noted.

Independently from the Jacobs test program, COREM conducted bench scale laboratory tests and pilot plant testing of an identical sample of bulk Paul ore. The main objectives of the program were to:

- Demonstrate that column flotation technology can give P_2O_5 recovery of at least 90% with a concentrate grade of 39% P_2O_5 or higher during an extended test (>8 hour).

- Provide test data to support development of process engineering for the Feasibility Study conducted by Cegertec WorleyParsons.

The column cell pilot plant was configured as a rougher, two cleaners, and a cleaner-scavenger. The cleaner-scavenger tails were recycled. Feed F_{80} was nominally 185 µm and operation was continuous for 8 to 9 hours. Three formal sampling campaigns were carried out during the continuous pilot plant test and the P_2O_5 recovery and grade for each campaign are given in Table 25.5.1. After making minor adjustments in reagent usage, cell solids, and air flow rates, the pilot plant was allowed to stabilize prior to conducting sampling campaigns 2 and 3. The average P_2O_5 recovery and concentrate grade from sampling campaigns 2 and 3 are 91.6% and 38.6% P_2O_5, respectively; which better represents the performance attainable from the pilot plant using column flotation cells.

Testing Campaigns	Weight %	%P_2O_5	%P_2O_5 Recovery
Campaign 1	12.2	39.6	74.2
Campaign 2	16.9	39.2	91.8
Campaign 3	18.0	38.1	91.5
Average (1-3)	**15.7**	**39.0**	**85.8**
Average (2-3)	**17.6**	**38.6**	**91.6**
Recommended for FS		**38.6**	**90.0**

Table 25.5.1 Pilot Plant Test Results Summary

For the FS, the averaged P_2O_5 recovery was downgraded to 90% to compensate for scale-up to a commercial facility. The concentrate grade selected for the FS was 38.6% P_2O_5 although there is potential to increase the product grade to 39% P_2O_5 or even higher while still maintaining the overall P_2O_5 recovery at or near 90%.

After reviewing the results from both cell types, Jacobs concluded that column cells appear to be a superior option for beneficiating Lac a Paul ore.

Chemical analysis of a representative sample of the flotation concentrate collected from the column cell confirmation test run is given in Table 25.5.2.

Constituent	Units	Analysis
P_2O_5	%	38.60
CaO	%	51.25
MgO	%	0.70
Fe_2O_3	%	2.00
Al_2O_3	%	0.45
SiO_2	%	1.55
TiO_2	%	0.65
Na_2O	%	0.37

Constituent	Units	Analysis
K_2O	%	0.19
Cl	%	0.06
F	%	1.08
LOI	%	0.54
CaO/P_2O_5	Ratio	1.33
MER	Ratio	0.08

Table 25.5.2 Concentrate Chemical Analysis Results

Based on the data and information generated from the bench and pilot plant test programs, additional testing is recommended to finalize the design basis for beneficiating Lac a Paul ore. This additional test work should be completed prior to initiating detail design of the beneficiation facility and should be conducted on the Paul Zone ore where the titano-magnetite has not been removed. Since the viability of using mechanically agitated flotation cells to process the Paul Zone ore has not been demonstrated, future pilot plant testing should be conducted using flotation columns.

25.6 Infrastructure

The infrastructure is made up of off-site and on site utilities. The onsite infrastructure will consist of the following;

- Tailings Storage facility – designed for the life of mine and incorporates water recovery from the storage facility.
- Waste rock dump - The open pit mining operation will generate approximately 180 Mm^3 of waste rock and this will be stored on a purpose built storage facility on the mine site.
- Site layout and camp site accommodation – this will be made up of various sectors on the Lac a Paul mine site. They include the Paul zone mine pit, North waste rock dump, primary crusher, beneficiation plant, ancillary support services and building for the beneficiation plant and mine site, workers camp, water intake station, metallurgical tailings storage facility, site roads for plant and mine vehicles,
- Site water management will comprise tailings storage water recovery systems, various grades of water and associated water distribution systems across the mine and beneficiation site. Ground water runoff will be managed so as to recover and use as much of the collected water on site.
- On site power distribution and control systems for the in-pit mine area, crusher, beneficiation plant, tailings storage facility and worker camp.

25.7 Market Studies and Contracts

The reports are relatively consistent in expectations for benchmark Moroccan-quality export concentrate prices over the life of the Lac a Paul Mine, with a relative spread of ±15%. However, the

CRU report credits Arianne with a selling price reflecting only P_2O_5 content, freight differentials and the cost of the acid necessary to convert the phosphate rock concentrate into fertilizer products at various consumer destinations. The Integer report also develops a premium based on value-in-use to high-purity phosphate product producers, also across various customer locations such as the US Gulf, Brazil and Northern Europe.

Based on the marketability of the concentrate as discussed in both reports, Arianne has developed a marketing plan for the life of the Lac a Paul Mine which includes both fertilizer customers and high-purity product customers, across various destinations where demand exists for product with the characteristics verified by the metallurgical test work included in the product quality sections of this report.

Using the projections from both CRU and Integer reports, Arianne has modeled its sales price forecast (in constant 2013 US$/t) over the life of the Lac a Paul mine and in summary, the figures listed in Table 25.7.1 were used:

Item	Selling Price $USD
Average Benchmark Morocco price for 65-75 BPL rock FOB Morocco	137
Price adj. for freight, P_2O_5 content and acid to N.A. fertilizer producers	60
Price adj. for delivery to Brazilian and European high-purity producers	80
Price adj. for delivery to US and Gulf high-purity producers	91
Average price for sales mix (1/3 to each market zone)	**213**

Table 25.7.1 Selling Price Forecast Summary from Arianne

No sales contract and no letter of intent have been secured at this stage of the project.

25.8 Capital and Operating Costs

25.8.1 Capital Costs

The capital cost in Table 25.8.1 is for the Lac a Paul Project based on a milling rate of 55,000 tonnes per day, and is based on Cegertec WorleyParsons' standard methods applicable for a Feasibility Study.

All duties and taxes are excluded from the capital cost, but are considered in the economic analysis. Escalation and interests incurred during construction are excluded from the capital cost. The effective date for the cost estimate is September, 2013.

The pre-production initial capital cost for the mine and ore processing facility is US$M 982.5, of which US$M 73.9 is contingency. The pre-production initial capital cost for the mine-to-port transportation scope is US$M 232.2, of which US$M 18.1 is contingency.

Item	Feasibility Study (US$ M)
Mill	470.8
Project general	108.5
General Mine Site	65.3
Mine Development	42.5
Open Pit Mine	29.6
Temporary Construction Facilities & Services	23.1
Construction Support/Equipment/Consumables	57.7
EPCM	61.7
Contingency	73.9
Owner’s Cost	49.4
TOTAL	**982.5**

Table 25.8.1 Initial Capital Costs - Mine Site

The open pit mine development, the ore processing facilities and all on-site infrastructure and services necessary to support the mine operation have an estimate accuracy of +/- 15%.

Item	Feasibility Study (US$ M)
Off-site facilities & infrastructure	167.9
Temporary construction facilities & services	7.7
Construction support/equipment/consumables	3.3
EPCM	20.9
Contingency	18.1
Owner's cost	14.3
TOTAL	**232.2**

Table 25.8.2 Initial Capital Costs – Mine to Port

Capital cost for the Mine to Port system is estimated at an accuracy of +/- 25%.

Item	Feasibility Study (US$ M)
Initial Capital Cost	1,214.7
Sustaining Capital Cost	385.8
Total Direct Capital Cost	1,599.5
Mine Closure and Rehabilitation	44.8

Table 25.8.3 Life of Mine Capital Costs

25.8.2 Operating Costs

Based on all operating costs outlined in the Feasibility Study, the phosphate concentrate annual operating cost at FOB Port of Saguenay is US$ 93.7/tonne. Table 25.8.4 shows a breakdown of operating cost per tonne.

Item	Feasibility Study ($/tonne)
Average Extraction Cost	27.3
Average Processing Cost	48.1
Average General and Administrative Cost	4.3
Average Shipping Cost	14.0
Total Operating Cost	**93.7**

Table 25.8.4 Estimate of Operating Costs per tonne of concentrate

Item	Feasibility Study (US$M)
LOM Mining Operating Cost	2,069.1
LOM Process Operating Cost	3,642.3
LOM General & Administration Operating Cost	323.2
LOM Concentrate Transport Operating Cost	1,057.0
LOM Operating Cost	7,091.5

Table 25.8.5 LOM Estimate of Operating Costs

25.9 Economic Analysis

Annual cash flow projections for the Project were estimated by Ernst and Young over the Project's production life based on the production schedule, sales revenue, production costs, capital expenditures and corporate costs (taxation, royalties, etc.). The main financial assumptions used in the base case are given in Table 25.9.1.

Item	Unit	Base Case Value
Phosphate Concentrate Price	US$/tonne	213
Exchange Rate	CAD$/US$	0.9524
Life of Mine (Paul zone)	years	25.75
Discount Rate	% per year	8.0%

Table 25.9.1 Macro-Economic Assumptions

The main technical assumptions used in the base case are given in Table 25.9.2.

Item	Units	Value
Total Ore Mined (Life Of Mine)	M tonnes	472.1
Average Ore Grade to Mill	% P_2O_5	6.88
Concentrate Grade	% P_2O_5	38.60
Total Tonnes of Concentrate Produced	M tonnes	75.7
Processing Design Rate	Tonnes/day	55,000
Average Process Recovery over Mine Life	%	90.00
Average Extraction Cost	(US$ / tonne concentrate)	27.33
Average Processing Cost	(US$ / tonne concentrate)	48.11
Average General and Administrative Cost	(US$ / tonne concentrate)	4.27
Average Shipping Cost	(US$ / tonne concentrate)	13.96
Total Operating Cost	(US$ / tonne concentrate)	93.68

Table 25.9.2 Technical Assumptions

The key financial results of the base case scenario are presented in Table 25.9.3.

Item	Before-Tax	After-Tax
NPV @ 8%	1,910.1 $	1,065.9 $
IRR	20.7%	16.7%
Payback Period (years)	4.4	4.8

Table 25.9.3 Financial Results

26. RECOMMENDATIONS

26.1 Geology and Mineral Resources

The following recommendations are made to focus on two aspects: improvement of available data and a working plan to further develop the Property.

Improvement

- Have the resource model re-estimated with new specific gravity (SG) data with the combination of variable search ellipsoid in GENESIS.

  Cost estimate: $20K.

- Arianne should acquire software similar to GENESIS or other software which can connect to Geotic database. The technical team would be in a position to directly refine and update the interpretation into the software for further use during development process.

  Cost estimate: $20K.

- Arianne should process the six 25-tonnes bulk samples for process optimization and advanced characterization of Chlorine behavior to increase confidence in concentrate output grade; this additional knowledge and understanding will help determine whether the chlorine variation within the Paul Zone deposit should trigger ore blending in the mine plan, to ascertain that the concentrate chemical analysis always meets commercial specifications.
- Develop a resource model which will allow for a reliable forecast of phosphate rock concentrate quality based on the feed source within the pit.

  Cost estimate: $2,150K.

Work Plan to develop the project

- The Author suggests that continuous exploration work on the Property be maintained for ownership purposes in addition to define new mineral resource near the surface. Expand surface exploration and drilling campaign to include specific mineralized zones.

  Estimated cost: $ 2,400K.
- Definition drilling should take place in the pit shell of the first five years.
- Mining blocks to be outlined by the FS using the Paul Zone as a priority. Again, it is the Author's opinion that drilling should focus on the Paul Zone which has better grade and low overburden, should extension of the resources be required.
- All drill holes should have a SG measurement of core which connects to the exact form of the sample for development of a precise correlation between XRF results and in situ specific gravity.
- Once mineralized zone contacts are identified, proceed with analysis of samples using pulp (include chlorine analysis); it is important to better understand the Paul Zone deposit and the chlorine factor in the concentrate.
- Specific lock cycle test combining composite of core should be done in order to define the relation of feed to concentrate behavior and implement it into the resource model.

  Estimated cost: $ 1,675K.

26.2 Mining

The Lac a Paul Feasibility Study is comprised of mining work that has been selected, designed and estimated in a way to meet industry standards. For this level of study, WP has provided a mining plan for the future operation of the Paul pit. WP has provided a list of recommendations, which would be beneficial if contemplated during detailed design. These mining engineered recommendations include:

- Use a contractor for peak years of stripping of the current mine plan; potential contractor to be used on waste removal tasks.
- Developing strategic mine schedule in short-term detail (quarterly, monthly) and identifying opportunities for short-haul routes and in-pit dumping.

- Update pit slope designs for phase pits during detailed design phase of project, as new geotechnical information is collected;
- Perform trade-off study for mining equipment selection and size;
- As well, it is recommended that a trade-off study be performed for application of a trolley assist system; as the mine gets deeper it will take advantage of the availability of cheap electricity in Quebec. Within the scope of the trade-off-study, is to determine the potential savings in operating cost versus investment in additional equipment.

26.3 Mineral Processing and Metallurgical Testing

Based on the data and information generated from the bench and pilot plant test programs, additional testing is recommended to finalize the design basis for beneficiating Lac a Paul ore. This additional test work should be completed prior to initiating detail design of the beneficiation facility. Since the viability of using mechanically agitated flotation cells to process Lac a Paul ore has not been demonstrated, future pilot plant testing should be conducted using flotation columns. A listing of major components of the additional test program is given below.

- Conduct further evaluation of alternate apatite collectors.
- Conduct further evaluation of starches or starch substitutes to determine if a less costly alternative for wheat starch (WW82) can be found.
- Conduct additional bench scale tests to evaluate possible alternative pH regulators for the cleaner flotation stages as a possible replacement for sulfuric acid.
- The potential impact of Lac a Paul water on flotation response should be re-evaluated thoroughly. Bench scale locked cycle tests can be utilized to simulate the recycling of the process water.
- Polymers will likely be used to facilitate rapid settling and higher consolidation in the concentrate and waste thickeners. Since the thickener overflows are returned to the beneficiation plant water recycle system, it is important to test the potential impact of residual polymer on flotation response. This evaluation can also be conducted with bench scale locked cycle testing.
- Conduct bench scale tests to evaluate the flotation kinetics for each flotation stage (rougher, scavenger, and cleaners) for average, low, and high grade ore samples.
- Overall optimization of the crushing and grinding circuits needs to be undertaken. Some preliminary bench testing indicated that rod mill grinding resulted in better flotation performance than ball mill grinding. The column pilot plant test data was inconclusive with regard to grinding method preference, but it is intuitively evident that the grinding method utilized should result in minimal production of -20 µm “fines” and therefore give the highest flotation efficiency.
- Conduct additional bench and pilot plant testing on low and high grade ore samples to confirm the viability of the process flow sheet for processing ore body extremes and/or determine what process variables (operating conditions) require adjustment in order to maintain P_2O_5 recovery and grade.

- Intermediate conditioners were used in the pilot plant as vessels to suspend the pulp for adding reagents for the next flotation stage, but there were no tests to determine residence requirements (if any). Additional bench scale testing to optimize reagent conditioning residence times should be performed.
- The introduction of the scavenger cell facilitated the recycle of froth containing a disproportionate amount of coarse apatite particles that proved difficult to float in the cleaner stage. At the plant scale and with industrial equipment, this scavenger may not be needed; however, this should be confirmed.
- Additional pilot plant testing should be performed to confirm the need of a second cleaner stage due to the minimal upgrading of the cleaner 2 stage that was observed in the pilot plant.
- It was demonstrated in both bench and pilot scale testing, that magnetic separation prior to flotation is not required in order to attain the specified product grade and recovery. However, more piloting time is required to optimize the operating parameters and flotation response.
- Conduct a continuous, long duration (96 hours or longer) pilot plant test. The long duration test should ensure the generation of requisite test data under stable (equilibrium) operating conditions to facilitate the optimization of the flotation circuit operating parameters including:
    - % solids for each conditioning stage.
    - optimum cleaner pH.
    - collector and depressant consumption.

Eriez, the manufacturer of the column cell air injection system, tailings recirculation system, and associated control instrumentation, should be consulted regarding the development, execution, and optimization of future column flotation pilot plant programs, particularly where the test data will lead to a final process design that may include performance guarantees by the manufacturer.

The estimated cost for most of the recommendations in Section 26.3 is already included in the cost estimates for recommendations associated to Section 26.1.

26.4 Tailings Storage Facility and Water Management

The hydrogeological report will be analysed and the risks associated with seepage will be evaluated regarding changing groundwater level and disturbance of footprint under the TSF. An underground drainage system will be designed.

A number of geotechnical investigations, including seismic analysis, should be undertaken during the detailed design stage to confirm geotechnical design assumptions. It is also recommended to undertake a topographic survey of the borehole sites.

Testing of the tailings to determine their physical/mechanical/chemical properties and behaviour is necessary to confirm assumptions used for the tailings strength parameters:

- Physical/mechanical properties testing: size distribution, specific gravity, Atterberg limits, permeability, triaxial testing, proctor maximum dry density and optimum water content, maximum density by vibrator and by drying, minimum density, settling, stress consolidation settlement, freeze and thaw.
- Geochemical properties testing: ABA (for acid generation), humidity tests (coarse and fine fractions), fresh and aged supernatant analysis (coarse and fine fractions);

Investigation for borrow banks for suitable materials for construction of the various dykes, pads and roads as well as concrete aggregates should be undertaken to determine quantities available and distance from the various facilities.

The preliminary cost estimate to perform the recommended complementary studies for the tailings storage facility and water management is evaluated at $ 430K.

26.5 Infrastructure

- Continue design and environmental impact assessment for the 161kV power supply system from Chute-des-Passes to the Lac a Paul mine site.
    - Estimated cost range: $ 375K.
- Continue design for the road/handling/truck washer system associated with the transport of the concentrate from the Lac a Paul mine site to the proposed Saint-Fulgence export facility on the Saguenay River.
    - Estimated cost range: $ 400K-800K.

26.6 Environment

26.6.1 Waste Rock Dump Design Recommendations

The stability assessment for the waste rock stockpile located within the North Site has been completed at a preliminary or pre-feasibility level. The analysis and results are based on the limited site information that is currently available. The following recommendations are provided in order to confirm/update site information and to optimize the design of the waste rock stockpile as the Project is advanced in subsequent levels of design.

Additional site investigations, data collection and analysis will be required as the project is advanced to subsequent levels of design to confirm or revise the current assumptions used for the stability analysis.

1. The site investigation data that was available was limited and did not cover the entire extents of the proposed waste rock stockpile location. Further geotechnical information would be required to confirm the material parameters used and to update the stability analysis results. Drilling, particularly along the western extents of the site, along with geotechnical laboratory testing for index and in situ material strength parameters, would be recommended to determine more accurate foundation profiles. Stability models should be updated with the findings and results of the site investigation activities. Estimated cost: $115K-$125K.

2. The seismic parameters used for stability modelling should be reviewed for the site location prior to further modelling.
3. Stability models should be completed for interim stockpile layout and slopes as well as the final arrangements to ensure that the stockpile is stable during the operations. The planned sequencing for developing and filling the waste rock stockpile can also be used for scheduling of additional required field investigations. Estimated cost for items 2 and 3: $30K-$50K.

The ball park cost figure for the waste rock dump design recommendations is therefore estimated in the $145-$175K range.

26.6.2 Geochemical Program Recommendation

Preliminary report by URSTM was used for the NI-43101 report and long term analyses were on-going for an additional 6 months from the last report date (May 2013). Confirm that the final report reaches the same conclusion. Additional analysis could be recommended in the final report. The preliminary estimated cost for additional analysis could be in the $50K-$75K range.

26.6.3 Water Management Recommendation

Preliminary waste rock sedimentation pond and pit water pond were designed. Additional site investigations, data collection, survey and analysis will be required as the Project is advanced to subsequent levels of design, to confirm or revise the current assumptions used for the pond locations and size. Estimated cost: $50K.

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21 June 2013

The Lac a Paul Phosphate Project: Market Outlook and Competitive Position

A report prepared for Worley Parsons

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Appendix B: Phosphate rock regional market summary

Executive summary

The purpose of this report is to describe the market for phosphate rock that the Lac a Paul mining project proposes to supply and specifically to provide the basis for a price assumption that can be used to underpin reserve and resource estimates. It has been prepared by CRU Strategies (CRU), the management consulting division of CRU International. We understand that this report is intended to be relied upon by a "Competent Person" in connection with the preparation of a technical report on the project according to the requirements of Canada's NI 43-101.

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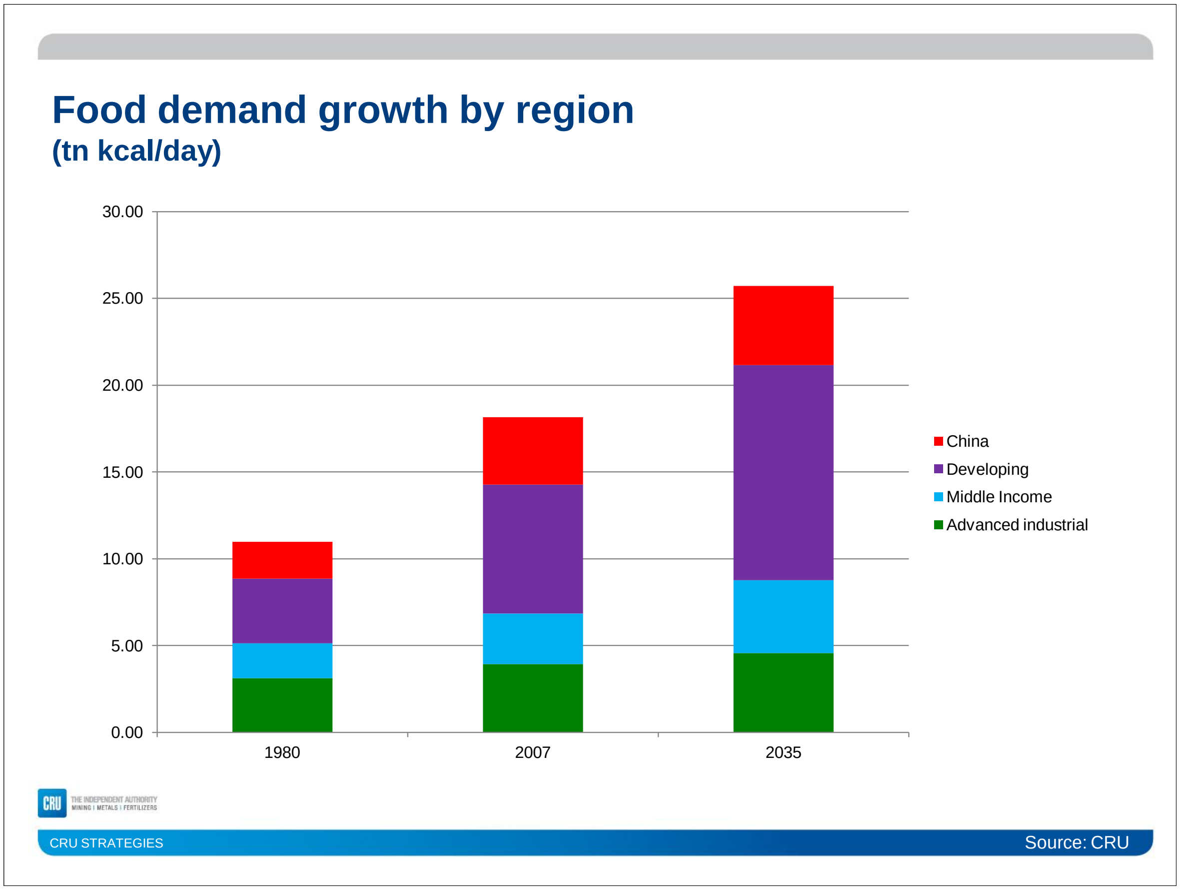
Currently, 88% of the world demand for phosphate is for fertilizer, and a further 6% is for animal feed supplements. Fundamentally, therefore, the outlook for the consumption of phosphate rock depends on the world's requirements for food. This is increasing faster than the population because rising per capita incomes are associated with an increase in demand for calories. In addition, higher incomes and urbanization appear to trigger changes in dietary habits, specifically an increase in the proportion of calories from animal sources, which in turn creates a demand for fodder crops. Another source of growth is the increasing use of crops for fuel, notably ethanol from corn in the US and sugar cane in Brazil.

The following chart shows that world food consumption has increased by approximately 50% in the past quarter-century, and CRU expects this to continue for the next quarter-century. China has been a large part of the growth story but will contribute less going forward. The emphasis is shifting to other middle income economies. In addition, there are still at least 2.5 million extremely poor people, located mostly in Asia and Africa, whose calorific consumption remains inadequate. Meeting these needs will ensure a growing demand for crops of all kinds. It is important to emphasize, however, that little to no growth is occurring in the industrial world.



Food demand growth by region

(tn kcal/day)

Source: CRU

The following table summarizes CRU's forecast of the impact of human food, animal food, and industrial/energy markets on the demand on key crops through 2035.

Table 1: World demand for crops, mn t

Crop Type	2000	Annual Growth	2010	Annual Growth	2020	Annual Growth	2035
Wheat	576.7	1.5%	667.9	2.4%	844.5	1.3%	1021.8
Rice	393.0	1.5%	457.9	2.3%	577.1	1.4%	707.0
Maize (corn)	608.0	2.3%	764.7	1.9%	926.5	1.4%	1133.8
Other grains	289.4	0.6%	308.6	1.5%	357.7	0.8%	404.8
Soyabeans	164.3	3.4%	230.5	1.6%	270.1	1.2%	321.4
Cotton	33.2	3.1%	45.0	0.6%	48.0	0.8%	54.3
Palm crops	6.1	6.9%	11.8	3.2%	16.1	2.0%	21.6
Other oilcrops	167.6	2.0%	205.1	1.5%	238.8	1.1%	283.2
Sugar	1497.5	2.3%	1880.4	1.2%	2112.8	1.0%	2456.4
Fruit & vegetables	1204.0	2.6%	1560.1	1.9%	1888.0	1.2%	2255.2
Other	82.8	1.6%	97.2	1.6%	113.7	1.6%	144.6
Total	5022.6	2.2%	6229.1	1.7%	7393.3	1.2%	8803.9

During the first decade of the century, world crop demand grew at 2.2% per annum, which was a full 1% per annum faster than population growth. Of this, about 0.5% can be traced to the improved nutrition levels associated with rising per capita incomes, with the balance being traced to a shift towards a higher proportion of animal products in the diet (and thus increased demand for animal feed) and to the increased demand for crops for industrial and bio-fuel purposes.

Looking forward, CRU anticipates a gradual decline in the growth of food production by about 1% by the 2030s. Half of this reflects slower population growth, with the balance being attributed to a larger portion of the global population moving to income levels where food consumption does not grow as strongly as it does at lower levels.

The only way these crops can be produced is through some combination of increased acreage in production and increased yields. Since the supply of arable land is finite, and some of it may be threatened by climate change, the primary emphasis will continue to be on improving yield. Many factors affect yield, but our statistical analysis of past data suggests that between 25-40% of the improvements over time are related to fertilizer use. Among the key NPK elements, we believe that P and K are under-applied relative to N. Consequently, we expect continued growth in phosphate fertilizer demand as summarized in the following table.

Table 2: Phosphate fertilizer demand by region, 2000-2035, mn t P_2O_5

Crop Type	2000	Growth	2010	Growth	2020	Growth	2035
North America	4.6	2.4%	5.8	1.3%	6.6	1.5%	8.2
Asia-Pacific, advanced	2.4	-3.2%	1.7	1.5%	2.0	2.0%	2.7
Europe	4.6	-0.9%	4.2	0.7%	4.5	1.1%	5.2
Latin America	3.8	3.7%	5.5	3.2%	7.5	1.7%	9.7
Russia & CIS	0.5	9.6%	1.2	3.1%	1.7	3.0%	2.6
China	8.7	4.9%	14.0	1.6%	16.3	1.3%	19.8
Asia-Pacific, developing	4.2	6.3%	7.7	1.2%	8.7	0.9%	10.0
India	2.6	1.9%	3.1	2.4%	4.0	2.3%	5.6
Middle East	0.8	1.3%	0.9	3.1%	1.3	1.8%	1.7
Africa	1.0	3.1%	1.3	3.6%	1.9	4.5%	3.6
Total	33.1	3.2%	45.5	1.8%	54.4	1.6%	69.1

Source: CRU

CRU expects that phosphate fertilizer demand will decrease moving forward. The forecasted growth rate of 1.8% to 2020 is below the previous decade's growth rate of 3.2%. Likewise, growth is expected to decrease even more after 2020. The decline in global population growth is the main cause for this slowdown in growth.

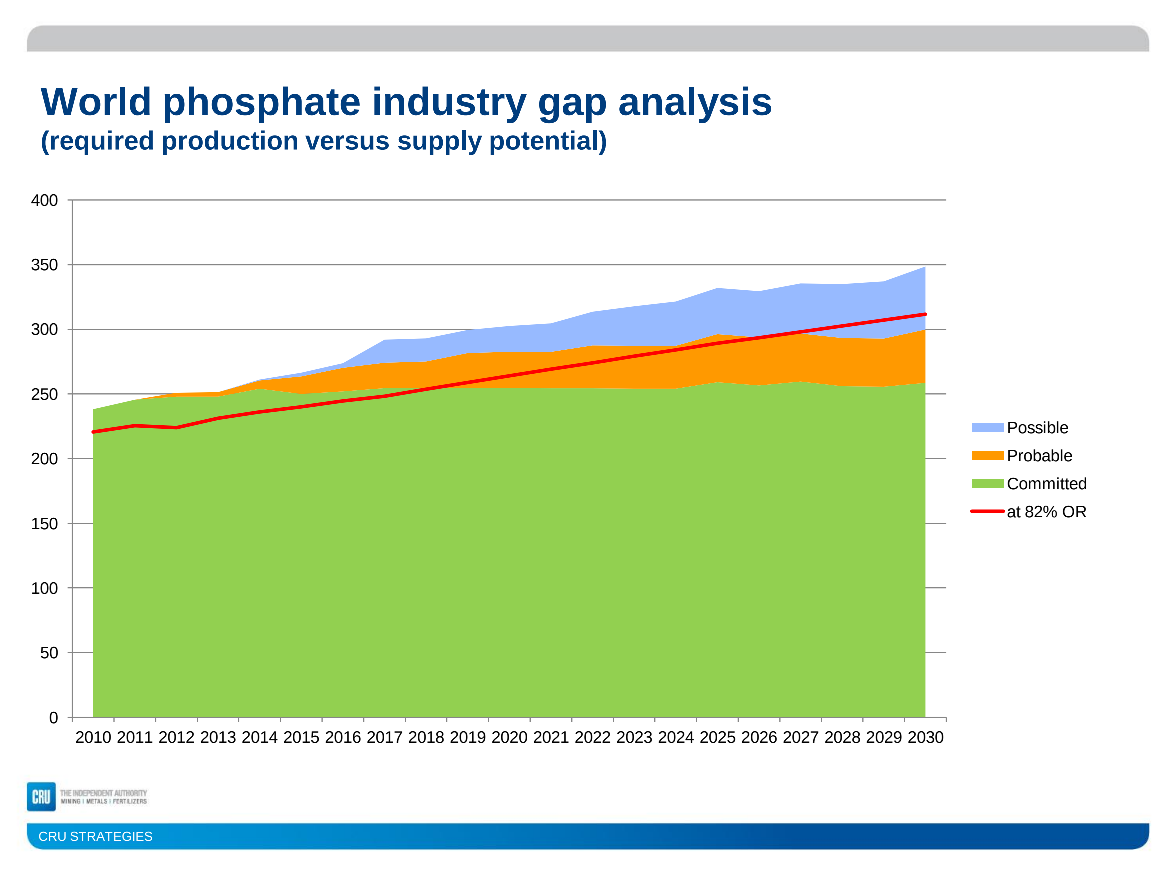
Prospects for the non-fertilizer uses of phosphates are less encouraging. Although the fundamentals suggest that the demand for animal feed phosphates should be growing faster than fertilizer phosphates, CRU does not think this is likely to be the case because of the availability of two substitutes – phytase and fishmeal. We estimate that were it not for the growth of these substitutes, the current market for animal feed phosphates would be about 1.2 mn tpy (16%) greater than its current size.

The largest single segment of industrial phosphates is the detergent industry. This probably accounts for 70-75% of industrial phosphate demand. The balance is represented by the food additives industry. The use of detergents rises strongly as incomes increase and particularly with urbanization. This creates favourable fundamentals for this sector. However, there are significant environmental issues associated with detergent usage, and phosphates are now being discouraged in this market.

Taking all of these factors into consideration, CRU expects phosphate demand to grow at around 1.6-1.8% over the long term. New mines need to be developed to meet this increase in demand as well as to replace mines that are approaching the end of their commercial life. CRU has compiled a database of all known mines and credible future projects. The latter can be classified as committed, probable, or possible on the basis of the progress made to date. The following chart shows the relationship between expected demand and the potential supply of phosphate rock.

This chart, which is based on the assumption of a typical 82% operating rate for nominal capacity, shows that firm and committed projects together exceed demand through 2017, indicating that supply restraint is required. Thereafter, demand exceeds supply, indicating that some new capacity will be needed by 2017 and that by 2025 the entire probable project inventory will be absorbed.

There is no likelihood of any absolute shortage of phosphate over the period to 2030. The implication of this analysis is that only the lowest-cost projects in the industry are likely to be justified in this timeframe, which suggests that prices will be determined by the third or fourth quintile of the supply curve.



The increase in demand for phosphate rock between 2010 and 2035 is around 85 mn tonnes. Lac a Paul intends to produce at a rate of 3 mn tpy and therefore accounts for less than 4% of the potential increase in supply.

The phosphate market has undergone a significant structural change in recent years with prices rising from traditional levels of $50-60/t fob Morocco[1] to $350/t in the run-up to the global financial crisis. They then fell to $125/t before recovering in 2010. For the past two years relative stability has returned to a level of about $185/t.

In the long term CRU considers that phosphate rock prices are likely to reflect the industry's long-run marginal cost of production. We measure this by modelling a representative sample of new projects we think the industry is likely to develop. This sample is drawn from the pool of probable

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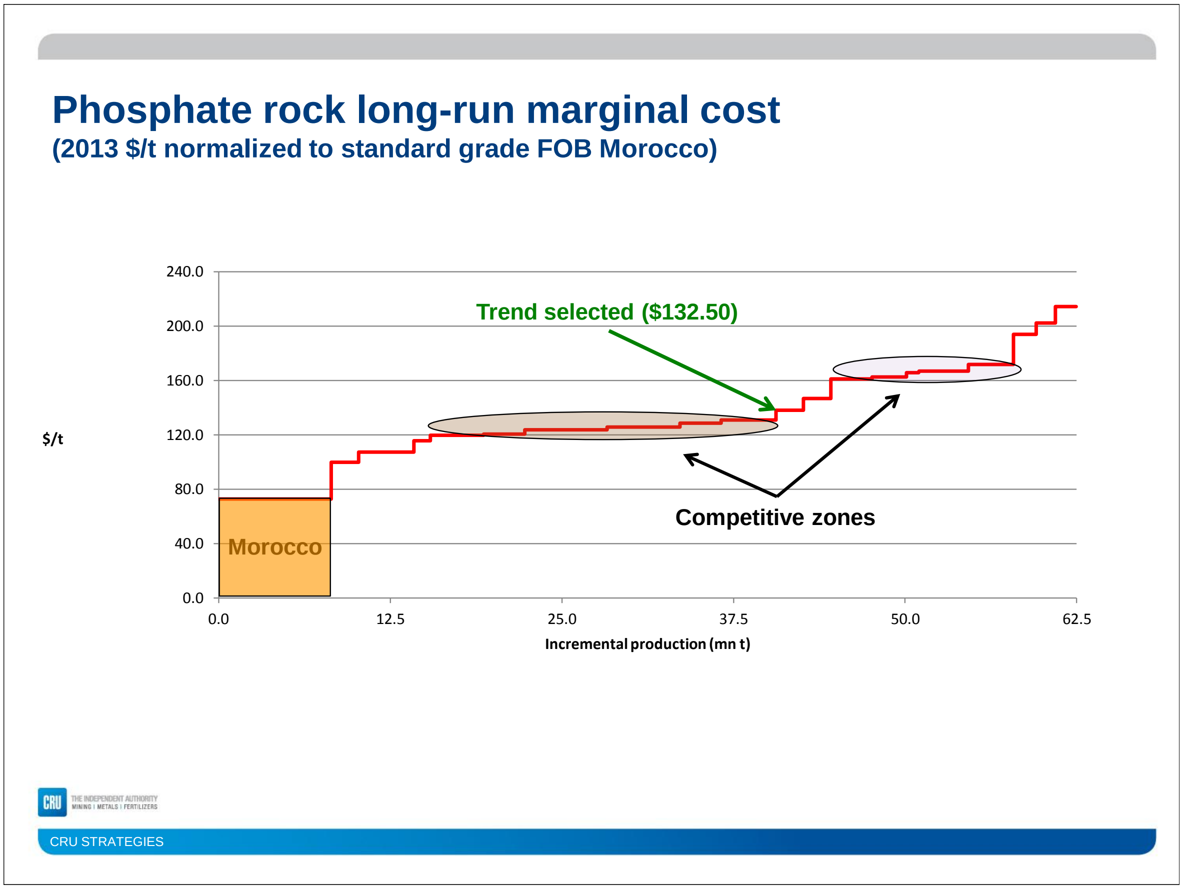
[1] This is the generally accepted reference price in the industry and refers to a 72 BPL rock with impurities below penalty levels. Morocco is the world's leading exporter; supplies all relevant markets; and contains around 70% of the world's phosphate resources.

and possible projects discussed above, and the results are grossed up to reflect the full universe. The following chart summarizes this assessment in 2012 dollars.



Phosphate rock long-run marginal cost

(2013 $/t normalized to standard grade FOB Morocco)

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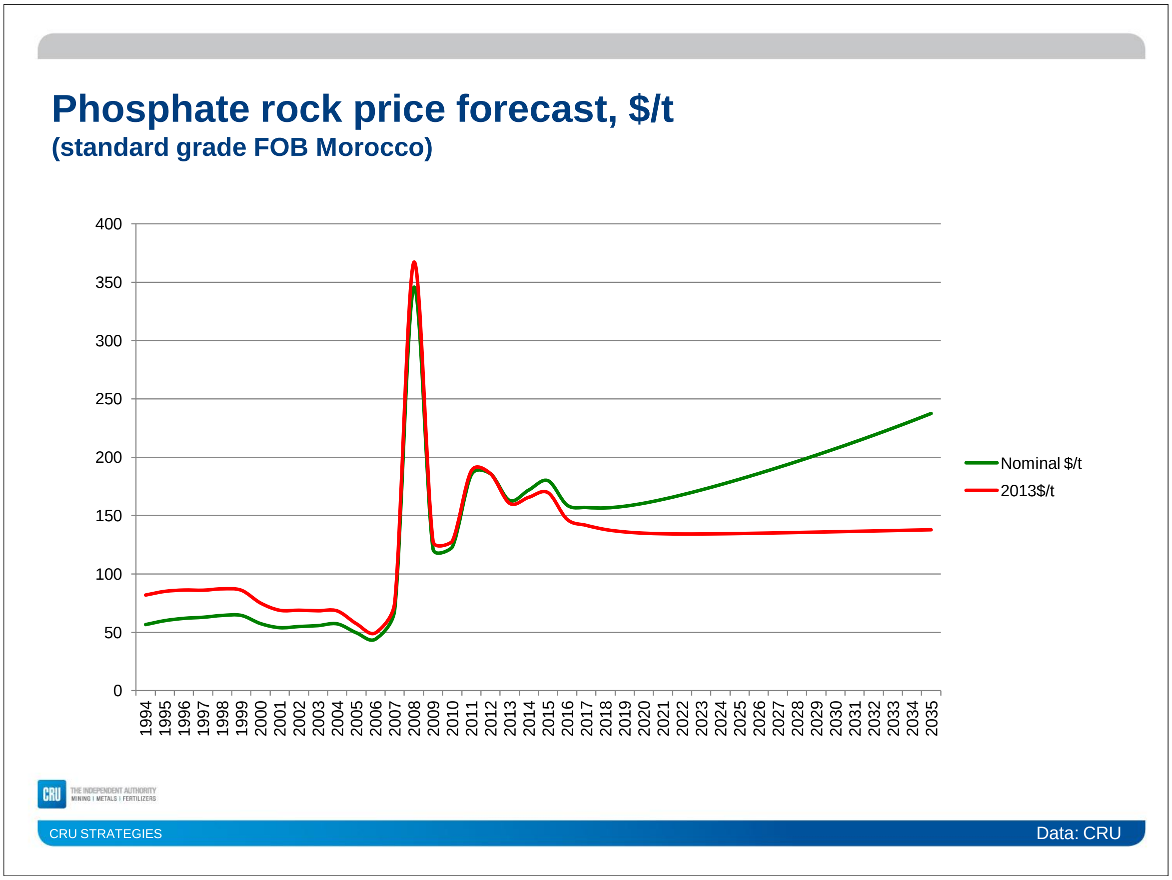
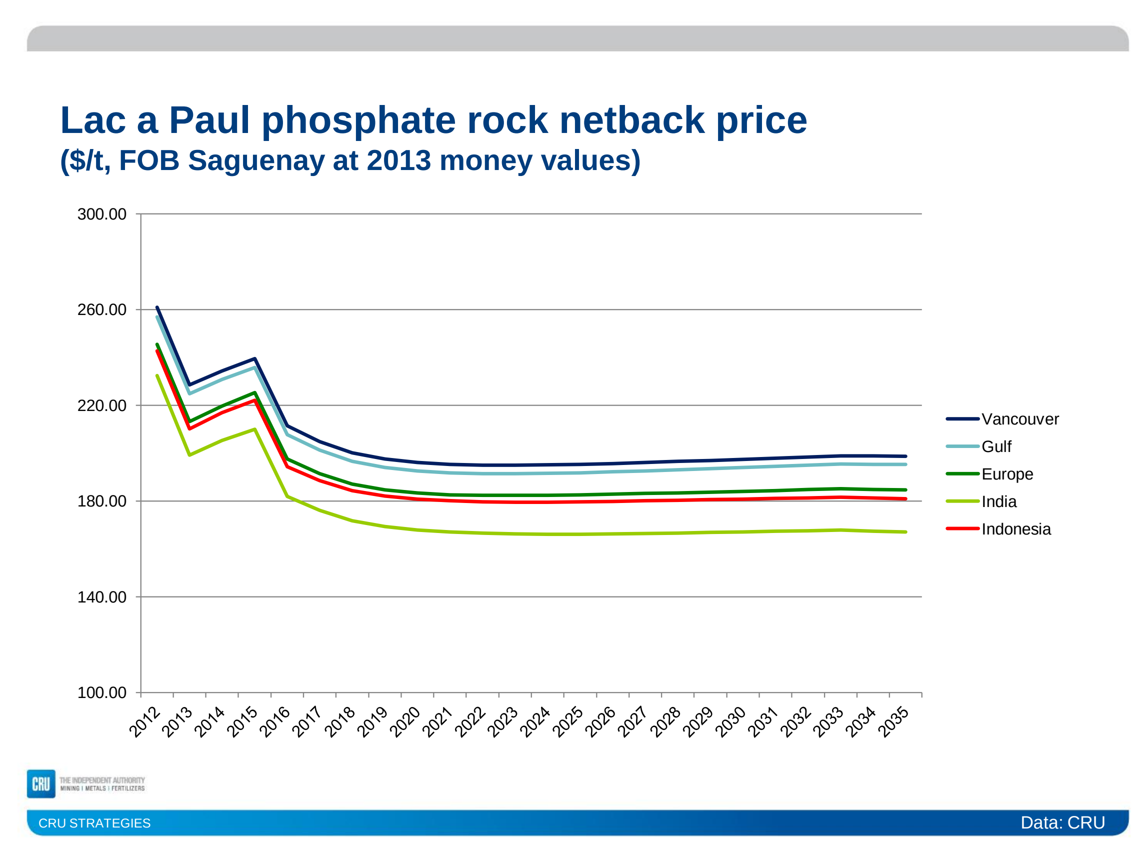
The lowest cost projects on this chart are in Morocco, which has vast reserves with relatively easy mining conditions and an established infrastructure. Russia is another low cost producer because their mines benefit from substantial premiums earned on very high-grade product (up to 88 BPL) and in some cases from significant by-product credits. However, CRU believes that the key projects in this curve are represented by sub-Sahara Africa and Australia and have costs estimated to be in the range of $120-135/t. Under more vigorous growth assumptions, prices could be forced up to the $150-160/t range. These projects usually have more demanding infrastructure requirements. However, CRU's demand forecasts do not support this upside potential at present.

This assessment underpins our forecast of the benchmark Morocco price that is outlined in the next chart. The structural upward shift in price is very similar, in broad order-of-magnitude terms, to what can be observed in many other sectors of the mining industry. There has been a distinct increase in real terms in the underlying cost structure of this industry between the first and second halves of the past decade, which reflects the impact of demand pressure from China and the need to restore the profitability of the industry's supply chain after almost two decades of persistent margin squeezes on suppliers of equipment and services between approximately 1982 and 2002.



The price earned by the Lac a Paul project will differ from this not only because of location but, more importantly, because its rock is of higher quality. Each tonne of rock contains around 21% more phosphorous than the standard Morocco rock and it contains a lower calcium ratio, implying that less sulphuric acid will be required for each tonne of phosphoric acid produced from the rock. These two factors should be the basis for a significant price premium.

CRU has examined a large number of possible marketing scenarios and calculated the netback values of the rock from six different potential markets around the world. The following chart summarizes the results and is expressed in 2013 dollar values. The highest netbacks are associated with sales to Vancouver (for Agrium's Alberta operations).



Lac a Paul phosphate rock netback price

($/t, FOB Saguenay at 2013 money values)

Data: CRU

Markets in India are the least attractive due to very high freight costs from Quebec. They represent buyers of last resort at approximately $165/t. CRU considers that the most likely markets are likely to be elsewhere in Vancouver or the US Gulf at prices in the range $195/t-$200/t in 2013 dollars.

CRU has examined the specifications of the marketable rock and the phosphoric acid production tests that have been performed. These indicate that the rock contains no deleterious elements that will limit its marketability. With the exception of a chlorine level that is above average (though still less than some rock suppliers), we see no basis for any penalties for chemical impurities. In the case of chlorine, it is far from certain that penalties will be taken as these are not universally applied. However, confirmation of this will have to await the negotiation of letters of intent with specific buyers. The primary marketing challenge for Lac a Paul arises from the fact that most phosphate rock producers are integrated with acid plants. The market for traded rock is only 30 mn tpy, and it has not shown appreciable growth in recent years. The negotiation of an offtake agreement or some form of strategic partnership is recommended to address this challenge.

There is some upside pricing opportunity for the project, as CRU's analysis is based on supplying only the fertilizer market. There is a small market for high purity phosphoric acid that commends a much higher acid price on the basis of which a further premium is potentially available to the miner. This market could consume up to 250,000 tpy of the project’s output.

Chapter 1 – Introduction

The purpose of this report is to describe the market for phosphate rock that the Lac a Paul mining project proposes to supply and specifically to provide the basis for a price assumption that can be used to underpin reserve and resource estimates. It has been prepared by CRU Strategies (CRU), which is the management consulting division of CRU International.

CRU understands that this report is intended to be relied upon by a "Competent Person" in connection with the preparation of a technical report on the project according to the requirements of Canada's NI 43-101. CRU is one of the world's leading business information, market research, forecasting and consulting organizations specializing in the global mining, metals and fertilizer industries. We are a privately held company that is entirely independent of all industry stakeholders. We are frequently asked to prepare similar reports relating to the full range of commodities in which we have research competence.

The project intends to supply 3 mn tpy of marketable high grade (approximately 39% P_2O_5) phosphate rock. The ability to sell this material and the price received depends ultimately on the demand and supply fundamentals in the global phosphate rock industry. Approximately 88% of all phosphates are used directly as fertilizers and a further 6% are used indirectly as animal feed supplements[1]. Accordingly the starting point of our analysis is a forecast of the global agricultural outlook, which is set out in chapter 2 of this report. It describes the outlook for population, food consumption, animal feed requirements and industrial crops. On the basis of this we develop a forecast of crop production.

The implications of this for fertilizer demand are explored in chapter 3. We prepare forecasts of agricultural acreage and the yields required to satisfy the production requirement. Based on past relationships between yield and fertilizer application rates we then derive a forecast of demand for phosphate fertiliser.

Chapter 4 supplements this forecast with a discussion of the outlook for non-fertilizer uses of phosphates. In recent years this has grown about the same rate as fertilizer demand and we expect this to continue. This chapter describes the salient features of these markets, identifies the key issues and provides the rationale for our growth assumption.

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[1] The remaining 6% is used in detergents and a variety of specialized industrial applications

Lac a Paul is competing with other potential new phosphate rock mining projects to supply the growth of demand and to compensate for mines that are closing because of resource depletion. Chapter 5 therefore describes the supply side of the industry and the prospects for rock production in detail. The end point of this analysis is an estimate of the "gap" that exists between currently committed phosphate rock supply and probable demand. This provides a global market context against which to evaluate the need for the project.

CRU's research supports the view that phosphate rock is sold in a global commodity market in which prices around the world are systematically related to one another by differences in transportation costs, and in some cases, differences in quality. Chapter 6 provides the analytical foundation for this opinion. Since a portion of the world's phosphate rock mines face depletion each year and since the overall market demand is increasing, the development of new phosphate rock mines is required. While prices in a commodity market are liable to fluctuate considerably in the short-term due to market imbalances, in the long-term they reflect the global industry's cost of developing and operating these mines. Accordingly CRU develops a benchmark price forecast based partly on our assessment of the current market and partly on our evaluation of industry long-run marginal cost.

Chapter 7 discusses the specific marketing issues facing Lac a Paul. Because the initial downstream processing step for phosphate rock involves the production of merchant grade acid (MGA), the bulk of the chapter consists of a review of global phosphoric acid market and comments on the opportunities or constraints that Lac a Paul faces in each major region around the world. This is used to form the basis of an opinion on marketing strategy and, more specifically, to identify the areas where its products are most likely to find a home.

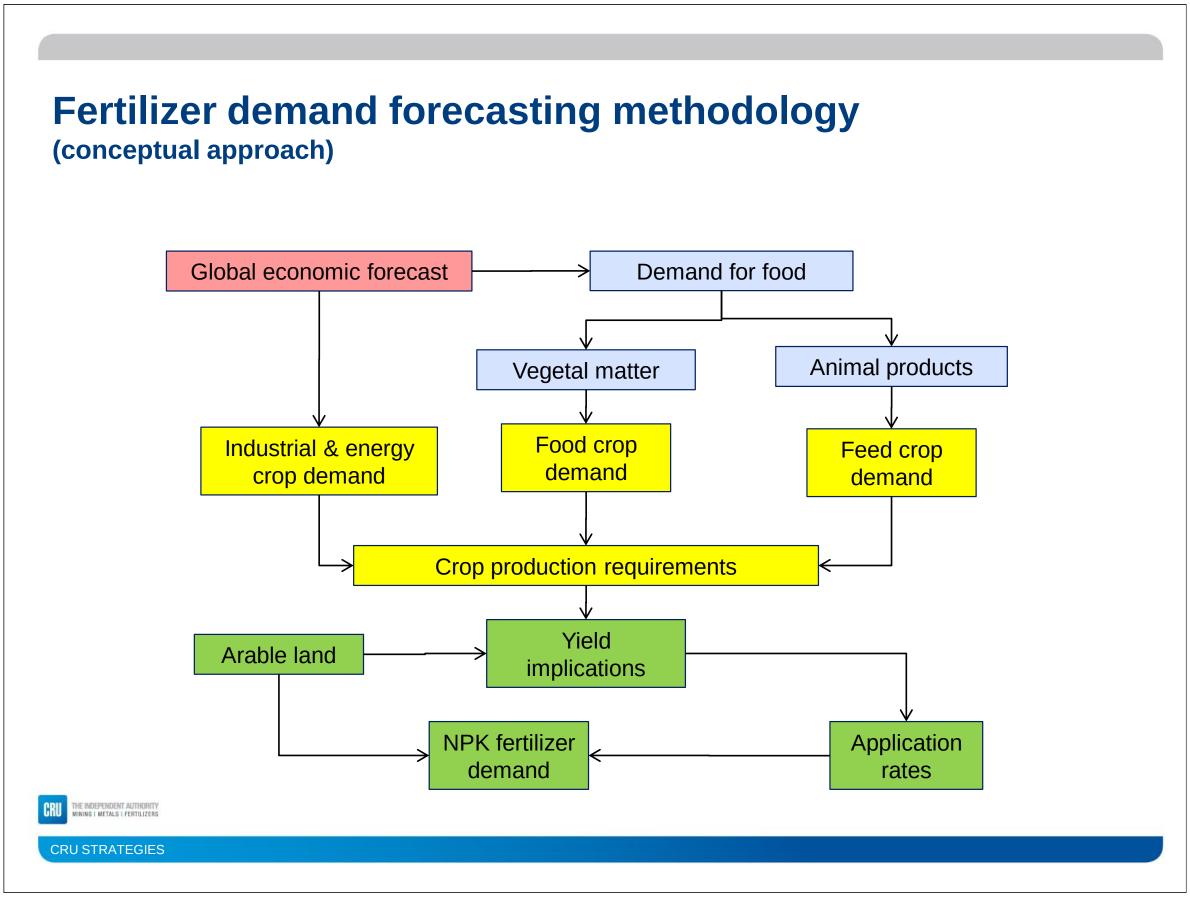
The final chapter pulls together the above information into an assessment of the probable netback value of the ore FOB Montreal. It takes account of the probable premium that the project will earn because of its high rock quality as well as the transportation logistics to various markets. We provide a variety of netback values reflecting the different geographic markets in which the project may be able to secure sales.

Chapter 2 – Global agricultural outlook

2.1 Methodology

Approximately 88% of phosphate rock ultimately ends up in fertilizers. Demand is therefore driven by the global production of agricultural crops. The use of fertilizers is one of the ways in which yields can be improved on existing arable land and one of the ways in which marginal lands can be converted to arable uses. In turn, crop production is a function of the demand for agricultural products for human consumption, both directly and indirectly via consumption of animal products that creates a demand for animal feed. In addition to this, some crops also have industrial and energy uses. Finally, human food consumption, industrial production, and energy supply are all a function of broader economic growth.

CRU's methodology captures all of the key components in this dynamic process as summarized in the following conceptual diagram.



Fertilizer demand forecasting methodology

(conceptual approach)

Global economic forecast

Demand for food

Vegetal matter

Animal products

Industrial & energy crop demand

Food crop demand

Feed crop demand

Crop production requirements

Arable land

Yield implications

NPK fertilizer demand

Application rates

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This chapter describes the outlook for global agricultural production. The specific forecasting steps involved are the following:

- a forecast of the population, GDP, and per capita incomes;
- a forecast of human food consumption, divided into animal and vegetable products;
- a forecast of animal feed demand associated with the human consumption of animal products; and
- a forecast of crop demand for industrial and energy products.

Chapter 3 below then takes this forecast and develops the implications for fertilizer demand with specific emphasis on phosphate fertilizers.

2.2 Population growth and incomes

2.2.1 Historical trends

The past five years have witnessed a significant deterioration in the rate of growth of the world economy when compared with previously established long-term trends. The most recent five-year average growth rate is now under 2% compared with 3.5% in the late-1990s. The following table summarizes economic trends by major regions since 1980. It highlights some of the major global shifts over this period including the maturing of the advanced Asia-Pacific economies since 1990, the rise of China and India, the meltdown of the former Soviet Union in the 1990s, and the Latin American debt crisis of the 1980s.

Table 2.1: World GDP by region, 1980-2012

Region	1980-85	1985-90	1990-95	1995-00	2000-05	2005-10	2007-12
North America	3.2%	3.2%	2.4%	4.3%	2.4%	0.8%	0.6%
Europe	1.7%	3.1%	1.4%	2.9%	2.0%	1.0%	-0.1%
Asia-Pacific, advanced	4.5%	5.3%	2.5%	1.9%	2.0%	1.4%	0.8%
Latin America	0.9%	2.0%	3.2%	3.2%	2.5%	3.7%	3.0%
Russia & CIS	3.1%	1.2%	-9.8%	1.6%	6.8%	4.0%	2.3%
China	10.7%	7.9%	12.3%	8.6%	9.8%	11.2%	9.3%
Asia-Pacific, developing	4.2%	6.9%	7.0%	2.9%	5.0%	5.2%	4.5%
India	5.0%	5.8%	5.1%	6.2%	6.6%	8.5%	7.4%
Middle East	-0.9%	1.9%	3.1%	4.2%	4.4%	4.6%	3.9%
Africa	1.3%	2.5%	1.3%	3.5%	4.7%	4.8%	3.7%
Total	2.6%	3.5%	2.1%	3.4%	2.8%	2.3%	1.6%

Source: CRU

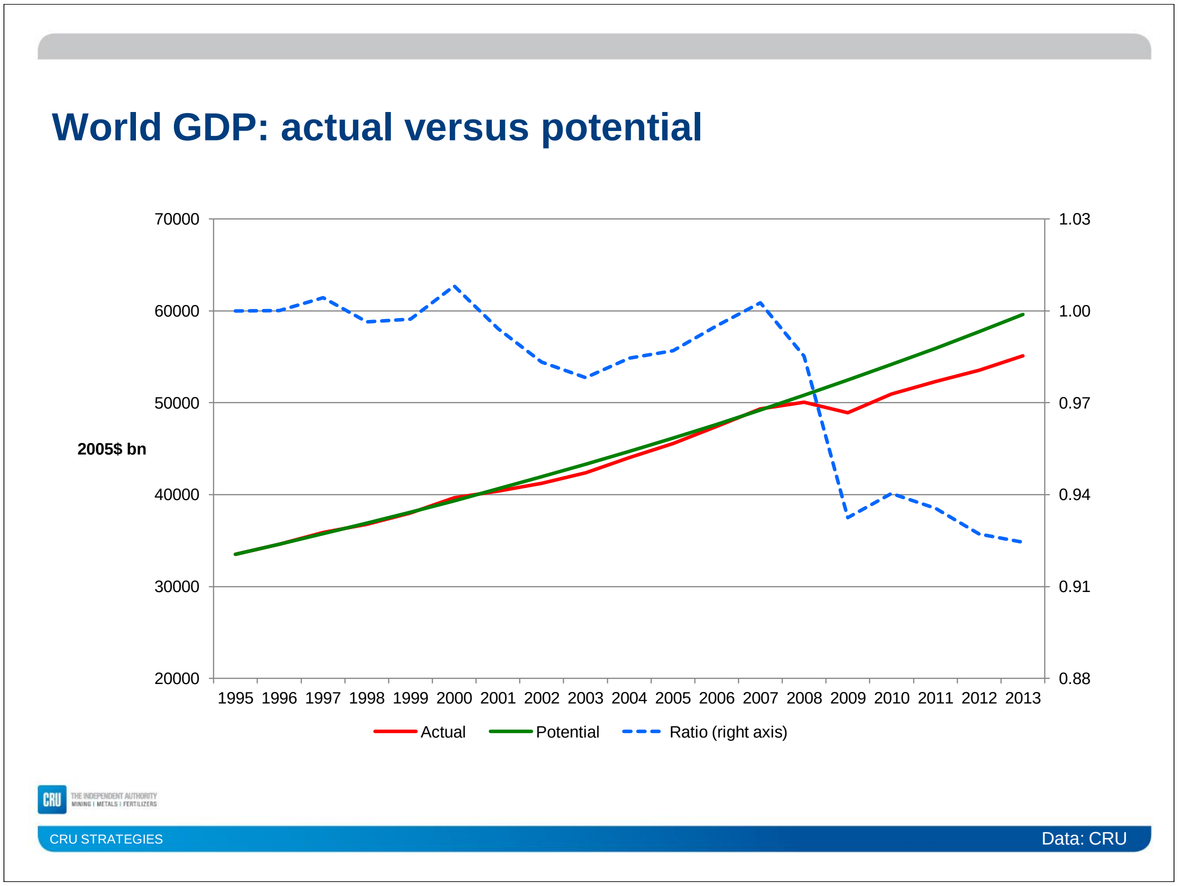
The principal reason for the current weakness in the global economy is the absence of significant growth in the advanced industrial countries that can be traced to the global financial crisis of 2008, the very slow subsequent recovery, and the more recent uncertainties associated with fiscal and monetary imbalances in Europe.

There has also been some slowdown in Chinese economic growth, but the extent of this has been relatively small and growth rates remain high in absolute terms. Likewise, most of the developing countries continue to experience positive growth rates compared with earlier periods. In particular, it will be noted that India’s growth has accelerated to 8.5% in the period 2005-2010 – a level that is comparable to 8.6% recorded in China in the period 1995-2000 – thus giving rise to hopes that India may be on the point of repeating the Chinese economic miracle.

The last period of comparable weakness in the global economy was between 1990 and 1995. At that time the key factor was the collapse of the economy of the former USSR. Clearly, what is going on today in North America and Europe is in no way comparable to the Soviet experience, but its global economic impact is broadly similar.

2.2.2 Current situation and the business cycle

The failure of the economies of the advanced industrial countries to recover properly from the global financial crisis is illustrated in the following chart. This compares the actual trend of world GDP with its potential.



World GDP: actual versus potential

Data: CRU

Up to approximately 2007, actual GDP fluctuated very closely around its potential level. The Asian financial crisis in the late-1990s caused a small gap, but this was closed by 2000. The so-called "dot-com bust" recession and the aftermath of the 9/11 terrorist attack in the United States caused a somewhat larger discrepancy between actual and potential GDP, but again this was recovered by 2007. The global financial crisis has proved to be a far more severe cycle. It is now clear that the world economy has not recovered these losses. At best, the situation has been stabilized at a level involving considerably underutilized capacity and suboptimal employment levels around the world. Even this stability may be an optimistic interpretation of what is going on, given the current European financial crisis.

CRU's short-term assessment of the global economy is that the primary uncertainties lie in Europe, specifically in the impact of potential defaults by governments in weaker countries such as Greece. The key issue is whether the core European economies, particularly Germany and France, are willing to provide what essentially amounts to unlimited financial support to Greece (and possibly some other minor economies) to confine any default or exit from the Euro and in particular to prevent contagion from spreading to larger economies such as Italy and Spain. This almost certainly involves a significant sacrifice of political sovereignty as well as the willingness of the richer parts of Europe to effectively transfer wealth to the poorer parts – much as happened between West and

East Germany in the 1990s. CRU's base case forecast is that Europe will, in the end, provide this support, because in the final analysis we believe the EU has delivered a half century of peace and relative prosperity that no significant European constituency wants to jeopardize.

CRU's base forecast is that the recovery in North America and the industrialized Far East countries will continue at relatively modest rates compared with past cycles, mainly because of the significant financial constraints faced by policymakers. Eventually the US will need to tackle its unsustainable deficit if it is to avoid a significant acceleration of inflation. The least painful way to do this is through export-led expansion. However, this will be difficult as long as Europe remains depressed and the dollar remains relatively strong in its capacity as a safe-haven currency.

Finally, it is now becoming clear that the days of double-digit growth in China are probably over. The Chinese government has an excellent track record of delivering on five-year plans, and we note in this context that the current plan is for somewhat slower growth. However, CRU's view is that Chinese pessimism is misplaced. Growth rates in the 8% range are still significant and, because the base of the economy is so much larger, the absolute increase in activity associated with such growth rates is comparable to what has been experienced in the past decade.

The following table presents CRU's current base case growth projections for the short term.

Table 2.2: Current economic situation and short-term outlook

	2007	2008	2009	2010	2011	2012	2013
North America	1.9%	-0.3%	-3.4%	3.0%	1.8%	2.1%	2.3%
Europe	3.3%	0.3%	-4.2%	2.2%	1.8%	-0.4%	0.6%
Asia-Pacific, advanced	3.2%	0.0%	-3.6%	4.9%	0.7%	2.0%	2.4%
Latin America	5.5%	3.9%	-2.0%	6.0%	4.3%	3.2%	3.9%
Russia & CIS	8.9%	5.4%	-6.8%	4.9%	4.9%	3.9%	3.7%
China	14.2%	9.6%	9.2%	10.4%	9.2%	8.0%	8.7%
Asia-Pacific, developing	6.5%	4.2%	1.7%	7.4%	4.6%	5.0%	5.7%
India	9.7%	7.5%	7.6%	8.2%	7.5%	6.3%	7.6%
Middle East	5.4%	5.6%	1.3%	4.8%	4.4%	3.5%	4.0%
Africa	6.0%	5.0%	2.4%	4.7%	1.9%	4.6%	4.9%
Total	4.0%	1.5%	-2.3%	4.1%	2.7%	2.2%	2.8%

Source: CRU

2.2.3 Long-term trends and structural issues

CRU's assessment is that the long-term outlook for the global economy revolves around a fairly limited number of key questions that include primarily the following.

- Will the European and North American economies be able to make the structural reforms necessary to restore economic growth to its full potential rather than following a path similar to that experienced by Japan since 1990?
- How quickly will the Chinese economy slow down? More specifically, will China be able to repeat, in the interior regions of the country, the development model that has been so successfully implemented in the coastal regions over the last 20 years?
- Will any other large-population, developing country – India being the most obvious initial candidate – repeat the Chinese experience or will they find an alternative development path?
- Will world economic growth be limited by energy constraints, either geological or as a product of political disruption, or will technological innovation succeed in overcoming any such constraints?
- Will potential climate change lead to a food crisis that will undermine global economic development, or will technological innovation succeed in offsetting any such tendencies?

The major structural issue facing the advanced industrial economies is the rising proportion of the elderly population and the related increase in the cost of pensions and health care, which is often seen as a burden on the productive economy. CRU does not believe these problems are economic in nature. Instead, we have concluded that they are essentially political. The demographic challenge can be met by the expediency of people working longer and retiring at a later age. Since the physical working environment in most sections of the economy is considerably less demanding than a generation ago and since life expectancy has increased, this represents an eminently feasible economic solution. The barriers to this change are cultural and political in nature. An alternative solution, namely increased immigration from the Third World, also raises political issues. CRU believes that North America has a significantly better appreciation of the choices that will need to be made than either Europe or Japan. Consequently, in our base case forecast North America continues to somewhat outperform these regions.

Thanks to its rapid growth in the last quarter century, China has become one of the most unequal countries in the world. Per capita income in the poorest regions of China is between one-fifth and one-sixth of incomes in the major metropolitan provinces such as Beijing, Tianjin, and Shanghai. This compares, for example, with a factor of less than three between Mississippi and Connecticut in the United States. However, the history of many countries, including Italy (poor south/rich north) and the UK (rich south/poor north), shows that regional income discrepancies can persist even in the face of very substantial government fiscal measures and policies designed to reduce them.

Germany has achieved a somewhat better record in closing the gap in living conditions between the eastern and western portions of the country since reunification, but there is still a significant gap and the size of the transfer payments required has been truly massive.

This experience suggests that “catch up” in interior China is far from automatic. It is unlikely that central China will be able to follow the same export-led manufacturing model that worked so well in coastal China if only because it has to compete with coastal China in overseas markets. For this reason central China will need to depend more on the growth of the domestic consumer market.

In CRU’s opinion, Indian economic development is not likely to mirror that of China for a number of reasons, not the least of which is that India has a democratic political system. This requires a much higher level of consensus than in China. Building consensus is inevitably time consuming. In practical terms, the symptom of this is a more burdensome regulatory environment facing business, which is highly visible, for example, in the case of industries like mining and metallurgy. Moreover, Indian manufacturing companies will have to compete with those from China in developing export markets. As a result of this, CRU believes India will have a somewhat slower rate of growth than that experienced in China and that it will be more balanced across different economic sectors. This means a less metals-intensive development profile particularly. Other large-population developing countries appear to be somewhat behind India in terms of potential breakthrough and under our base case forecast are likely to become a factor only towards the end of the period under consideration.

Energy remains a key uncertainty in the global economy. Oil is unique among commodities in that it appears to be facing possible long-term supply constraints. CRU does not believe in the “peak oil” theory as a representation of geological reality. However, it is clear that unconventional sources of oil are already required to meet demand at the margin and that the production costs associated with these are considerably higher in real terms than conventional resources. Currently, our base case forecast assumes the Canadian tar sands represents the long-run marginal source of supply and will thus dictate the trend of prices. Frankly, this implies that oil prices may very well be uncompetitive with those of natural gas (particularly post-shale technology) and coal. Thus, our base case forecast envisages that oil demand will grow quite slowly and that oil will increasingly be reserved for markets where it has unique advantages, primarily in the transportation sector. The logic of this argument is that there will be a decoupling between the oil and gas prices in the base case forecast.

In recent years food security has re-emerged as a potential source of global economic disruption. This used to be a chronic issue in the 1950s and 1960s but was largely addressed by the green revolution. Until recently, food prices were declining relative to other commodities. This led to various forms of protectionism for farmers in rich countries and considerable agricultural distress in poor ones. Global climate change clearly has the potential to effect the availability of water and, therefore, agricultural production in a number of key parts of the world. However, as with energy, there is considerable untapped technological potential to address this issue. At the simplest level the use of fertilizers, particularly potash and phosphates, is well below technically optimal levels because of a combination of financial and educational reasons. Longer term, technologies such as genetically modified foods, while extremely controversial, could help to address the challenges of global food security by improving productivity and reducing waste. Water is another agricultural issue whose significance is increasing. However, the use of water in agriculture is exceedingly inefficient in virtually every country in the world, which indicates that there is large potential for improvement as has been demonstrated for many years by farming in dry countries like Israel. Consequently, CRU's base case forecast embodies the assumption that the world will continue to adapt successfully to climate change.

Against the background of these core issues, CRU's global economic forecast is built from three fundamental assumptions, namely:

- the rate of population growth;
- the rate at which the population is employed in the formal economy; and
- productivity per employee.

The following table summarizes our assumptions regarding population growth. These numbers are taken from population statistics provided by the UN.

Table 2.3: World population, 2000-2035, mn

Region	2000	Annual Growth	2010	Annual Growth	2020	Annual Growth	2035
North America	313.2	1.0%	344.4	0.8%	374.3	0.7%	413.8
Europe	586.3	0.5%	615.4	0.3%	634.4	0.1%	647.3
Asia-Pacific, advanced	223.7	0.3%	231.6	0.2%	236.3	-0.1%	234.2
Latin America	504.7	1.3%	573.4	1.0%	635.9	0.7%	706.0
Russia & CIS	276.2	-0.1%	273.6	0.1%	276.3	-0.1%	271.9
China	1246.9	0.6%	1318.1	0.3%	1364.0	0.0%	1357.7
Asia-Pacific, developing	840.8	1.4%	966.1	1.2%	1085.4	0.8%	1223.4
India	1053.9	1.5%	1224.6	1.3%	1386.9	0.9%	1579.8
Middle East	188.9	2.5%	242.9	2.0%	295.8	1.5%	369.7
Africa	811.1	2.3%	1022.2	2.3%	1278.2	2.0%	1713.1
Total	6045.6	1.2%	6812.4	1.1%	7567.5	0.8%	8516.8

Source: UN Population Statistics

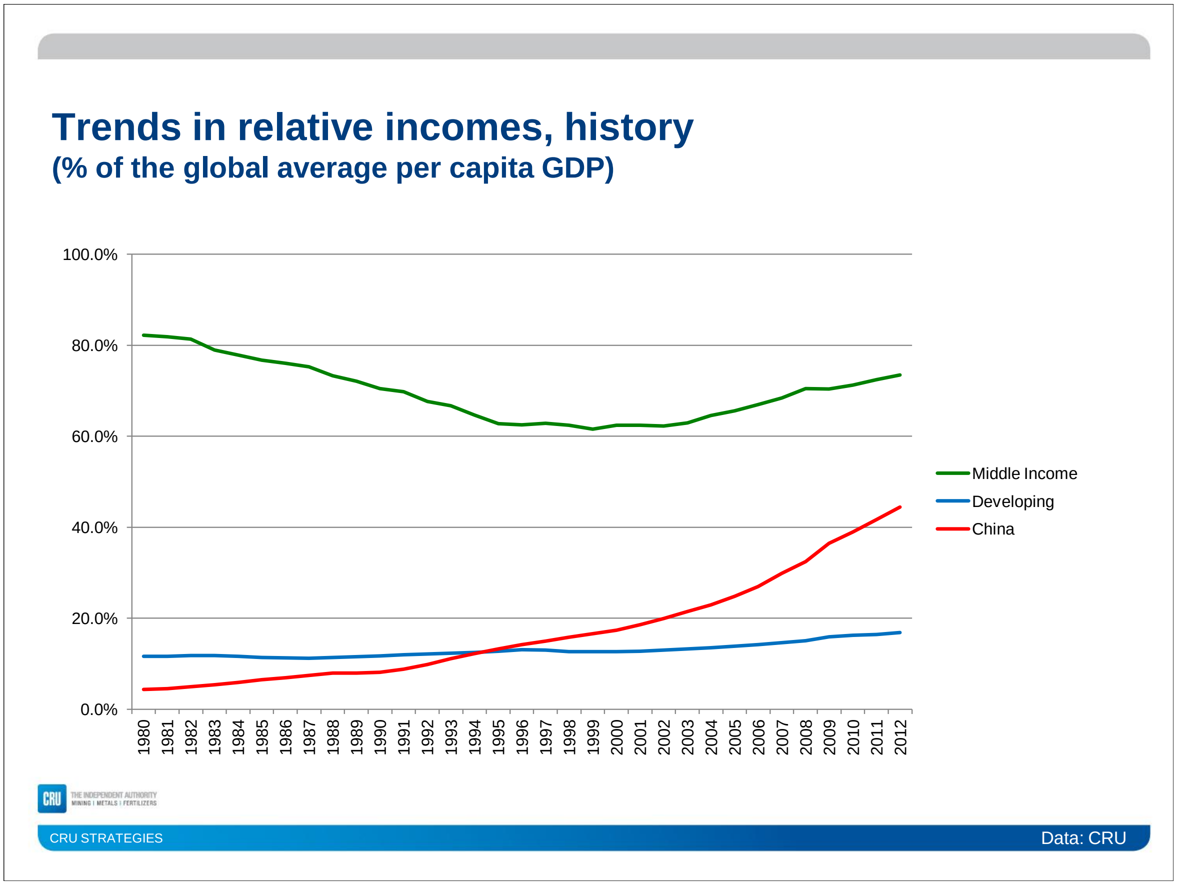
The world's population growth is slowing down. It is essentially zero or declining in all of the advanced industrial countries and Russia. North American growth almost entirely reflects immigration. China also has near zero growth due to the success of its one-child policy. We assume that this policy will shortly be relaxed; otherwise, the population will begin to decline. In the developing countries, population growth tends to slow down as living standards rise. Hence, Asian growth is slowing more noticeably than that of Africa.

Apart from short-term changes related to fluctuations in the business cycle, employment rates tend to be fairly stable around the world and to reflect two basic factors:

- economic development; this typically increases employment rates by moving people from subsistence agricultural activities into the advanced industrial sector where employment is formalized; in this context, Africa has relatively low participation rates compared with other areas of the world; and
- population growth; as population growth slows, there is a risk that employment rates will decline because a higher proportion of the population will be retired; however, as discussed above, CRU's base case assumption is that this is unsustainable and that people, especially in advanced industrial countries, will begin to retire at later dates than is currently assumed.

CRU's forecast therefore involves relatively stable long-term employment rates in urbanized economies, while rates in developing countries gradually increase as economic development progresses.

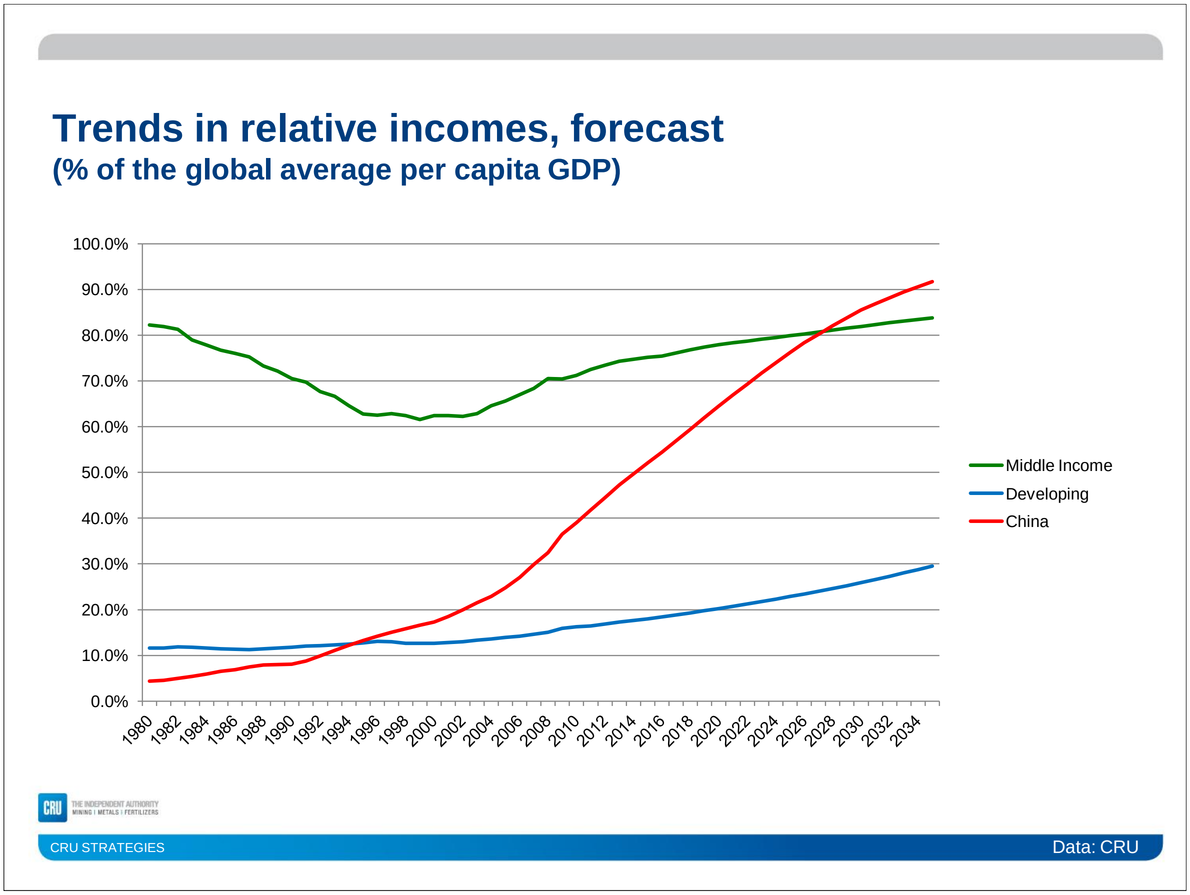
In our opinion, the key uncertainty with respect to any long-term economic forecast is the trend of productivity and, by implication, per capita incomes. The following chart shows how per capita incomes outside the industrial world have developed over the period 1980-2012. For the purpose of this chart, middle-income countries are defined as Latin America, Russia and the Middle East, while developing countries include India, Africa, and other Asian-Pacific countries. China is shown separately.



Prior to 2000 global economic development was unimpressive. Middle-income countries were getting poorer relative to industrial countries, implying that their productivity growth was not keeping pace. The Latin American debt crisis in the 1980s and the meltdown of the former USSR in the 1990s were the main drivers of this depressing performance. Poor countries were basically treading water at income levels, and this therefore implied productivity levels around one-tenth those of the industrial world. Only China was catching up during this period and relatively modestly.

Since 2000 the situation has significantly improved. There are clear signs of accelerated productivity growth in middle-income countries. High oil prices have certainly assisted in the Middle East and Russia, while a combination of improved commodity prices and improved political governance and economic management have helped many, but not all, Latin American countries. China’s growth has, of course, dramatically accelerated and has, in fact, been the major feature of the global economy in the last decade. In addition, the above chart shows that a modest improvement is now taking place in the rest of the developing world, probably facilitated by improving terms of trade for many commodities.

CRU’s forecast is that these trends will continue. By 2020 we expect the middle-income countries to have achieved a relative income level back to their 1980 position; thereafter, we continue to expect modest gains. We predict that China will become a middle-income country by 2035, at which time its relative pace of development will start to ease. Finally, we expect a noticeable acceleration in the pace of development for poor countries, particularly after the period 2020-2025. By 2035 we believe it is reasonable that these countries can aspire to reach the relative position that China currently occupies. These forecasts are presented graphically below, and the subsequent table presents this forecast in numeric terms, showing the productivity assumptions implicit in the relative income forecast just discussed.



Trends in relative incomes, forecast
(% of the global average per capita GDP)

Data: CRU

Table 2.4: Productivity and incomes by region, long-term trends, 2005$

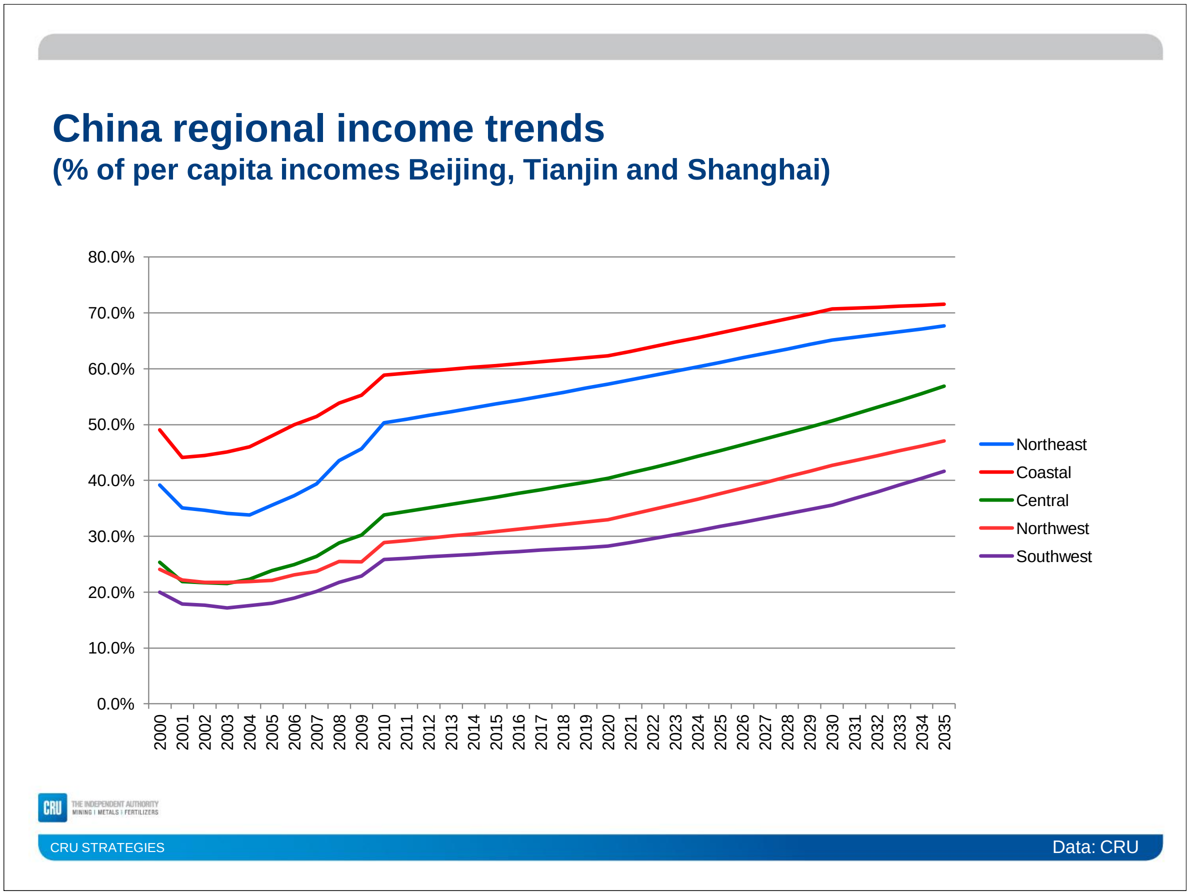
	Productivity/Employee			Income/Capita		
Region	**2010**	**2020**	**2035**	**2010**	**2020**	**2035**
North America	91547	103062	126951	41498	48569	60256
Europe	61792	70783	89035	25699	29404	36622
Asia-Pacific, advanced	63936	75694	95332	31423	37428	45845
Latin America	12077	15176	19849	5571	7361	9757
Russia & CIS	9112	13326	23747	4448	6461	11691
China	5053	10264	21234	2913	5884	11277
Asia-Pacific, developing	3437	4760	7706	1488	2179	3612
India	2464	4382	10882	993	1824	4756
Middle East	18623	21281	29066	5783	7177	10369
Africa	4687	5289	7200	1221	1570	2562
World, average	17342	20750	27735	7478	9143	12318

Source: CRU

The Chinese component of this forecast reflects a forecast that China will be reasonably successful in closing the gap between poorer inland regions and coastal regions. In this respect we are making the following assumptions:

- coastal and north-eastern China will continue to catch up to metropolitan provinces albeit at a much slower rate than in the past because the major urban structure is complete in the coastal regions;
- with a total population of 400 million people, central China is the key region to monitor for the future; on our base case forecast, its rate of catch up will accelerate to the point where it is within 10-15% of coastal China by 2035; and
- northwest and southwest China will also catch up but at less rapid rates; in these regions relative income levels will reach 40-50% of the metropolitan areas by 2035.

If realized, these assumptions imply that China will resemble today’s advanced industrial economies in terms of relative income distribution by around 2035. The above assumptions are presented graphically in the following chart, and the subsequent table presents this forecast in numeric terms showing the productivity assumptions involved in the above relative income forecasts.



China regional income trends

(% of per capita incomes Beijing, Tianjin and Shanghai)

CRU STRATEGIES

Data: CRU

Table 2.5: Chinese regions: per capita productivity and income, 2005$

	Productivity/Employee			Income/Capita		
Region	**2010**	**2020**	**2035**	**2010**	**2020**	**2035**
Metropolitan	13021	23095	37749	6473	11768	18044
North East	6808	14066	27520	3256	6734	12207
Coastal	6442	12445	23650	3809	7332	12913
Central	3724	8163	19008	2189	4754	10260
North West	3780	7761	17886	1867	3881	8499
South West	2654	5362	13271	1673	3322	7518
China, average	5053	10264	21234	2913	5884	11277

Source: CRU

As discussed above, CRU's base case scenario assumes there are no major discontinuities arising from events in either the energy or food markets. This means that world economic growth is determined by the fundamental demographic, employment, and productivity assumptions just described. The implication for world economic growth is summarized in the following table.

Table 2.6: World economic growth by region to 2035

Region	2000-10	2010-15	2015-20	2020-25	2025-30	2030-35	2010-35
North America	1.6%	2.9%	1.9%	2.2%	2.1%	2.1%	2.3%
Europe	1.5%	2.0%	1.4%	1.9%	1.6%	1.4%	1.6%
Asia-Pacific, advanced	1.7%	2.6%	1.3%	1.4%	1.3%	1.2%	1.6%
Latin America	3.1%	4.9%	2.9%	2.9%	2.6%	2.4%	3.1%
Russia & CIS	5.4%	4.9%	2.9%	3.9%	4.0%	3.8%	3.9%
China	10.5%	10.0%	5.4%	5.6%	4.3%	3.2%	5.7%
Asia-Pacific, developing	5.1%	6.4%	3.8%	4.4%	4.3%	4.1%	4.6%
India	7.5%	9.1%	6.1%	7.7%	7.5%	7.4%	7.6%
Middle East	4.5%	4.8%	3.6%	4.4%	4.0%	3.6%	4.1%
Africa	4.7%	5.5%	4.3%	5.7%	5.3%	5.1%	5.2%
Total	2.5%	3.8%	2.5%	3.0%	2.8%	2.6%	2.9%

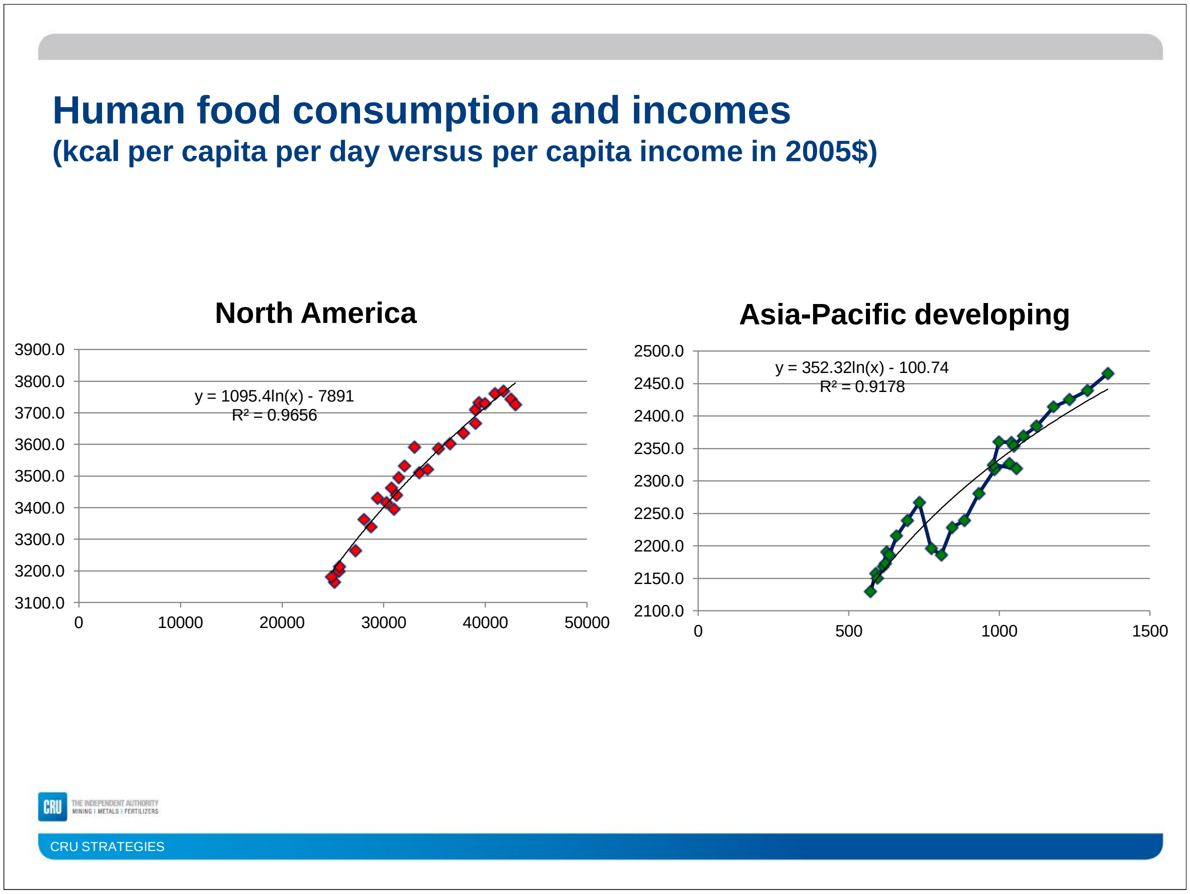
Source: CRU

Looking forward, CRU is projecting growth rates in the world economy in the range of 2.75-3.00% over the long term, with a somewhat higher rate in the initial five-year period reflecting a delayed cyclical recovery from the 2008/2009 global financial crisis. The geographic composition of this growth, however, changes considerably. Economic growth in China is down to 3% per annum by 2030, and India then becomes the leading growth economy in the world. The advanced industrial economies grow at not much more than 2% per annum, suggesting that they will contribute very little to the rate of growth of demand for basic commodities over this period.

2.3 Food requirements

CRU's analysis of human food requirements is based on food supply balance data available from the UN Food and Agricultural Organization (FAO). This database covers some 186 countries, which represents 98% of the world's population. The primary areas excluded from analysis are those that have been characterized by chronic warfare such as Afghanistan, Iraq and Somalia, as well as certain non-member countries, such as Taiwan, and city states with little or no agricultural activity, such as Singapore and Hong Kong.

The FAO database runs from 1961 to 2007. However, human food requirements display sufficiently stable trends such that CRU considers this database to be a reliable basis for forecasting. A statistical analysis of human food consumption data reveals that for most parts of the world there is a fairly close correlation between per capita incomes and food consumption over time. The following chart shows this relationship for North America, the highest income region in the world, and for the Australia/Pacific developing country region, one of the poorest in the world.

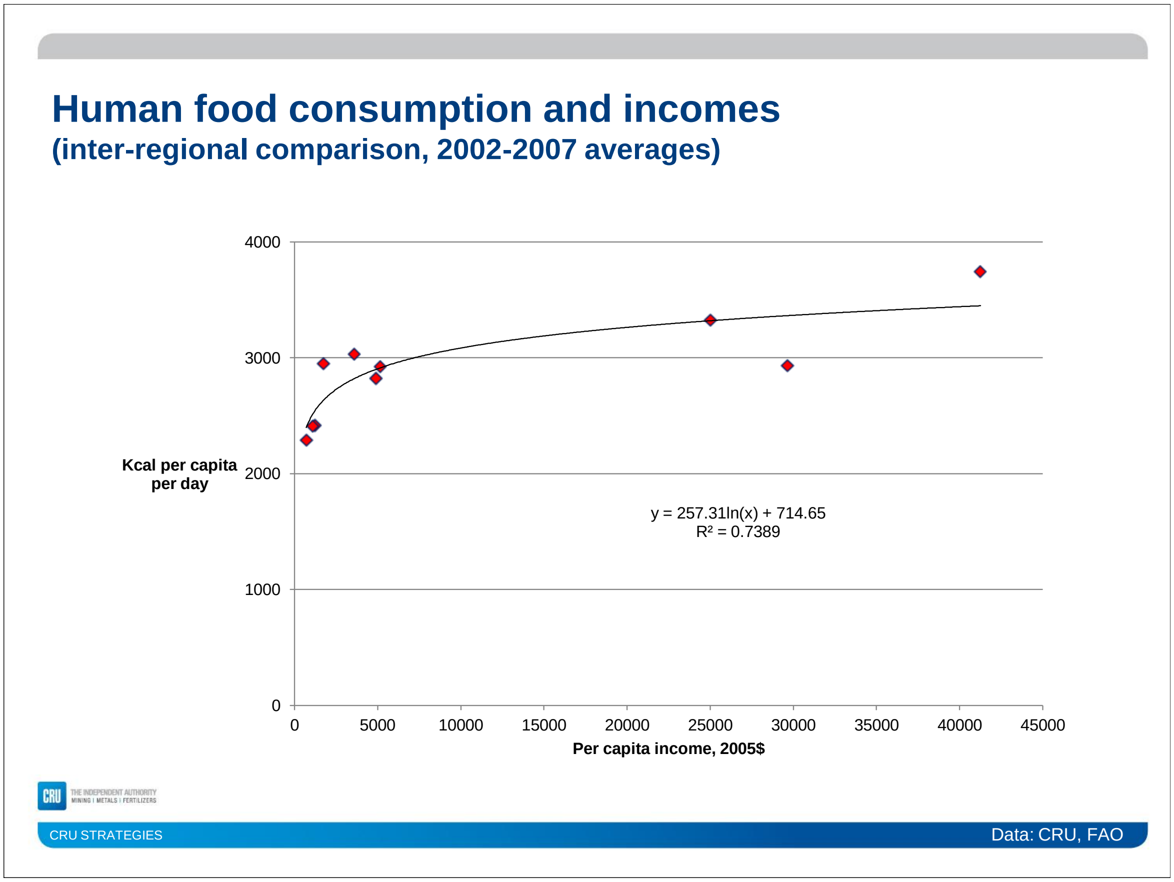


Human food consumption and incomes

(kcal per capita per day versus per capita income in 2005$)

CRU has determined that there are very good statistical relationships of this kind for all the regions of the world apart from the Asia-Pacific industrial countries, the Middle East, and Africa. In the case of the Asia-Pacific industrial countries, the statistical relationship is markedly weaker than elsewhere in the world, but it still displays a similar form and slope to that of other regions. Therefore, our conclusion is that it can be used for forecasting purposes. In the Middle East and Africa, however, there is no statistically significant relationship between calorie consumption and per capita income in the historical data.

The slope of the curves shown in the above slide differs according to the stage of development of the economy. Further insight into this is available through a cross-sectional analysis of the data. The following chart contains such an analysis for the period 2002-2007 and relates per capita incomes and food consumption across regions.



Human food consumption and incomes

(inter-regional comparison, 2002-2007 averages)

CRU STRATEGIES

Data: CRU, FAO

This chart shows that human food requirements, expressed in kilocalories per capita per day (kcal/cap/d), rises from a minimal level of around 2000 kcal at subsistence income levels to around 3000 kcal at income levels around $5,000 per year. This is an income level that roughly corresponds to today's middle-income economies. Beyond this point, calorie consumption continues to rise, but at a much slower rate until it reaches roughly 3500 kcal/d at North American income levels.

It must be noted that these figures are gross calories that are supplied to the market rather than the net calories actually consumed by people. It has been estimated in various sources that between 20% and 40% of all food is wasted at the post-production stage.[1] Using a figure in the middle of this range, net calorie consumption in rich countries appears to be around 2450 kcal/cap/d. This is consistent with human energy requirements. In fact, it is somewhat above the ideal level and is thus compatible with the observation that most advanced industrial countries are demonstrating a

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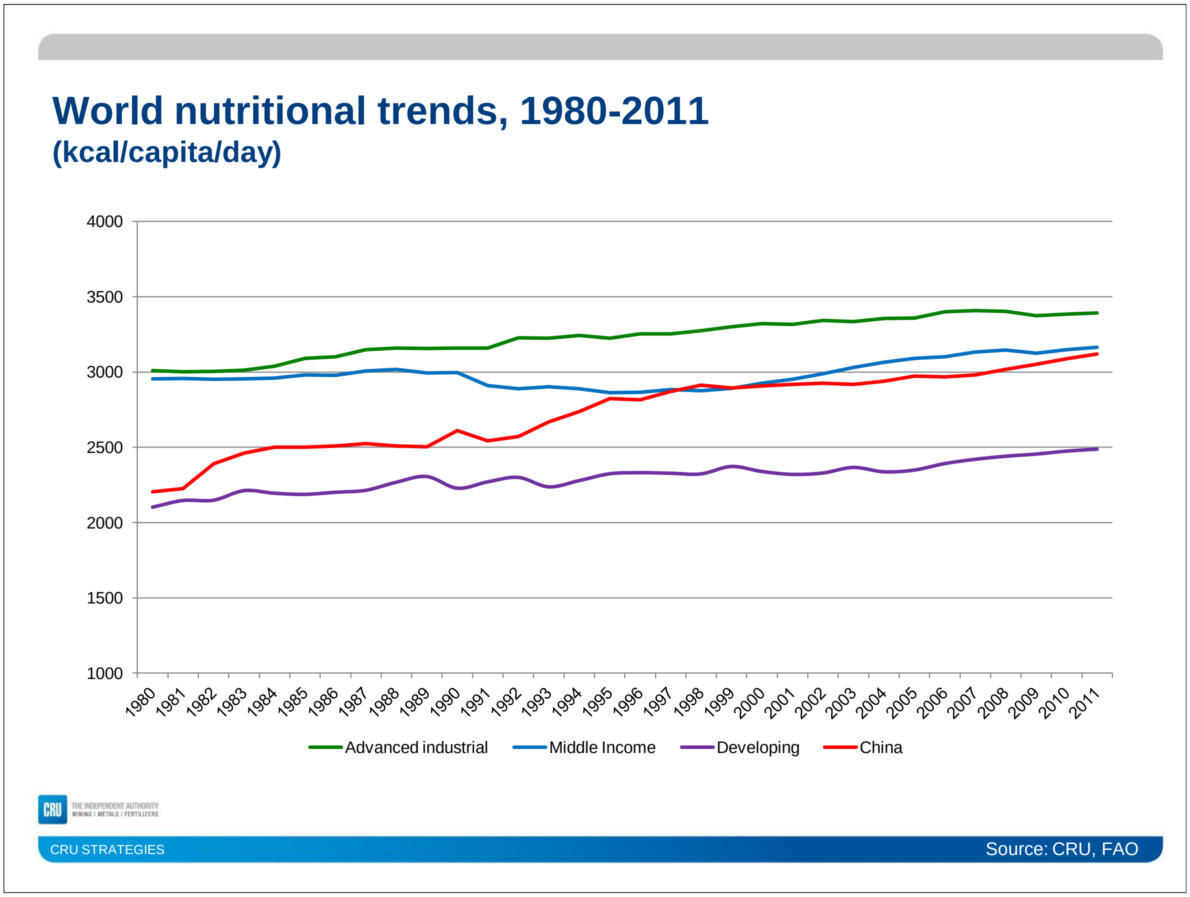
[1] There are additional substantial losses in the form of crops not harvested and crops that spoil in the trade and processing steps of the food industry (normally referred to as "pre-production losses"). The FAO data takes such losses into account but does not include losses after the food is sold to the wholesale level in the food chain.

growing trend towards obesity in their populations. Post-production waste is probably at the low end of the range in very poor countries. However, assuming a 20% post-production loss, the implication is that near-zero income people will have only around 1600 kcal/cap/d on a net basis. This is significantly lower than the 1900 kcal/cap/d required to maintain an adult human[2] and therefore is consistent with widespread malnutrition in such societies.

The following chart shows food demand trends over the past 30 years in terms of calorific consumption.



World nutritional trends, 1980-2011
(kcal/capita/day)

Source: CRU, FAO

Both the advanced industrial countries and the developing countries have experienced increases in per capita food consumption as their incomes have improved. For middle-income economies, however, the trend has been flat. Most of this can be traced to a significant structural change that occurred when the USSR economy collapsed in the 1990s, which significantly reduced calorie

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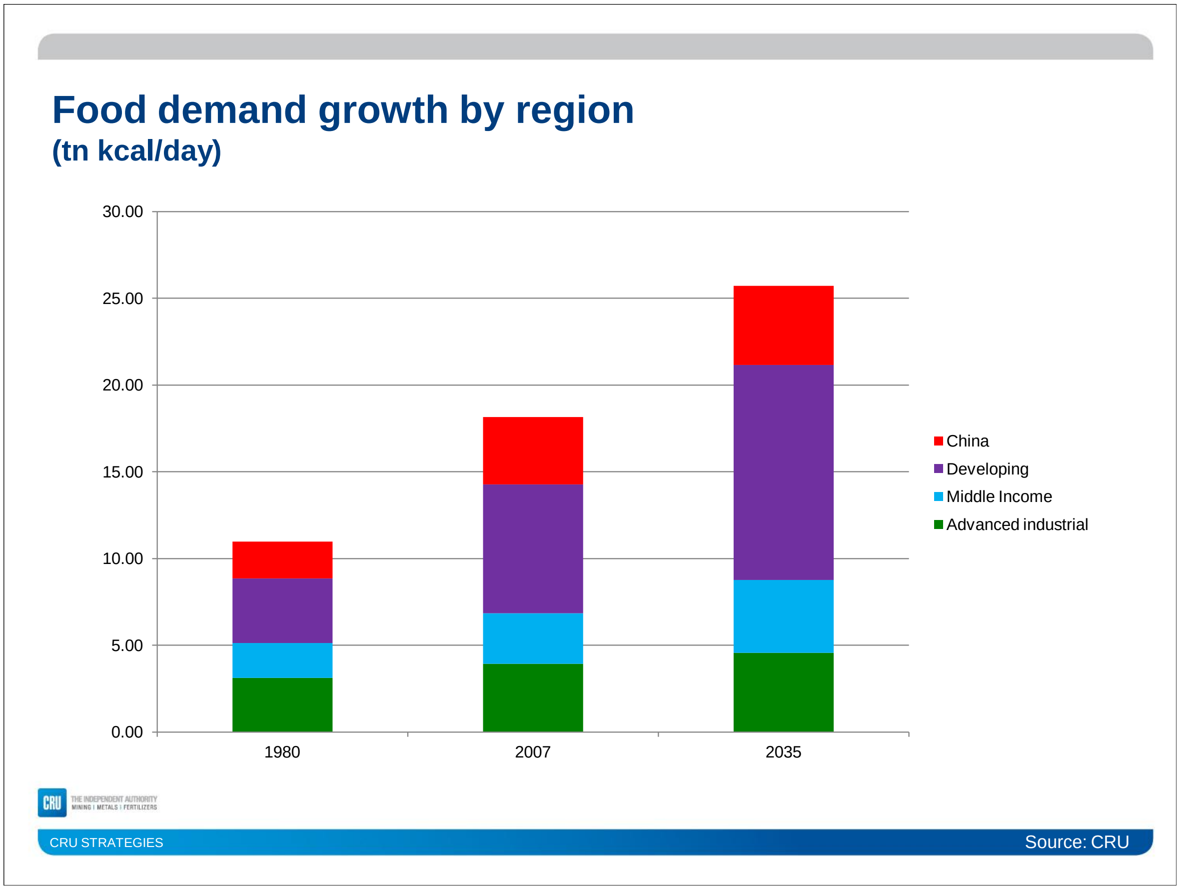
[2] This is based on the Harris-Benedict formula and assumes a 32-year-old man with a height of 167 cm and a weight of 64 kg and a 35-year-old woman at a height of 152 cm and weight of 45 kg, both of which conduct moderate levels of activity.

consumption in that country. The most striking feature in this chart is the increase in food consumption in China, which now has a calorie level that is broadly equivalent to a middle-income country, whereas it was similar to the developing country group in 1980.

When trends in calorie consumption are combined with population growth forecasts, the result is a very substantial increase in global food requirements. The following chart shows that this rose by 65% between 1980 and 2007. Projecting these trends forward, our global forecast is that by 2035 world food requirements will be around 2.35 times greater than they were in 1980. Most of this growth occurs in middle-income and poorer countries, because advanced countries are experiencing little or no population increase and have already reached high, and some would say excessive, daily calorie consumption levels.



Source: CRU

In making its projections of future food requirements, CRU uses a weighted average of the forecasts produced by the cross-sectional and time series models that we have estimated. Our overall forecast of additional requirements is summarized in the following table, while the subsequent table summarizes the implications of these for the absolute size of world food demand.

Table 2.7: World nutritional requirements (gross kcal/capita/day)

Region	2000	Annual Growth	2010	Annual Growth	2020	Annual Growth	2035
North America	3711	0.0%	3713	0.4%	3859	0.3%	4040
Europe	3254	0.3%	3366	0.2%	3431	0.3%	3568
Asia-Pacific, advanced	2958	0.0%	2952	0.1%	2987	0.1%	3021
Latin America	2730	0.7%	2913	0.7%	3109	0.4%	3292
Russia & CIS	2750	1.3%	3142	0.4%	3262	0.5%	3517
China	2908	0.6%	3089	0.8%	3333	0.4%	3537
Asia-Pacific, developing	2359	0.6%	2513	0.5%	2648	0.4%	2804
India	2314	0.4%	2419	0.6%	2578	0.5%	2793
Middle East	3711	0.0%	3710	0.1%	3752	0.2%	3867
Africa	2353	0.6%	2508	0.4%	2604	0.3%	2734
Total	2734	0.5%	2861	0.4%	2992	0.3%	3138

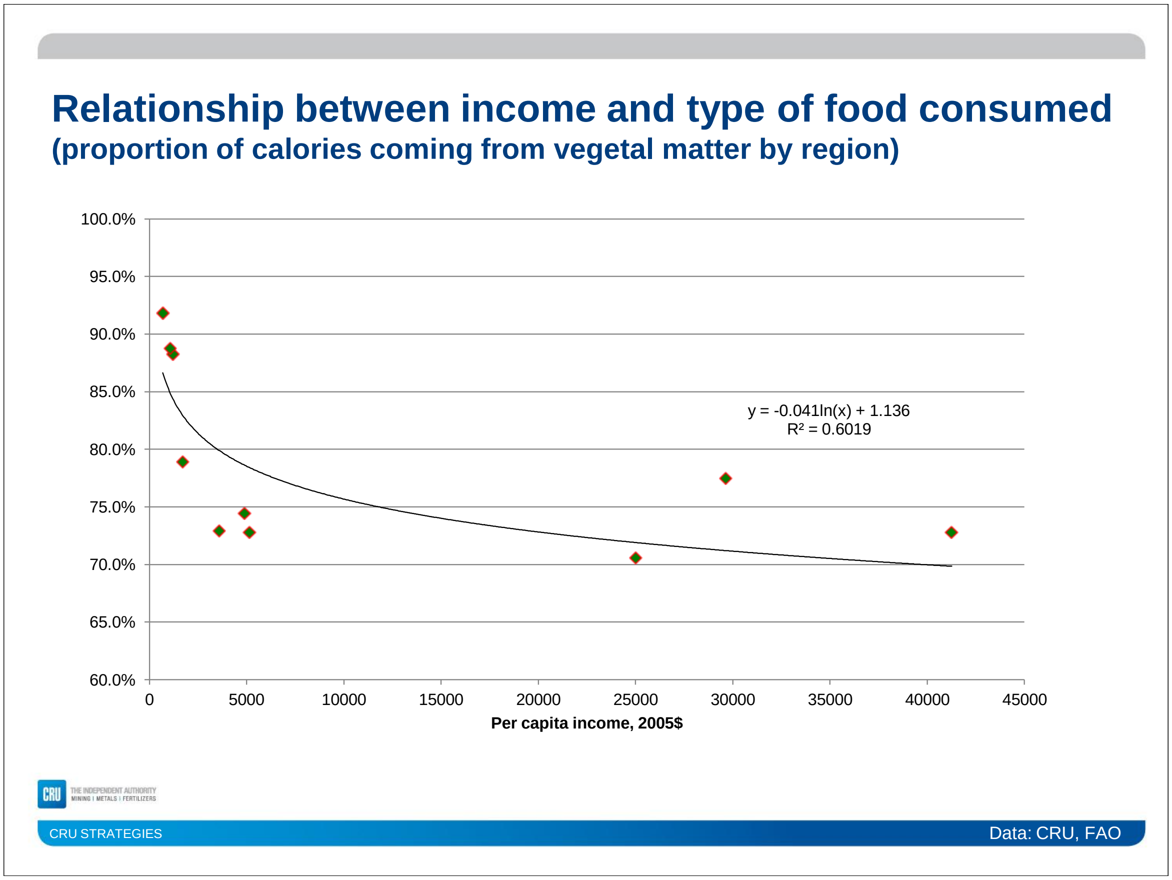
Source: CRU

Table 2.8: World food demand growth (t kcal/day)

Region	2000-10	2010-15	2015-20	2020-25	2025-30	2030-35	2010-35
Advanced industrial	0.8%	0.7%	0.7%	0.6%	0.5%	0.5%	0.6%
Middle income	1.9%	1.6%	1.5%	1.3%	1.1%	1.0%	1.3%
Developing	2.3%	2.2%	2.0%	1.8%	1.7%	1.5%	1.8%
China	1.2%	1.3%	0.9%	0.6%	0.4%	0.1%	0.7%
Total	1.7%	1.6%	1.4%	1.3%	1.1%	1.0%	1.3%

Source: CRU

Not only does income determine the absolute level of calorie consumption, but it also affects the form in which these calories are consumed. This is illustrated in the following graph, which shows the relationship between incomes and the percentage of calories that are provided in the form of vegetal matter as distinct from animal products. It is clear that rising income levels are associated with the more intensive use of animal products. In very poor countries, more than 90% of total calories are in the form of vegetable matter, whereas this figure drops to around 70% for the advanced industrial countries.



Relationship between income and type of food consumed
(proportion of calories coming from vegetal matter by region)

CRU STRATEGIES

Data: CRU, FAO

The relationship shown in the above chart does not, however, account for all of the differences between food consumption patterns in different countries. In fact, it explains only about 60% of the inter-regional differences. Much of the remainder reflects such things as the history of these societies, their culture, and the traditional availability of different food in different forms. For example, the Asia-Pacific advanced countries have a significantly greater share of vegetable products in their diets than predicted by the model. This reflects dietary preferences, because the weight of the east-Asian population far exceeds the weight of the Australasian population in this region of broadly similar income levels. CRU handles this by adjusting the forecast results for cultural and social focus on the basis of the past relationship between the demand predicted by the cross-section model and the actual values recorded.

The following table summarizes the results of our forecast for the share of total calories in vegetable matter. At the global level it is clear that rising prosperity leads to a lower share for vegetable matter and a greater reliance on animal products in overall diets. The vegetable matter share has fallen from 83.8% in 1980 to 80.4% in 2007. Our forecast envisages a further decline to 77.6% by 2035.

Table 2.9: Calories from vegetal matter, % of total human intake

Region	1980	1990	2000	2007	2015	2025	2035
North America	69.3%	72.0%	72.8%	72.7%	71.3%	70.5%	69.8%
Europe	75.5%	75.9%	70.9%	68.9%	69.8%	69.3%	68.8%
Asia-Pacific, advanced	77.1%	74.4%	77.3%	77.2%	74.7%	73.7%	73.1%
Latin America	76.1%	75.8%	75.3%	73.8%	74.3%	73.6%	74.0%
Russia & CIS	74.6%	72.4%	73.0%	71.5%	73.8%	72.9%	71.4%
China	92.0%	88.0%	80.3%	78.6%	77.1%	75.0%	73.5%
Asia-Pacific, developing	93.2%	89.6%	87.6%	87.3%	85.1%	83.5%	82.0%
India	94.1%	92.8%	92.2%	91.6%	88.5%	85.6%	82.8%
Middle East	69.3%	72.0%	72.8%	72.7%	75.2%	74.7%	73.8%
Africa	89.6%	89.0%	88.2%	88.9%	88.2%	86.9%	85.5%
Total	83.8%	83.1%	81.1%	80.4%	79.8%	78.5%	77.6%

Source: CRU

2.4 Animal feeding crops

The world’s growing demand for calories from animal products creates additional demand for crops destined to be consumed as animal feed. This primarily affects various grain products, but significant quantities of root crops are also involved in certain countries. The table below presents CRU’s forecast of the cereals required for animal feed purposes. The overall global rate of increase is expected to be 2.2% per annum through 2020 and 1.5% per annum thereafter.

This forecast rate of growth is therefore somewhat greater than the overall rate of growth of human food consumption, which is 1.5% per annum through 2020 and 1.1% thereafter. This reflects the fact that the indirect consumption of calories via animals is an intrinsically less efficient form of consumption than the direct consumption of calories from vegetal matter.

China, India and Africa are the main regions contributing to this differential growth, as these are places where we expect a significant further shift of preferences towards animal products. However, most of this effect is going to be concentrated in the period after 2020. This is because the shift to animal products occurs most rapidly in the early stages of rising per capita income and, as shown earlier, tapers off quite dramatically once incomes exceed approximately $7,500/person.

Table 2.10: Consumption of grains for animal feed (mn t)

Region	2000	Annual Growth	2010	Annual Growth	2020	Annual Growth	2035
North America	190.9	0.2%	195.0	1.5%	227.0	1.0%	264.7
Europe	297.5	1.3%	339.1	1.9%	409.4	1.4%	504.2
Asia-Pacific, advanced	31.8	0.4%	33.1	2.0%	40.4	1.5%	50.4
Latin America	66.5	-0.1%	66.0	0.4%	68.4	0.8%	77.1
Russia & CIS	51.6	0.7%	55.4	1.7%	65.4	1.2%	78.1
China	116.4	1.1%	129.3	2.6%	167.7	2.0%	226.9
Asia-Pacific, developing	23.0	9.3%	55.8	5.1%	91.7	1.4%	113.4
India	6.8	3.2%	9.3	4.9%	15.0	3.5%	25.2
Middle East	18.8	6.5%	35.4	3.8%	51.5	1.4%	63.0
Africa	22.4	3.1%	30.4	4.4%	46.9	3.2%	75.6
Total	825.7	1.4%	949.0	2.2%	1183.4	1.5%	1478.6

Source: CRU

2.5 Industrial and energy demand for crops

As is the case with animal feed, the major impact of potential energy production from crops will also be felt in the grains sector. In the United States at present, some 30-40% of the corn crop is used to produce ethanol. Admittedly, this figure is somewhat misleading, as approximately 30% of the calorific value of the corn used to make ethanol is ultimately returned as animal feed by-product. However, there is no doubt that the rising use of ethanol in the US has already made a substantial impact on the agricultural sector and is widely credited, for example, with an increase in food prices and farm incomes.

Ethanol can be produced from a number of other crops. The most important of these is sugar cane, which is the primary source of ethanol in Brazil. In theory ethanol can be produced from many other crops including potatoes and manioc. However, at present the United States accounts for over 50% of the world's ethanol production and Brazil for over 30%.

The manufacture of gasoline from ethanol is controversial. It has been alleged that in the United States this process depends for its economic viability on government subsidies and mandates requiring that gasoline contain a minimum of 10% ethanol. The scientific literature suggests that corn ethanol has a positive energy ratio (energy out divided by energy in) of about 1.3. The ratio for sugar ethanol is considerably higher – closer to 8.0. It has also been argued that ethanol demand for corn is exerting upward pressure on crop prices and therefore on food prices to the detriment not only of US consumers but the world as a whole given the importance of US grain exports in the global food balance.

This debate is technically complex, and most of the protagonists have, unfortunately, a hidden agenda of one kind or another. However, for the purposes of this study, CRU has taken a relatively cautious view of the future of ethanol. We assume that current policies will be maintained but that they will not be further intensified for the following reasons:

- the United States is becoming less concerned about dependence on imported oil, thanks to the shale gas boom; and
- most other industrial countries appear to be willing to control oil usage through taxation and carbon pricing.

The following table presents our outlook for industrial and energy demand for cereal products. Despite our business-as-usual assumptions regarding the prospects for ethanol, the growth rate of demand for cereals used in industrial and energy applications is somewhat faster than for other parts of the crop market. Global growth between 2010 and 2020 is expected to average 3.4% per annum before declining to 2.9% thereafter. The main difference with other parts of the crop market is the continuation of rapid growth in the United States as the country moves from a 10% ethanol mix in its fuel to 15%.

Table 2.11: Industrial and energy demand for cereals (mn t)

Region	2000	Annual Growth	2010	Annual Growth	2020	Annual Growth	2035
North America	58.3	3.9%	85.4	4.1%	127.6	3.6%	217.3
Europe	46.7	3.6%	66.4	3.9%	97.2	1.5%	121.7
Asia-Pacific, advanced	8.8	0.2%	9.0	1.5%	10.4	1.8%	13.7
Latin America	23.4	1.5%	27.1	0.5%	28.6	0.8%	32.1
Russia & CIS	23.2	3.1%	31.5	2.7%	40.9	2.1%	56.1
China	52.2	1.9%	62.8	3.0%	84.0	2.7%	124.7
Asia-Pacific, developing	27.1	3.5%	38.0	3.8%	55.2	3.1%	87.4
India	15.2	1.4%	17.4	3.6%	24.9	4.7%	49.9
Middle East	4.4	0.6%	4.7	2.1%	5.7	1.8%	7.5
Africa	18.2	3.2%	24.8	5.1%	40.8	4.9%	83.0
Total	277.4	2.8%	367.2	3.4%	515.4	2.9%	793.3

Source: CRU

2.6 Crop demand

The following table brings together the human food, animal food, and industrial/energy demand for crops into an overall summary of the world’s demand for different types of crops.

Table 2.12: World demand for crops, mn t

Crop Type	2000	Annual Growth	2010	Annual Growth	2020	Annual Growth	2035
Wheat	576.7	1.5%	667.9	2.4%	844.5	1.3%	1021.8
Rice	393.0	1.5%	457.9	2.3%	577.1	1.4%	707.0
Maize (corn)	608.0	2.3%	764.7	1.9%	926.5	1.4%	1133.8
Other grains	289.4	0.6%	308.6	1.5%	357.7	0.8%	404.8
Soyabeans	164.3	3.4%	230.5	1.6%	270.1	1.2%	321.4
Cotton	33.2	3.1%	45.0	0.6%	48.0	0.8%	54.3
Palm crops	6.1	6.9%	11.8	3.2%	16.1	2.0%	21.6
Other oilcrops	167.6	2.0%	205.1	1.5%	238.8	1.1%	283.2
Sugar	1497.5	2.3%	1880.4	1.2%	2112.8	1.0%	2456.4
Fruit & vegetables	1204.0	2.6%	1560.1	1.9%	1888.0	1.2%	2255.2
Other	82.8	1.6%	97.2	1.6%	113.7	1.6%	144.6
Total	5022.6	2.2%	6229.1	1.7%	7393.3	1.2%	8803.9

During the first decade of the century, world crop demand grew at 2.2% per annum, which was a full 1% per annum faster than population growth. Of this, about 0.5% can be traced to the improved nutrition levels associated with rising per capita incomes, with the balance being traced to a shift towards a higher proportion of animal products in the diet (and thus increased demand for animal feed) and to the increased demand for crops for industrial and bio-fuel purposes.

Looking forward, CRU anticipates a gradual decline in the growth of food production by about 1% by the 2030s. Half of this reflects slower population growth with the balance being attributed to a larger portion of the global population moving to income levels where food consumption does not grow as strongly as it does at lower levels.

Chapter 3 – Phosphate fertilizer demand

In order to translate the demand for crops into the demand for fertilizers, the following steps are involved:

- converting the crop demand forecast into a crop production forecast;
- decomposing the crop production forecast into a forecast of acreage cultivated and yield per acre; and
- forecasting the relationship between fertilizer application rates and yields.

These steps in the analysis and our eventual phosphate fertilizer demand forecast are discussed in this chapter.

3.1 Crop production

Converting the demand forecast expressed in terms of the human, animal, and industrial/energy crop requirements into a production forecast requires a number of adjustments, the most important of which are the following:

- year-to-year movements in food inventories; these reflect the inevitable year-to-year imbalances between the relatively stable consumption of crops and the weather-induced volatility of supply; in a long-term forecast the only reasonable assumption is that such inventory movements will have a neutral effect;
- international trade in agricultural products; although this does not affect production requirements at the global level, it determines how this production is allocated among different countries and regions; in the case of a number of crops, certain countries or regions dominate international trade (e.g. North America for grains, Asia for rice, Brazil for soybeans, Southeast Asia for palm crops, and so forth); and
- losses between the point at which crop production is measured (typically the farm gate) and the point at which demand is measured (typically the shipment of wholesale products); this is particularly noticeable for crops like oil seeds and sugar cane where production is measured at the seed and cane level, whereas demand is for oils and sugar respectively.

The following table shows CRU's forecast of global crop production by type after taking into account these adjustments.

Table 3.1: World crop production by type, mn t

Crop Type	2000	Annual Growth	2010	Annual Growth	2020	Annual Growth	2035
Wheat	585.7	1.1%	650.9	2.6%	840.9	1.3%	1018.0
Rice	599.4	1.2%	672.0	2.7%	876.6	1.4%	1078.0
Maize (corn)	592.5	3.6%	844.4	1.3%	961.7	1.3%	1168.1
Other grains	282.7	-0.6%	264.9	2.9%	352.3	0.9%	404.6
Soyabeans	161.3	5.0%	261.6	0.6%	276.4	1.1%	324.8
Cotton	53.1	2.5%	68.3	1.1%	76.4	0.9%	86.8
Palm crops	120.5	5.8%	210.9	3.7%	303.9	2.0%	409.4
Other oilcrops	103.2	1.0%	114.0	2.2%	142.2	1.2%	169.9
Sugar	1508.4	2.4%	1914.8	1.1%	2135.8	1.0%	2481.1
Fruit & vegetables	1251.6	2.3%	1574.9	2.1%	1940.5	1.2%	2322.7
Other	158.5	0.9%	173.5	2.1%	214.6	1.7%	274.6
Total	5416.8	2.2%	6750.2	1.9%	8121.1	1.2%	9737.9

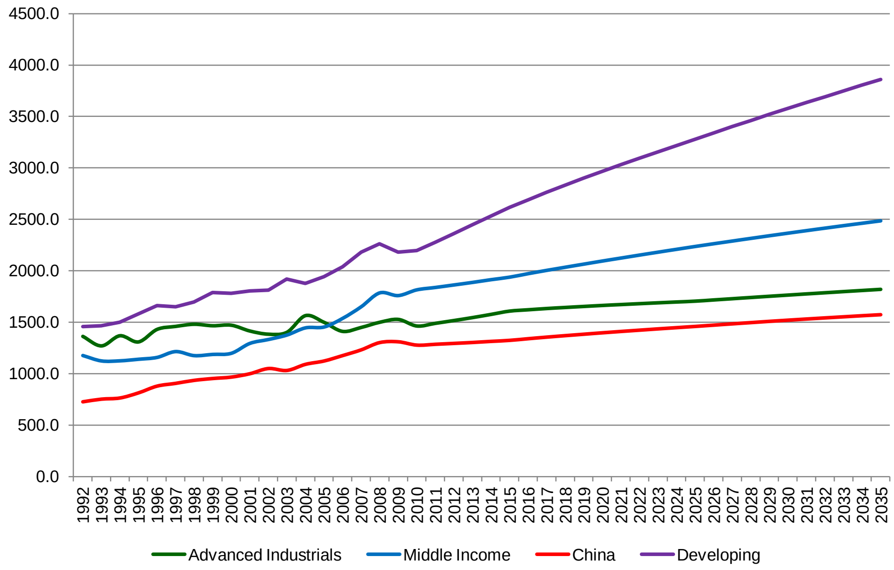
Source: CRU

Crop production has recorded an annual average increase of 2.2% over the past decade. Three crops stand out as major contributors to this. The first is palm crops, which have grown very rapidly from a low base, thanks particularly to developments in tropical Southeast Asia. Soybeans have also expanded their production rapidly, led by Brazil. Another standout is the North American corn industry where the impact of ethanol demand is apparent.

CRU's forecast is that crop production growth though 2020 will average 1.9% per annum, which is slightly slower than the rate over the past decade. However, we see a more significant deceleration thereafter as the impact of slower population growth and the inevitable decline in the rate of increase of calorific intake with rising incomes takes its toll.

The above forecast can also be expressed in terms of the production of crops by region. One caveat is that these figures are expressed in tonnes. Clearly, adding up tonnages of different crops does not produce a meaningful total. However, in this industry the product mix is changing quite slowly so that an analysis of this nature does provide a general guide to the likely rate of expansion of the agricultural sector. The forecast by region is presented in the following graph and table.

Growth of world crop production by region, mn t



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Data: CRU

Table 3.2: World crop production by region, mn t

Crop Type	2000	Annual Growth	2010	Annual Growth	2020	Annual Growth	2035
North America	637.3	0.7%	682.2	1.6%	801.6	1.1%	945.5
Asia-Pacific, advanced	143.8	-1.3%	126.4	1.0%	140.0	0.7%	154.9
Europe	691.0	-0.5%	655.6	1.0%	722.7	0.0%	720.5
Latin America	908.2	4.8%	1450.4	1.2%	1634.4	1.1%	1930.0
Russia & CIS	206.8	2.3%	258.3	1.9%	311.1	1.3%	376.0
China	966.7	2.8%	1276.7	0.9%	1396.1	0.8%	1571.6
Asia-Pacific, developing	704.8	1.0%	775.0	2.1%	951.2	1.7%	1222.6
India	676.6	3.1%	916.5	2.9%	1216.9	1.5%	1524.0
Middle East	82.2	2.6%	105.8	3.5%	149.5	1.2%	180.1
Africa	399.4	2.3%	503.2	4.7%	797.6	2.2%	1112.8
Total	5416.8	2.2%	6750.2	1.9%	8121.1	1.2%	9737.9

Source: CRU

This shows that the growth of the world’s agricultural production is taking place overwhelmingly in the middle-income and poorer countries of the world. In the first decade of this century, the fastest growth was in Latin America and was concentrated primarily in Brazil whose agricultural sector was transformed during this period. Well above average growth rates have also been noted in India, China, and the Middle East. The reason for this is twofold. Firstly, these are parts of the world where crop demand is rising fastest due to a combination of income improvements and changes in dietary behaviour. Secondly, these parts of the world have an existing agricultural industry that has relatively low productivity by world standards; consequently, they offer the greatest potential for catch up.

CRU’s forecast is that these trends will continue throughout the period. However, we think Latin America will soon cede its position as the leading growth area of the world in agricultural production to India, the developing countries of the Asia-Pacific region, and eventually Africa – which is currently the world’s poorest region.

In the case of China the agricultural industry has done extremely well over the past 25 years, and Chinese diets have greatly improved. The outlook going forward is for a considerable slowdown in demand as the population peaks and as changing diet has a progressively smaller impact at the margin. Chinese agriculture will continue, however, to be a sector of considerable innovation. Rising productivity is implicit in our broader economic forecast, as the urbanization trend established in eastern China will spread to the central parts of the country during the forecast period. However, the growth in total crop production levels will probably be significantly slower than in the past.

3.2 Implications for acreage and yields

Generally speaking, there are two ways in which the world can increase the production of agricultural crops, namely by converting more land to arable use and by improving yields on land already in use. Historically, both of these strategies have been employed. For example, in the past 18 years the world has put approximately 9% more acreage into agricultural production. Effectively, about one-quarter of the increase in world crop production has been accommodated in this way with the remaining three-quarters coming from improved yields.

It is sometimes assumed that land is a finite resource. While this is true in the absolute, it is not a fundamental constraint within the timeframe relevant to this study, as the world is quite a long way short of fully exploiting potentially arable lands. Arable land is under pressure in many of the industrialized parts of the world, mainly from urban sprawl. However, even there, the evidence is far from conclusive. North American acreage declined by 2.2% between 1992 and 2010, and that of Europe dropped 9.9%. However, in both regions the acreage planted is highly susceptible to policy incentives or disincentives. Considerable concern has also been expressed by the Chinese government over the loss of arable lands to urbanization and industrial development in eastern China. Overall, however, Chinese acreage in service rose 11.7% between 1992 and 2010. Russia lost more than 20% of its acreage in the same period, but clearly this mostly reflected the collapse of collective farming (and its replacement by far more efficient private operations using smaller acreage). It is reasonable to assume that this "lost" acreage can be recovered if necessary, and Russia is one of the areas of the world where global warming may actually result in better farming conditions going forward.

The land in service rose by more than 20% in the 1992-2010 period in the Asia-Pacific region, Latin America, and Africa. It is generally recognized that there is substantial untapped land potential in all three of these regions. In fact, water, not land, is expected to be the key constraint in the long term.

CRU's forecasting approach considers land to be the residual in the calculation. In other words, we make assumptions about yields, combine them with our forecast of crop production, and derive the implications for land. We then review these for their reasonableness.

Yields have been steadily increasing in most parts of the world over the past quarter-century as a result of numerous factors, of which increased fertilizer use is only one. The following table summarizes recent trends by crop.

Table 3.3: Average crop yields, t/ha, 1992-2010

	1992	2000	2005	2010	% change	Low	High
Wheat	2.54	2.72	2.85	3.00	18.1%	1.68	4.75
Rice	3.59	3.89	4.09	4.37	21.9%	2.52	7.54
Maize (corn)	3.89	4.32	4.84	5.22	33.9%	1.96	9.60
Other grains	1.71	1.70	1.75	1.77	3.1%	0.86	3.59
Soyabeans	2.04	2.17	2.32	2.55	25.4%	1.07	2.96
Cotton	1.55	1.67	2.00	2.12	37.0%	1.00	4.51
Palm crops	9.80	12.01	14.13	14.06	43.5%	3.81	18.63
Other oilcrops	1.00	1.00	1.00	0.99	-1.4%	0.85	1.01
Sugar	52.31	59.10	62.08	66.94	28.0%	26.12	76.76
Fruit & vegetables	11.40	13.04	13.66	14.55	27.6%	8.39	26.04
Other	1.19	1.18	1.19	1.21	1.2%	1.03	1.49

Source: CRU

Yields for most crops over this period have increased by 20% or more. Moreover, if we look at the spread between the regions with the highest yields (generally North America and Europe) and the lowest yielding region (generally one of the poor, developing country regions), the gap is usually by a factor of three or more. In our opinion, this indicates that there is plenty of potential for improved yield, and our forecast reflects this expectation. The following table summarizes the assumptions that CRU has made regarding future yield trends by crop.

Table 3.4: Average yield forecasts, t/ha

Crop Type	2000	Annual Growth	2010	Annual Growth	2020	Annual Growth	2035
Wheat	2.7	1.0%	3.0	1.2%	3.4	0.8%	3.8
Rice	3.9	1.2%	4.4	0.5%	4.6	0.6%	5.1
Maize (corn)	4.3	1.9%	5.2	1.4%	6.0	1.0%	6.9
Other grains	1.7	0.4%	1.8	1.4%	2.0	0.6%	2.2
Soyabeans	2.2	1.7%	2.6	0.9%	2.8	0.8%	3.1
Cotton	1.7	2.4%	2.1	1.2%	2.4	1.0%	2.8
Palm crops	12.0	1.6%	14.1	1.4%	16.2	1.4%	20.0
Other oilcrops	1.0	-0.1%	1.0	1.0%	1.1	0.8%	1.2
Sugar	59.1	1.3%	66.9	0.7%	72.1	0.7%	79.6
Fruit & vegetables	13.0	1.1%	14.5	1.4%	16.7	1.1%	19.6
Other	1.2	0.2%	1.2	1.0%	1.3	0.9%	1.5

Source: CRU

When these assumptions are combined with crop production forecasts, the implications for acreage planted can be derived. This is shown in the following table.

Table 3.5: Acreage in production by crop type, 2000-2035, mn ha

Crop Type	2000	Annual Growth	2010	Annual Growth	2020	Annual Growth	2035
Wheat	215.4	0.1%	217.0	1.4%	249.3	0.5%	268.1
Rice	154.1	0.0%	153.7	2.1%	189.9	0.7%	212.2
Maize (corn)	137.0	1.7%	161.9	-0.1%	160.9	0.3%	168.5
Other grains	166.2	-1.0%	150.0	1.4%	172.9	0.4%	182.6
Soyabeans	74.4	3.2%	102.4	-0.4%	98.7	0.3%	103.4
Cotton	31.8	0.1%	32.2	-0.1%	31.9	-0.1%	31.3
Palm crops	10.0	4.1%	15.0	2.2%	18.7	0.6%	20.5
Other oilcrops	103.1	1.1%	115.3	1.3%	130.8	0.4%	138.9
Sugar	25.5	1.1%	28.6	0.4%	29.6	0.3%	31.2
Fruit & vegetables	96.0	1.2%	108.3	0.7%	116.2	0.1%	118.5
Other	134.5	0.7%	143.5	1.1%	160.0	0.8%	180.0
Total	1148.0	0.7%	1227.8	1.0%	1358.9	0.5%	1455.0

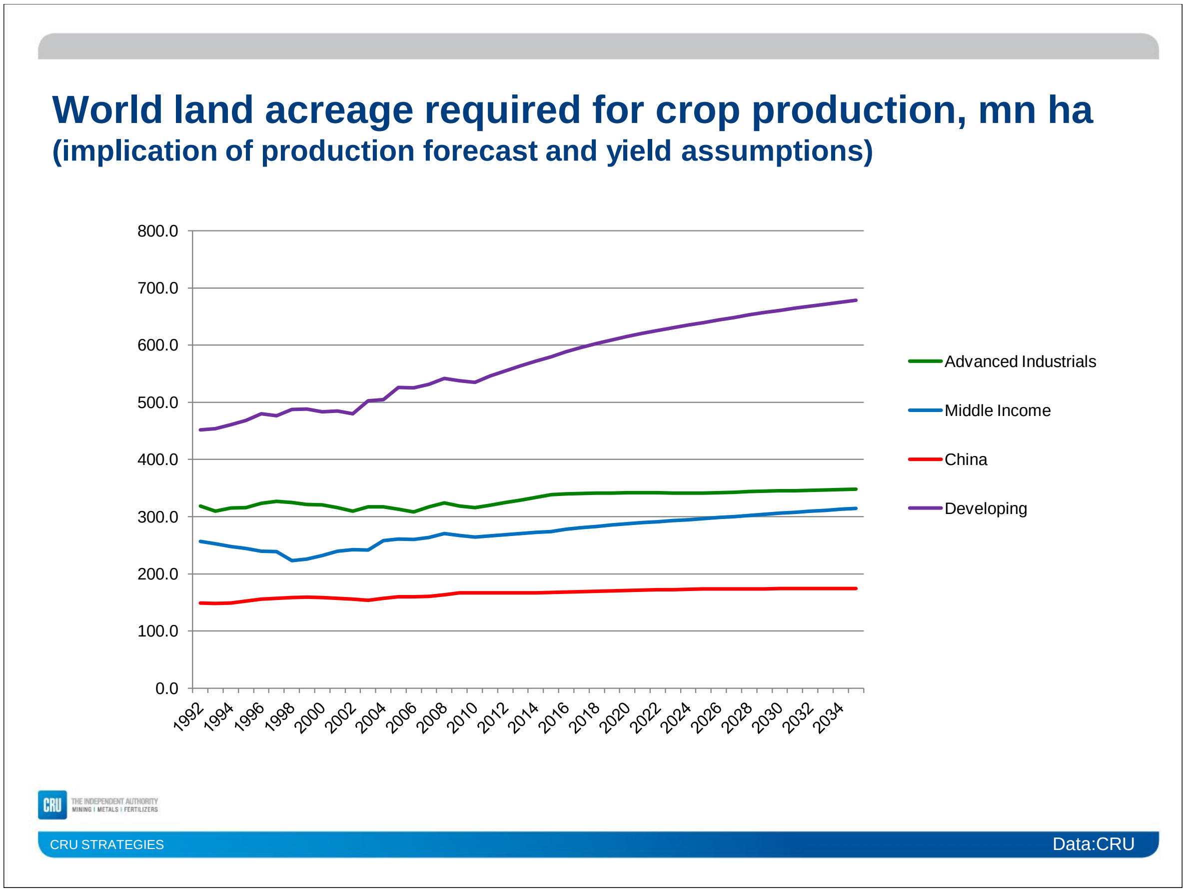
Source: CRU

The same forecast is presented by major geographic region in the following table and chart.

Table 3.6: Acreage in production by region, 2000-2035, mn ha

Crop Type	**2000**	**Annual Growth**	**2010**	**Annual Growth**	**2020**	**Annual Growth**	**2035**
North America	126.8	-0.3%	122.5	0.8%	132.6	0.2%	136.1
Asia-Pacific, advanced	27.9	0.4%	29.1	0.6%	30.9	0.3%	32.1
Europe	119.1	-0.7%	110.5	1.0%	121.6	-0.1%	119.3
Latin America	112.2	2.2%	139.3	0.5%	146.1	0.5%	158.2
Russia & CIS	98.1	0.2%	100.4	1.1%	112.1	0.8%	126.4
China	158.7	0.5%	166.5	0.3%	171.0	0.1%	174.4
Asia-Pacific, developing	169.9	0.0%	170.6	1.2%	192.5	1.0%	223.4
India	139.8	1.3%	159.8	2.0%	194.7	0.5%	211.4
Middle East	21.7	1.2%	24.4	1.8%	29.2	0.2%	30.0
Africa	173.8	1.7%	204.9	1.1%	228.0	0.4%	243.6
Total	1148.0	0.7%	1227.8	1.0%	1358.9	0.5%	1455.0

Source: CRU



World land acreage required for crop production, mn ha
(implication of production forecast and yield assumptions)

The chart shows that most of the increase in land placed into agricultural service will be coming in the developing countries, with some further increase in middle-income countries, notably in Latin America and possibly, depending on climate change, in Russia. There will be little or no longer-term growth in the industrial countries or China.

3.3 Fertilizer application rates and yields

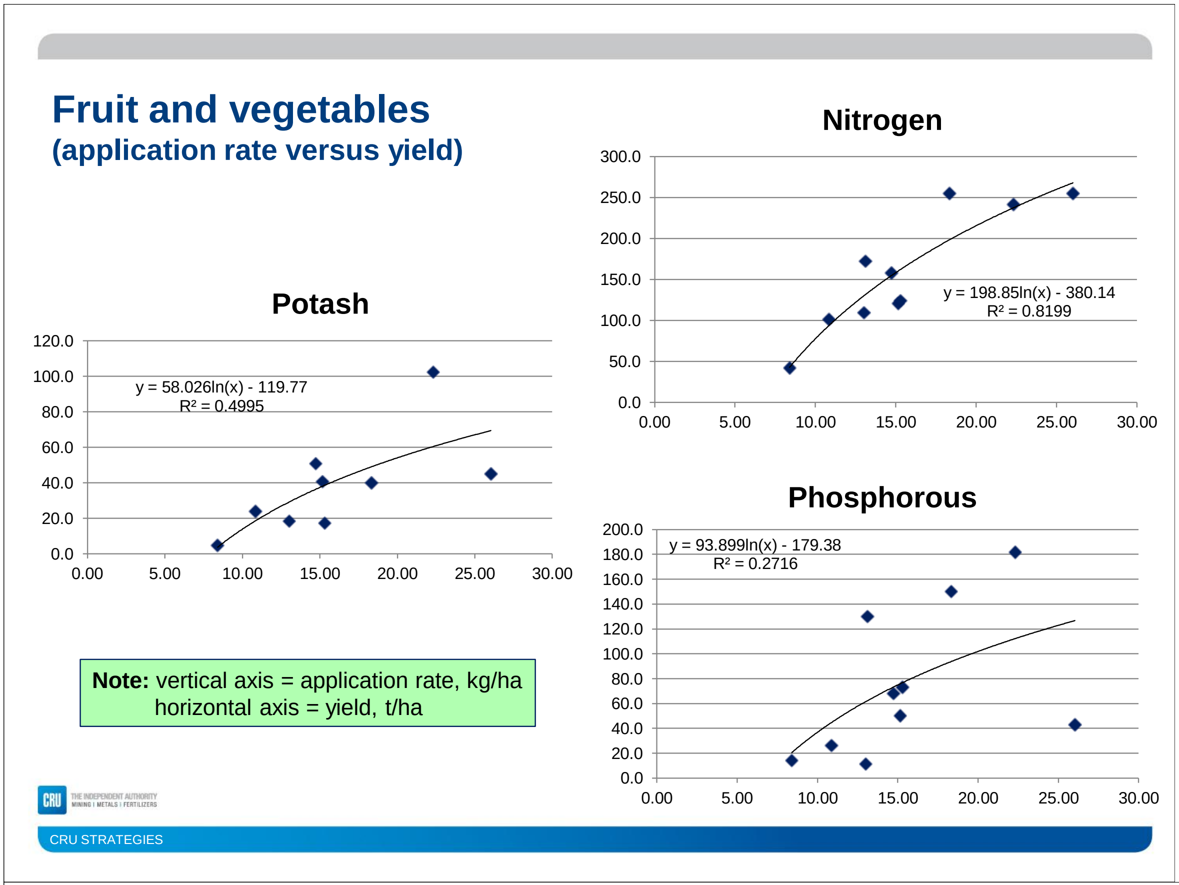
Whether future crop production requirements are met by increasing acreage or by improving yield, both have positive implications for fertilizer demand. New land is typically marginal. This means that it may already be deficient in certain key nutrients. Even if it is not, nutrient levels are likely to be relatively low and therefore quickly depleted. Unfortunately, it is very difficult to quantify the impact of bringing new land into production and its impact on fertilizer demand, because the initial requirements will vary enormously depending on soil types.

What is much better known is the relationship between fertilizer demand and agricultural yield on lands that have been established in production for many years. The harvesting of crops removes nutrients from the soil. Consequently, the higher the crop yields per acre, the greater the requirement for nutrient replacement. Yields can, of course, be improved in a number of ways other than through increased use of fertilizers. Irrigation is probably the prime example in many places in the world. However, in addition to this there is a huge and highly innovative industry involved in developing better crop varieties, crops that resist insect infestation, and the like. Thus, fertilizer application rates only account for a portion of the yield differences between regions.

CRU has conducted a cross-sectional analysis of the relationship between fertilizer application rates and yields based on fully reconciled 2010 data. The following chart shows the NPK relationships for fruit and vegetables, a crucial strategic sector for fertilizer use. It illustrates that the application of NPK fertilizer is somewhat correlated with yields in this key sector.

A subsequent chart shows similar relationships between application rates and yields for phosphate applied to the grains/cereals sector. In overall market terms, this is a crucial sector because it accounts for almost 60% of world agricultural activity in terms of land use. The correlations were less dramatic for other crops. However, these were mostly residual categories comprised of diverse items – for example, “other oil seeds” and “other crops not elsewhere specified”.

The broad finding from this research is that between 20% and 40% of yield improvements can be attributed to increased fertilizer use. As a result of this relationship, we can expect fertilizer demand to increase somewhat faster than agricultural production.



Fruit and vegetables
(application rate versus yield)

Potash

Nitrogen

Phosphorous

Note: vertical axis = application rate, kg/ha
horizontal axis = yield, t/ha

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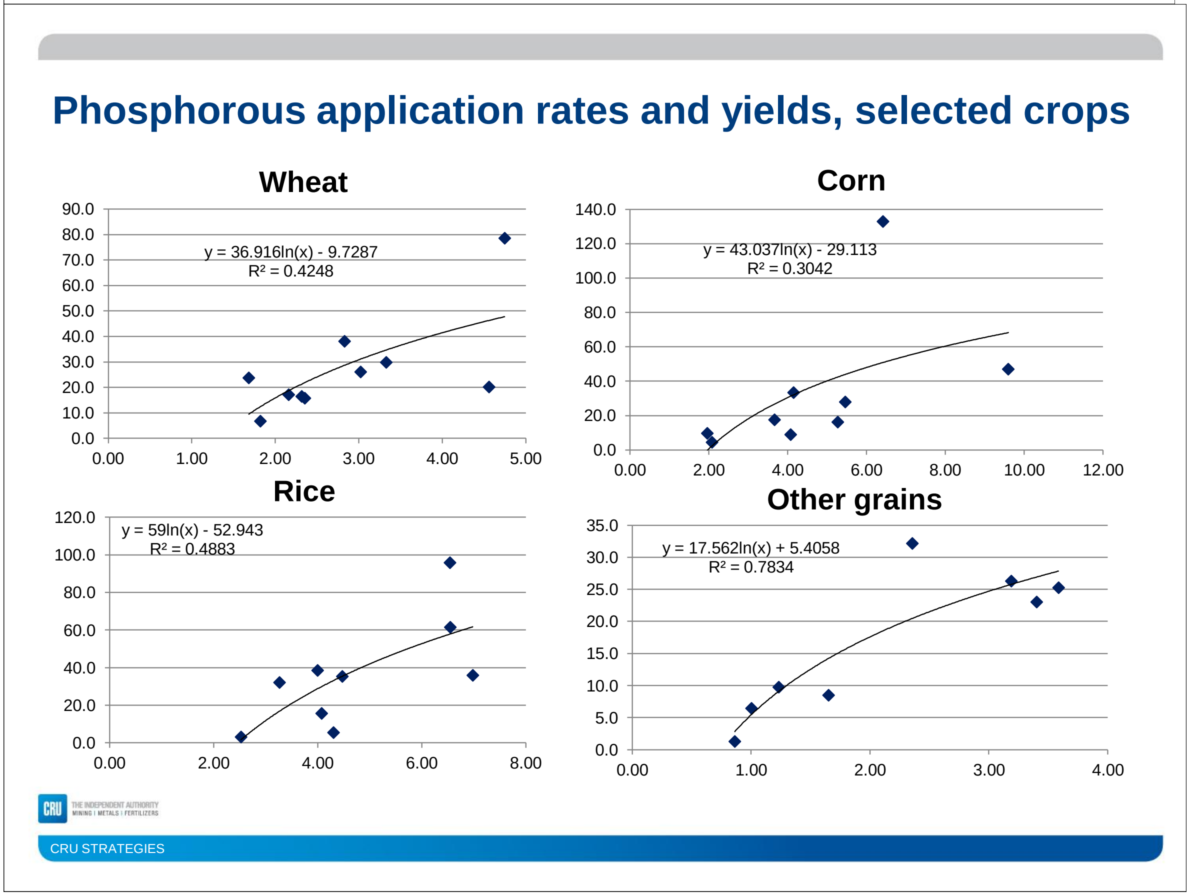

Phosphorous application rates and yields, selected crops

Wheat

Corn

Rice

Other grains

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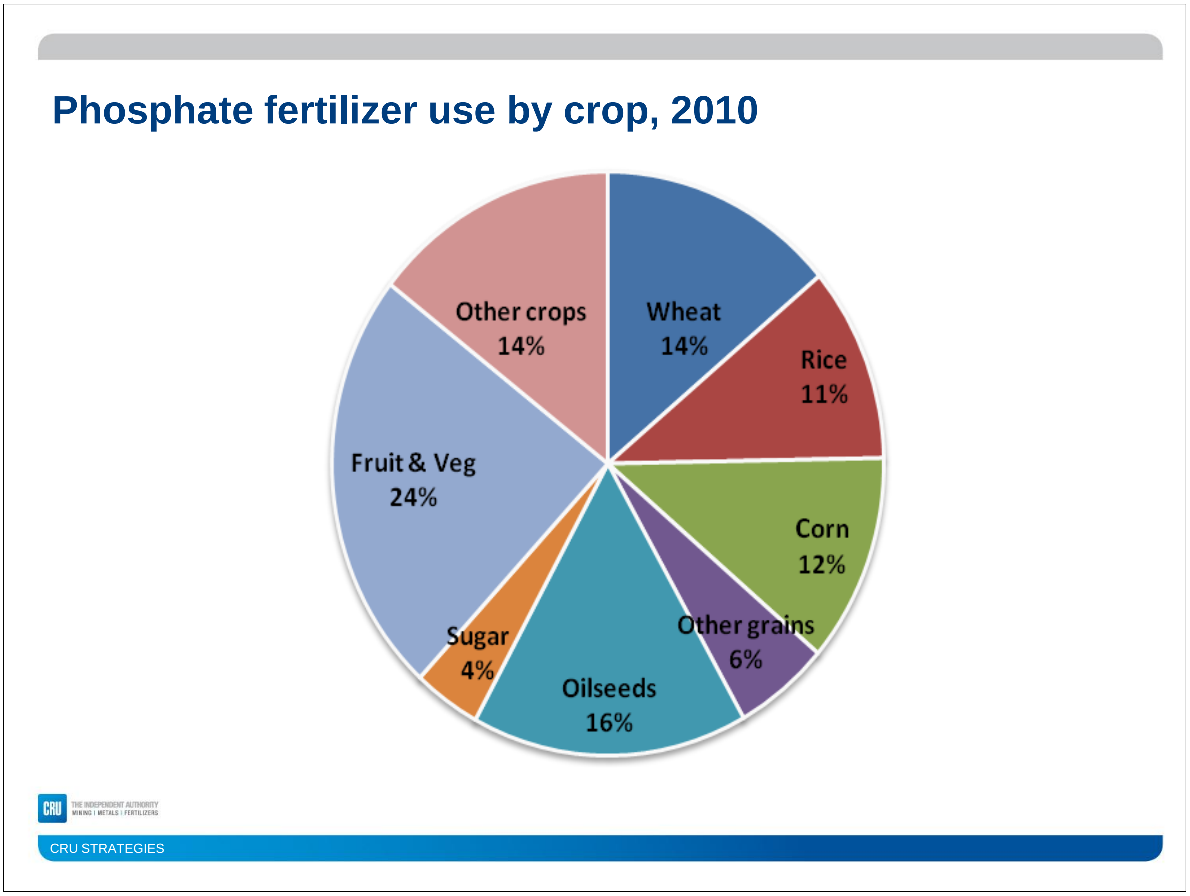
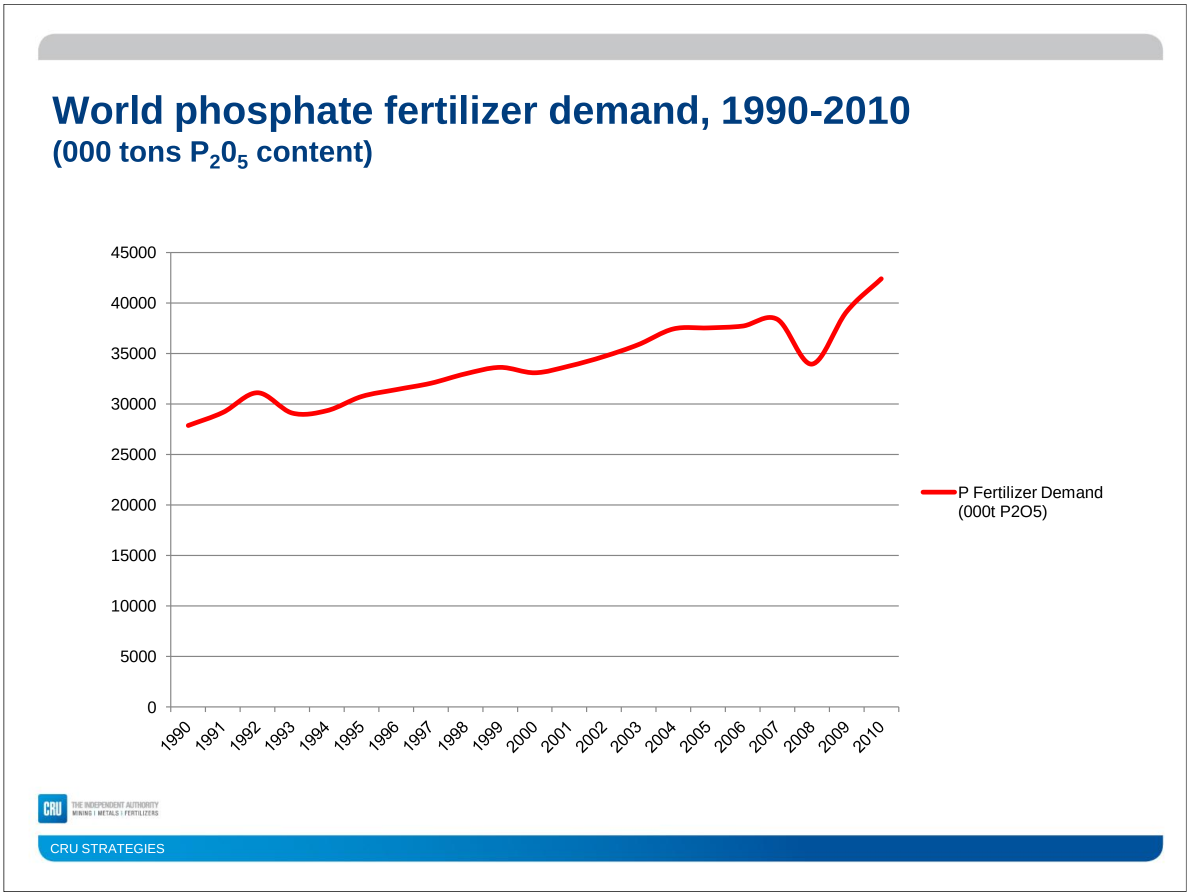
3.4 Implications for phosphate demand

Phosphate fertilizer use is well diversified across the world’s crops. The following chart shows how phosphate applications in 2010 were distributed. No one crop accounts for a disproportionate share of demand, although fruit and vegetables have the largest single share, absorbing approximately 24% of total applications.



Phosphate fertilizer use by crop, 2010

The use of phosphate fertilizers was increasing strongly until approximately 2006. At that point there was a very sharp upward movement in fertilizer prices, resulting from the 2008 commodity bubble. This produced a collapse of demand and an associated severe inventory cycle, which is clearly shown in the following chart. Phosphate fertilizer demand has since recovered and has reached new record highs in 2010. CRU expects this trend to continue, given the market fundamentals.



World phosphate fertilizer demand, 1990-2010

(000 tons P_20_5 content)

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While it is clear that the huge surge in the prices of all NPK fertilizer elements created an affordability issue for farmers in the 2008/9 period, phosphates have been less affected than either nitrogen or potash. For example, the current phosphate rock benchmark price is around three times the prevailing level in the 1995-2005 period, whereas current nitrogen and potash prices have increased by a factor of four. The three-fold increase is about the average for all the major non-fuel minerals and simply reflects the cost structure of the global mining industry as discussed more fully in Chapter 6 below.

While there is fairly clear evidence that farmers have substituted for potash during the global financial crisis, phosphate was less affected than potash. Part of the reason may be that it is often supplied in conjunction with nitrogen in the form of DAP/MAP. Farmers have less discretion in the use of nitrogen. Reducing its application usually has a fairly immediate impact on yield. For reasons discussed more fully in Chapter 6, CRU believes that phosphate prices are currently at unsustainably high levels and will fall, thus addressing any residual affordability concerns that may exist.

The following table takes our acreage and yield forecasts and develops the implications for phosphate fertilizer demand, incorporating the assumption that there will be an element of price induced "catch up" between now and 2020.

Table 3.7: Phosphate fertilizer demand by region, 2000-2035, mn t P_2O_5

Crop Type	2000	Growth	2010	Growth	2020	Growth	2035
North America	4.6	2.4%	5.8	1.3%	6.6	1.5%	8.2
Asia-Pacific, advanced	2.4	-3.2%	1.7	1.5%	2.0	2.0%	2.7
Europe	4.6	-0.9%	4.2	0.7%	4.5	1.1%	5.2
Latin America	3.8	3.7%	5.5	3.2%	7.5	1.7%	9.7
Russia & CIS	0.5	9.6%	1.2	3.1%	1.7	3.0%	2.6
China	8.7	4.9%	14.0	1.6%	16.3	1.3%	19.8
Asia-Pacific, developing	4.2	6.3%	7.7	1.2%	8.7	0.9%	10.0
India	2.6	1.9%	3.1	2.4%	4.0	2.3%	5.6
Middle East	0.8	1.3%	0.9	3.1%	1.3	1.8%	1.7
Africa	1.0	3.1%	1.3	3.6%	1.9	4.5%	3.6
Total	33.1	3.2%	45.5	1.8%	54.4	1.6%	69.1

Source: CRU

CRU expects that phosphate fertilizer demand will decrease moving forward. The forecasted growth rate of 1.8% to 2020 is below the previous decade's growth rate of 3.2%. Likewise, growth is expected to decrease even more after 2020. The decline in global population growth is the main cause for this slowdown in growth.

Chapter 4 – Demand for specialty phosphates

Fertilizer demand constitutes approximately 88% of the total use of phosphates in the world economy. The remaining 12% is consumed in the animal food and industrial segments. These proportions have not changed greatly in the past decade as the underlying rates of growth in these sectors have been broadly similar to fertilizers, i.e. in the range 2-2.5% per annum.

These markets are potentially significant for Lac a Paul because they require purified phosphoric acid (PPA) as a feedstock rather than the merchant grade acid (MGA) used as the building block for fertilizers. PPA can be made from MGA but the cost of doing so is lower if the MGA is low in undesirable residuals. Because Lac a Paul plans to produce a very high grade rock, it is possible that some PPA producers may be prepared to pay a premium. At the very minimum, this segment may offer Lac a Paul a marketing edge.

This chapter briefly discusses the prospects for these markets. Their significance, however, should be kept in perspective. The fertilizer market currently consumes around 47 mn tpy P_2O_5. The animal feed market is around 7.6 mn tpy measured at 41% P_2O_5 which is the equivalent of just over 3 mn tpy P_2O_5. The industrial market is the same order of magnitude but is more fragmented. Together these two markets require about 20 mn tpy of phosphate rock per annum.

The remainder of this chapter briefly describes the main features of these markets and the issues that they face. It supports the basic assumption made in this study that the relationship of the specialty phosphate markets to the fertilizer market will not materially alter during the forecast period.

4.1 Animal feed

As discussed in chapter 3, the increase in living standards is associated with a changing diet that favors a gradual shift towards the consumption of animal products. This implies that the demand for animal feed may rise faster than overall food consumption. This has two positive effects on the phosphate sector. The first, captured in the analysis in the previous chapter, is that the crops consumed by animals require more fertilizer of all kinds, including phosphates. The second is that phosphate feed supplements for animals face a more favourable market outlook.

The main animal feed products are:

- dicalcium phosphate (DCP),
- monocalcium phosphate (MCP), and
- defluorinated feed phosphate (DFP).

The trend is for higher analysis products like DCP to replace lower analysis products like DFP. However, the latter still retains a significant market share because it delivers a higher sodium content which can be advantageous in certain situations. CRU estimates that DCP is 56% of the market, MCP is 31% of the market and DFP is the remaining 13%.

The phosphate content of these products varies from 40% to 45% P_2O_5. CRU uses a weighted average of 41% P_2O_5 in its estimates of this market. The market is not particularly transparent and reliable statistics on consumption, production, trade and prices are not routinely produced. CRU builds up estimates from first principles based on the demand for various livestock products including animal meat as well as milk and eggs.

The following table presents the most recent historical demand figures for animal feed product.

Table 4.1: Animal feed global demand forecast 2006-2012 ('000t at 41% P2O5)

Region	2006	2007	2008	2009	2010	2011	2012
World Total	**7,256**	**7,578**	**6,957**	**6,645**	**7,053**	**7,703**	**7,692**
West Europe Total	1,298	1,324	1,191	1,072	1,136	1,110	1,117
Central Europe Total	468	514	482	432	442	504	514
FSU Total	372	387	360	324	340	405	372
Africa Total	189	197	187	178	191	186	194
North America Total	1,310	1,313	1,015	867	799	898	909
Central America Total	108	106	82	112	144	100	111
South America Total	930	1,019	917	970	1,107	1,285	1,337
Middle East Total	182	191	200	184	194	221	213
South Asia Total	82	90	58	114	79	114	132
SE Asia Total	427	504	345	401	425	418	496
East Asia Total	1,857	1,900	2,079	1,940	2,168	2,437	2,269
Oceania Total	33	34	41	53	27	26	28

Source: CRU

As mentioned, the overall market size is currently estimated at 7.6 mn tpy. Virtually all the growth is occurring outside the advanced industrial countries, where demand has been falling at around 2% per annum. Latin America, the Middle East and Asia are all growing at around 4% per annum and China has been even faster, estimated at 9% per annum. As a result of these trends, North America and Western Europe now account for only 25% of global demand, having had a 50% market share in 2000. The reasons for this are the following:

- the developing countries are experiencing the greatest increase in consumption of animal products;
- meat production for export has been growing in some of these regions, particularly Latin America;
- a number of fertilizer-related phosphoric acid projects have been built in these regions improving the availability and reducing the local cost of phosphate feed additives.

The market is, however, price sensitive. There was a decline in consumption of animal feed phosphates between 2008 and 2010 reflecting the high price of phosphates in 2008 and, to a lesser extent, the effect of cyclically lower incomes on meat consumption.

Although the fundamentals suggest that the demand for animal feed phosphates should be growing faster than fertilizer phosphates, CRU does not think this is likely to be the case because of the availability of two substitutes – phytase and fishmeal. We estimate that were it not for the growth of these substitutes the current market for animal feed phosphates would be about 1.2 mn tpy (16%) greater than its current size.

Phytase is an enzyme that is widespread in nature, occurring in many plant seeds and in cereals and soybeans. This fosters bone development which is also the main rationale for phosphate feed supplements. From a cost perspective, phytase is not necessarily cheaper than phosphates under normal market conditions, although it probably was when prices spiked in 2008. However, it results in much lower levels of environmental phosphorous pollution. CRU believes that the growth in environmental regulations, and in some cases associated taxes and penalties, is a significant driver of phytase substitution in North America and Europe and one of the reasons why demand has been falling in these regions.

Fishmeal is another substitute. It is especially high in lysine and methionine, both of which are particularly desirable in poultry feed and to some extent in pig feeds. CRU estimates that the fishmeal industry delivers some 300,000 – 400,000 tpy of P_2O_5 that substitutes for regular phosphate feed supplements. CRU does not think that this sector presents the same longer-term substitution threat because there is competing human demand for some of these fish, e.g. sardines, pilchards and capelin particularly from Asian countries.

4.2 Industrial phosphates

The largest single segment of industrial phosphates is the detergent industry. This probably accounts for 70-75% of industrial phosphate demand. The balance is represented by the food additives industry.

The use of detergents rises strongly as incomes increase and particularly with urbanization. This creates favorable fundamentals for this sector. However there are significant environmental issues associated with detergent use. These have only partially been resolved by the introduction of products like linear alkylbenzenesulfonates, which are biodegradable.

The key problem arises from the heavy use of sodium triphosphate, which can comprise up to 50% by weight of detergents. The discharge of soluble phosphates into natural waters has adversely affected aquatic life in lakes and streams. With an increase in phosphates, especially in the absence of species feeding upon algae, algal blooms can be stimulated to the point where they consume most of the oxygen in the waters, killing fish and plants. The replacement of sodium triphosphate by zeolites offers some relief to this problem, but diminishes the demand for industrial phosphates.

In 2004, the European Union introduced regulations to require biodegradability in all detergents, and intends to ban phosphates in domestic products from 2013. Australia began phasing out the use of phosphates in its detergents in 2011, with an all-out ban expected to take effect in 2014. CRU expects regulations to adversely affect this sector in other parts of the world longer-term.

So far these regulations have been aimed mainly at the household sector. The environmental control of industrial detergents can usually be managed quite effectively within the overall environmental management system of an industrial site.

The phosphate food additive business is relatively diverse. Food grade phosphates are used as food additives to improve specific properties such as structure, flavour, succulence and colour. Phosphates are the key to producing high quality processed foods in a variety of markets including meat, seafood, poultry, dairy (including processed cheese) and bakery products. Food grade phosphoric acid is also is the most commonly used chemical for the control of plumbosolvency in drinking water.

In addition to food additives there are other industrial uses of phosphates. For example, there is a range of specially formulated aluminium polishing (brightening) solutions based on phosphoric and sulphuric acid. They produce a bright reflective surface on a wide range of aluminium alloys. The degree of brightness obtainable is superior to that produced by mechanical polishing; fine scratches and other imperfections are removed. Chemical polishing is an essential stage in the production of bright anodized and bright colour anodized products.

Finally there are a variety of other applications including agrochemical intermediates, drying and dehydration agents, effluent treatment, flame retardant intermediates, lubricants, and so forth.

Because of their diverse nature, these markets are likely to reflect the growth of the global economy generally, that is in the 4-5% per annum range long-term. Unfortunately this growth is from a small base and cannot completely offset the effect of environmental regulations in the larger detergent business.

Chapter 5 – Phosphate rock supply

5.1 Supply potential methodology

CRU has constructed its outlook for phosphate rock supply on the basis of a worldwide mine-by-mine analysis. In examining the industry's future supply potential, CRU divides projects into four categories:

- existing and committed capacity;
- probable capacity;
- possible capacity; and
- speculative capacity.

This allocation is made on the basis of a multidisciplinary analysis of the status of each project. In arriving at our assessment, CRU examines the geological, metallurgical/chemical, engineering, social/environmental, market/commercial, infrastructure, ownership/management, and financial aspects of each project. We may also adjust the timing of the project if it appears that there is insufficient time available to accomplish all the remaining work needed before production can be assured.

A project is considered to be committed when it has secured all relevant government approvals and licenses and when it has secured sufficient financing to complete and start the project without further recourse to the market. It must also have final board approval from all shareholders. While committed projects are almost certain to supply phosphate, they do not represent guaranteed production as delays can occur during construction and start up. Even when a project has passed its completion test and is fully operational, events of *force majeure* may cause production to be less than planned. In terms of the JORC code, a committed project will normally have sufficient probable and proven reserves to sustain the proposed mine life.

A project is considered to be probable when the preferred development option has been completely and finally identified and sufficient funding is in place to conclude the final feasibility study, the related environmental impact study, and all of the negotiations leading to financing. Typically, the required funds for these activities are between 5-10% of full capital costs. Probable projects are more than likely to supply phosphate; however, their timing is less uncertain than committed projects because technical issues may surface during the final feasibility study process and their scale may be adjusted in response to both physical market conditions and the state of financial markets. In terms of the JORC code, projects in the probable category will have sufficient measured resources to sustain the proposed mine life.

A project is considered to be possible when there is sufficient technical information available to identify a range of credible development options. A project is not considered possible until significant progress has been made on non-geological issues including the development of order-of-magnitude cost estimates; identification of environmental and social issues and stakeholders; and preliminary commercial issues such as basic product marketability studies. Sufficient funding must be in place to cover the complete work program leading to identification and approval of the preferred development option. As a guideline, this can be expected to amount to around 1% of the final capital cost. In terms of the JORC code, a possible project will have sufficient indicated resources to sustain the proposed mine life.

5.2 Phosphate rock supply by region

Global rock capacity stood at 245.6 mn t in 2011. Much of the key capacity was concentrated in just three countries – China, Morocco and the USA – which jointly accounted for over 60% of the global total. China had, by a considerable distance, the largest production capacity, which exceeded 82.9 mn tpy. However, the Chinese phosphate rock industry has very little impact on global markets as it is highly integrated with the downstream chemicals sector. China is neither a significant exporter nor a significant importer of rock.

Capacity in Morocco and the United States is approximately the same, namely 35.5 mn and 34.3 mn tpy, respectively. Despite this production the US is now a net importer of phosphate rock, while Morocco is by far the leading exporter in the world.

Global rock production was 195.7 mn t in 2011, an increase of 7.5% on the previous year. This represents an apparent operating rate of 79.7%. By historical standards this is normal. Operating rates in the phosphate rock industry seldom exceed 85%. Production at captive mines tends to be adjusted downwards any time final demand for phosphate chemicals declines, and this accounts for the low operating rate compared to other mining sectors.

Production is forecast to steadily increase over the 2012-2017 period and is expected to reach 219.9 mn t in 2017. Much of the main production will continue to be concentrated in the same three countries – China, the US, and Morocco – which is highly comparable with capacity. These countries jointly accounted for 68% of the global total. In line with capacity, China had the largest levels of production, which exceeded 81.3 mn t in 2011. Production for the USA and Morocco in 2011 stood at 27.6 mn and 23.6 mn t, respectively.

5.2.1 North America

Total **North American** phosphate rock capacity was 37.51 mn t in 2012. The USA accounted for 97% of this total and Canada just 3%. Total production in 2011 was 28.5 mn t, an increase of 9.1% on the previous year. In 2011, the USA regained its position as the second largest producer of phosphate rock globally. However, the downward trend in US market share is expected to resume given the substantial expected growth in Middle East (Saudi Arabian) production and increasing environmental constraints in Florida.

Canadian phosphate rock production was estimated at 0.9 mn t in 2011. Canada has only one operating phosphate rock mine, Agrium’s Kapuskasing mine in Ontario, which currently has an annual production capacity of 1.2 mn t. This site has begun winding down operations as reserves have dwindled. Once closed, Agrium plans to import rock from Morocco to supply its Redwater plant in Alberta. However, other mining sites in North America are being considered. Yara have plans to develop Mine Arnaud, which is expected to have a production capacity of 1.0 mn tpy starting in 2015. While environmental impact studies have been conducted, CRU does not yet consider the Mine Arnaud project to be committed.

Phosphate rock production in the **USA** was 27.6 mn t in 2011. Mosaic operates an estimated 16.0 mn t of production capacity, nearly half of the 34.3 mn tonne total production capacity in the USA. Mosaic is the second largest rock miner behind OCP. In 2010, the company acquired a 35% interest in a joint venture that owns the Bayovar phosphate mine in Peru, enabling Peruvian rock to supply its Louisiana production plants. Mosaic currently operates four mines in the US, all of which are located in central Florida. Developments at South Fort Meade have dominated local supply issues, as the mine has been subject to a lengthy and costly legal wrangle. Mosaic has also encountered difficulties in getting permits for the two Florida mines it intended would replace operations at South Fort Meade. Furthermore, controversy still surrounds the proposed mining of the Hardee County Extension, which Mosaic claims will allow for an additional ten years of mining at the central Florida site. Overall, the future of this mining development remains somewhat uncertain.

PotashCorp accounts for a further 9.6 mn t of yearly production capacity in the US at two separate sites. The Swift Creek/White Springs site in Hamilton, Florida, has a production capacity of 3.6 mn tpy, and the larger Lee Creek-Aurora site in North Carolina has a production capacity of 6.0 mn tpy.

The following table summarizes the current phosphate rock capacity of North America.

Table 5.1: Phosphate rock capacity (mn t) North America

	2012	2013	2014	2015	2016	2017	2018	2019
Existing & Committed	37.51	36.91	36.11	30.11	28.81	28.81	28.81	28.81
Probable	0.0	0.0	0.2	1.5	2.9	3.9	3.9	3.9
Possible	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total potential	37.5	36.9	36.3	31.6	31.7	32.7	32.7	32.7

Source: CRU

5.2.2 North Africa

Morocco was the third largest global supplier of phosphate rock in 2011 after China and the US. Production during the year was estimated at 23.6 mn t. The country has the largest phosphate rock deposits of any country and its only producer, OCP, has plans to significantly increase production capacity by 2020. The company operates two main processing hubs, Safi and Jorf Lasfar, which, due to their “Plug & Play” approach to production, have grown enormously since the first plants were commissioned in 1965 and 1986 respectively. Whilst earlier expansions were funded by OCP, more recent developments have been principally through joint ventures with overseas fertilizer companies.

Safi and Jorf Lasfar are both world scale operations in their own right. Safi, which is supplied by the Benguerir and Youssoufia mines, produces a combination of phosphoric acid, TSP and additionally, in 2012, DCP and MCP. Located 120 km north east of Safi is OCP’s second major hub, Jorf Lasfar. This not only contains the wholly-owned Marco Phosphore III and IV phosphoric acid, DAP and MAP plants, but also four joint venture plants (Emaphos, Imacid, Pakistan Maroc Phosphore, and Bunge Maroc Phosphore), which produce a combination of merchant grade acid (MGA), purified phosphoric acid (PPA), MAP and TSP. The Sofi and Jorf Lasfar complexes now contain sulphur burning plants with associated cogeneration, designed to produce more power than is actually required for ongoing operations. Safi, for example, is able to produce 122 MW of power each year, whilst Jorf Lasfar’s power capacity is 209 MW. Currently, surplus power is currently sold back to the national grid, but the company plans to divert this to two new desalination units that are planned for construction in the near future. Safi and Jorf Lasfar are both served by major port facilities that are geared to handle incoming raw materials (ammonia and sulphur) as well as export shipments of rock, phosphoric acid and fertilizers. OCP has phosphate rock production operations at four different sites in Morocco amounting to a yearly production capacity of 35.5 mn t. This increased from 33.9 mn t in 2010, due to OCP’s Youssoufia operations increasing capacity by 1.6 mn t.

The largest mines are in the 20.5 mn tpy Khouribga district (2012 capacity). This area contains three mines at Sidi Doui, Sidi Chennane and Mera el Alesh (located about 120km south-east of Casablanca). Four grades of ore are processed. The high grade and medium grade have a P_2O_5 content of about 32%, and most of this production is regarded as merchant grade with no beneficiation. The low grade and very low grade require some washing and floating. Roughly half of the rock is used at the Jorf Lasfar phosphoric acid plant, and the rest is exported from Jorf or via Casablanca.

The second largest site is Youssoufia, which is in the western part of the country in the Gantour deposit, about 90 km east of Safi. It has two underground mines and one surface mine, with a total capacity of 7.6 mn tpy. The site has two phosphate rock train-loading stations that can rail up to 20.0 mn tpy to Safi to feed the fertilizer and phosphoric acid manufacturing plants as well as some exports. Concentrate grade averages about 31% P_2O_5.

In the central part of the Gantour deposit is the Ben Guerir mining area. The site is 77 km away from Youssoufia. After extraction, the product is carried on trucks and by train either to Safi or to the treatment plant at Youssoufia. Part of the mine’s output is intended for export and is shipped out of Jorf Lasfar and Casablanca. This opencast mine has a current capacity of 4.1 mn tpy. Average concentrate is about 31.5% P_2O_5.

The fourth mining area is the Bou Craa site, which is located in the Western Sahara Desert about 50 km to the southeast of Laayoune and 1,200 km from Casablanca. The opencast mine has a capacity of 3.3 mn tpy. The rock from this deposit is of a high quality, with a P_2O_5 content above 36%, and all product is exported from Laayoune.

Tunisia is another important North African phosphate rock supplier with a considerable presence in global phosphate markets. Its phosphate rock mines are all state owned, operated by Compangnie des Phosphates Gafsa (CPG), which in turn is a subsidiary of downstream producer, Groupe Chimique Tunisien (GCT). Mining capacity stood at 9.8 mn t in 2011, with production amounting to 6.7 mn t during the corresponding period. This is lower than in the past, as, since the escalation of the Arab Spring, production has been hampered by continued strike action, both at the mining and logistical operations. These problems now appear to have been sorted out, and utilization rates should improve going forward.

Algeria’s production capacity increased by 22% in 2011 to 2.8 mn tonnes in 2011. This was solely caused by an increase in production capacity of 0.5 mn t at the Somiphos mine in Djebel Onk. Similar to Tunisia, Algeria’s production has been constrained due to strike action, which ended at the beginning of August 2012. Going forward, the company's focus is on moving into downstream production, and any capital expenditure is also to be used for this - thus, mining capacity is set to remain constant over the medium term.

The following table reflects these numbers.

Table 5.2: Phosphate rock capacity (mn t) North Africa

	2012	2013	2014	2015	2016	2017	2018	2019
Existing & Committed	61.09	61.09	61.09	63.09	62.34	68.34	68.34	68.34
Probable	0.0	0.0	5.7	9.1	11.6	11.6	11.6	15.1
Possible	0.0	0.0	0.8	1.8	2.1	7.1	7.1	7.1
Total potential	61.1	61.1	67.5	73.9	76.0	87.0	87.0	90.5

Source: CRU

5.2.3 Middle East

Saudi Arabia has begun developing phosphate rock resources in the north of the country. Phosphate deposits are under the control of Ma'aden Phosphate Company. The company was established in 1997 to facilitate the development of mineral resources (gold, phosphate, bauxite) in northern Saudi Arabia. Ma'aden has several mines in operation producing gold and base metals and two major joint-venture projects: an integrated aluminium project, in which Alcoa has a 40% stake, and the MPC phosphate project, in which SABIC has a 30% stake.

Ma'aden first began production of phosphate rock at the Al Jalamid mine in 2010, producing a total of 121,000 tonnes during the year. Its capacity was ramped up in 2011 to 4.0 mn t (from 1.0 mn t), in line with the commissioning of the Ras Al-Khair acidulation/granulation plant in June. However, due to continued production difficulties at the mining site (unofficial reports suggested that the mine's primary crusher had broken and had to be replaced) and logistical problems affecting the transportation of rock, production just barely passed 0.7 mn t for the year. Once these issues are resolved, the mine could theoretically ramp up to its 5.3 mn tpy capacity.

Ma'aden is also conducting a feasibility study into the construction of a second phosphate rock mine in Al-Khabra. The proposed site and beneficiation plant is forecasted to increase the company's annual phosphate capacity by 1.5 mn t P_2O_5.

The following table summarizes the most recent status of phosphate rock capacity in the Middle East.

Table 5.3: Phosphate rock capacity (mn t) Middle East

	2012	2013	2014	2015	2016	2017	2018	2019
Existing & Committed	21.65	21.65	21.65	21.65	24.15	26.65	26.65	26.65
Probable	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Possible	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0
Total potential	21.7	21.7	21.7	21.7	24.2	28.7	28.7	28.7

Source: CRU

5.2.4 China

China's phosphate rock production has risen rapidly over the past ten years from 38.8 mn t in 2001 to 81.3 mn t in 2011. Phosphate rock capacity was 85.43 mn t in 2012. However this has been accompanied by a decline in the average run-of-mine ore grade. Recent geological exploration has proved more than 15 bn tonnes of phosphate rock resource in China. Although ore containing over 30% P_2O_5 was once the norm, much of these high-grade reserves have now been exhausted and many operators are now working with lower grade ore deposits. The exploitation of lower grade ores raises production costs due to the additional volumes involved and the more elaborate beneficiation processes involved. As a result, many of the major producers including Yuntianhua and Wengfu have installed floatation lines at the mines that supply their own phosphate rock needs, as has Yihua in Hubei and a number of medium sized phosphate producers. For the producers of fertilizers and chemicals that do not have captive phosphate rock, this trend is leading to higher prices for purchased rock.

The following table presents CRU's current understanding of China's phosphate rock capacity.

Table 5.4: Phosphate rock capacity (mn t) China

	2012	2013	2014	2015	2016	2017	2018	2019
Existing & Committed	85.43	85.43	85.43	85.93	86.68	86.93	86.93	88.93
Probable	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Possible	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total potential	85.4	85.4	85.4	85.9	86.7	86.9	86.9	88.9

Source: CRU

5.2.5 Russia & CIS

Russia was the fourth largest global rock supplier in 2011, having produced a combined total of 10.3 mn t. Russia's phosphate capacity was 12.0 mn t in 2011. The two main Russian producers are Eurochem and PhosAgro, which together accounted for 89% of Russian phosphate rock capacity in 2011, and both companies operate in the Kola Peninsula. PhosAgro is the largest vertically-integrated phosphate enterprise in Russia. The company owns the country's largest mining operation, P.O. Apatit, located in the Khibiny mining area in the Kola Peninsula. This mine has a capacity of 8.0 mn tpy, which is expected to remain constant over the forecast period.

By contrast, EuroChem is a diverse company with fertilizer production plants in **Russia, Ukraine, Estonia and Lithuania**. The company has three integrated phosphate plants, two in Russia and one in Lithuania, which are all supplied with phosphate rock from the Kovdorky GOK apatite mine in the Kola Peninsula. The mines annual phosphate rock capacity is 2.7 mn t, which is also expected to remain constant over the forecast period. However, the company aims to invest over US$670 mn in its phosphate plants. Plans include building sulphuric acid and phosphoric acid capacity at both Russian plants and the construction of a compound fertilizer plant in Kazakhstan.

Table 5.5: Phosphate rock capacity (mn t) Russia & CIS

	2012	2013	2014	2015	2016	2017	2018	2019
Existing & Committed	20.45	20.95	20.95	20.95	20.95	20.95	20.95	20.95
Probable	0.0	0.0	0.0	1.5	1.5	1.5	2.0	2.5
Possible	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Total potential	20.5	22.0	23.0	25.5	26.5	27.5	29.0	30.5

Source: CRU

5.2.6 Supply summary

The following table presents a summary of the potential increase in the supply of phosphate over the period to 2019.

Table 5.6: World phosphate rock supply potential (mn t P_2O_5)

	2012	2013	2014	2015	2016	2017	2018	2019
Region								
Europe	1.0	1.3	2.8	2.8	2.8	2.8	2.8	2.8
Russia & CIS	20.5	21.0	21.0	22.5	22.5	22.5	23.0	23.5
North America	37.5	36.9	36.3	31.6	31.7	32.7	32.7	32.7
Latin America	12.0	12.3	14.2	15.3	17.9	19.1	19.1	19.1
China	85.4	85.4	85.4	85.9	86.7	86.9	86.9	88.9
India	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Middle East	23.0	23.0	23.0	23.0	25.5	30.0	30.0	30.0
Asia Pacific Developing	7.6	7.6	7.6	7.6	6.9	7.1	7.1	7.1
Asia Pacific Advanced	3.0	3.0	3.5	4.0	4.0	4.0	4.5	5.0
Africa	61.1	61.1	67.5	73.9	76.0	87.0	87.0	90.5
World total	253.0	253.5	263.3	268.6	275.9	294.1	295.1	301.6

Source: CRU

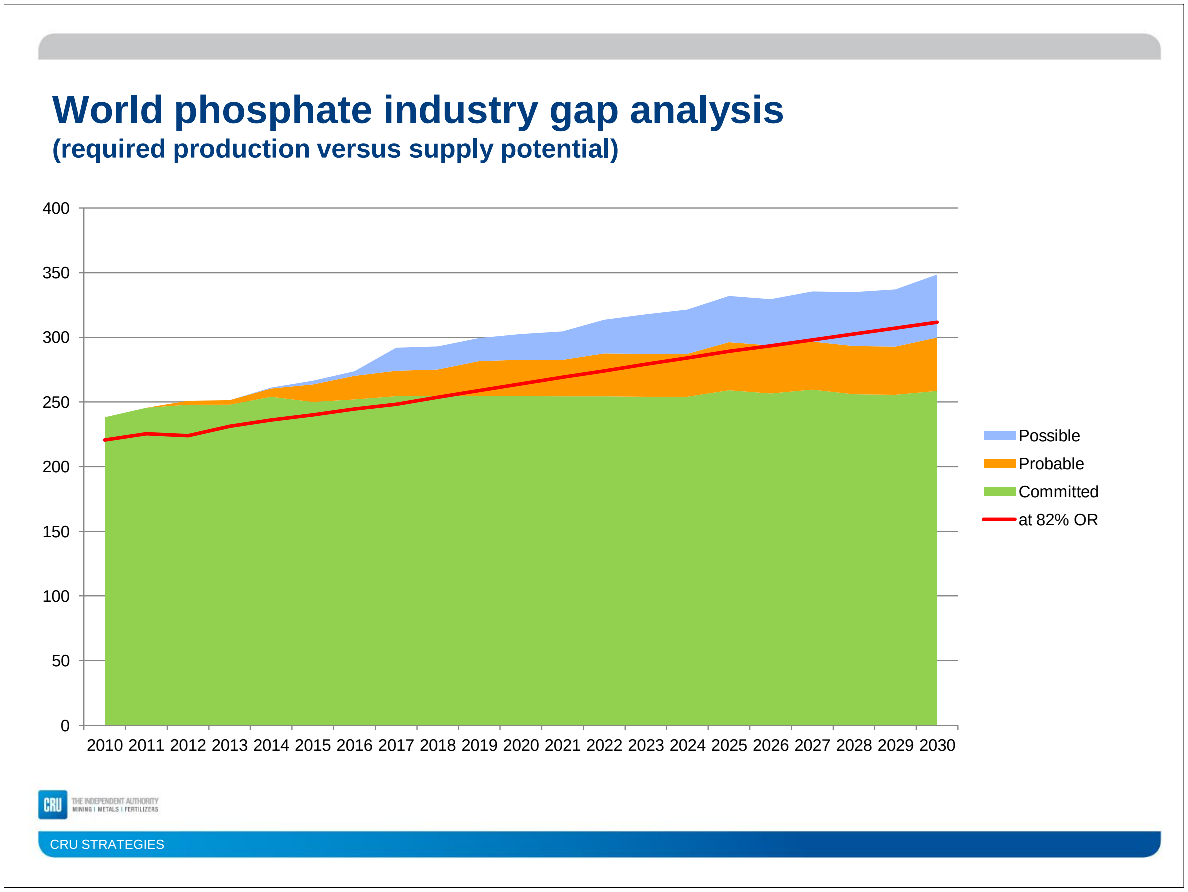
Existing and committed capacity by 2019 is predicted to be 301.6 mn t, which is 19% higher than the estimated 2012 capacity and represents an annual average growth of 2.4%.

This project-by-project supply analysis refers to nameplate capacity. Although companies routinely announce capacity in terms of the expected output of marketable products, in practical terms processing plants are designed around specific ore input rates. What this means is that unforeseen changes in ore quality have the potential to cause capacity to deviate from the nameplate amount, sometimes significantly. As discussed more fully in Chapter 5, CRU believes a comfortable operating rate in the phosphate rock industry is around 82% and that operating rates of more than 90% create conditions in which there is a risk of supply shortfalls and serious price spikes.

Finally, it is worth reiterating that the above analysis is not a forecast of future production, but rather a statement of industry supply potential.

5.3 Gap analysis – the need for new investment

The following chart compares CRU's forecast of potential supply with our projections of likely phosphate demand.



World phosphate industry gap analysis

(required production versus supply potential)

This chart, which is based on the assumption of a typical 82% operating rate for nominal capacity, shows that firm and committed projects track demand quite well through 2017. Thereafter, demand significantly exceeds supply, indicating there will need to be a period of production increases.

By 2017, however, new capacity will be needed, and by 2025 the entire probable project inventory will be needed.

There is no likelihood of any absolute shortage of phosphate over the period to 2030. The implication of this analysis is that only the lowest-cost projects in the industry are likely to be justified in this timeframe, which suggests that prices will be determined by the third or fourth quintile of the supply curve.

Chapter 6 – Phosphate rock price forecast

6.1 Background

Phosphate rock prices are negotiated directly between mining companies and either traders or chemical companies. There is no terminal market, and phosphate rock is not traded on any regulated commodity exchange. For these reasons, the price of phosphate rock is considerably less transparent than the price of many other commodities. However, prices can be inferred from data on the value and volume of international trade in phosphate rock and the trade press (e.g. *Fertilizer Week*[1]) conducts regular surveys.

The prices reported in trade data are obtained by dividing the value of trade by its volume. Therefore, this measures the actual result of trade between different pairs of countries. However, trade data must be interpreted with care. In particular, the following should be noted:

- the trade classification system includes a number of related products under the same tariff heading as phosphate rock; these products may sell at very different prices, which will distort average price calculations; this problem is normally most acute where bilateral trade flows involve small quantities of material; in the phosphate rock context this means flows of less than 1 mn tpy;
- trade data reflects the quality of the product actually delivered; this is not consistent from one country to another or from one time period to another; therefore, part of the change in price may reflect a change in quality; and
- trade data is based on documents such as bills of lading that reflect prices that were previously negotiated; even spot shipments will have been negotiated two to six weeks prior to vessel loading; more generally, a country's trade will reflect a portfolio of contracts including annual contracts, six-monthly contracts, quarterly contracts, and spot transactions; the average lag structure will differ from country to country and from one time period to another; all that can be said is that these prices lag actual prices.

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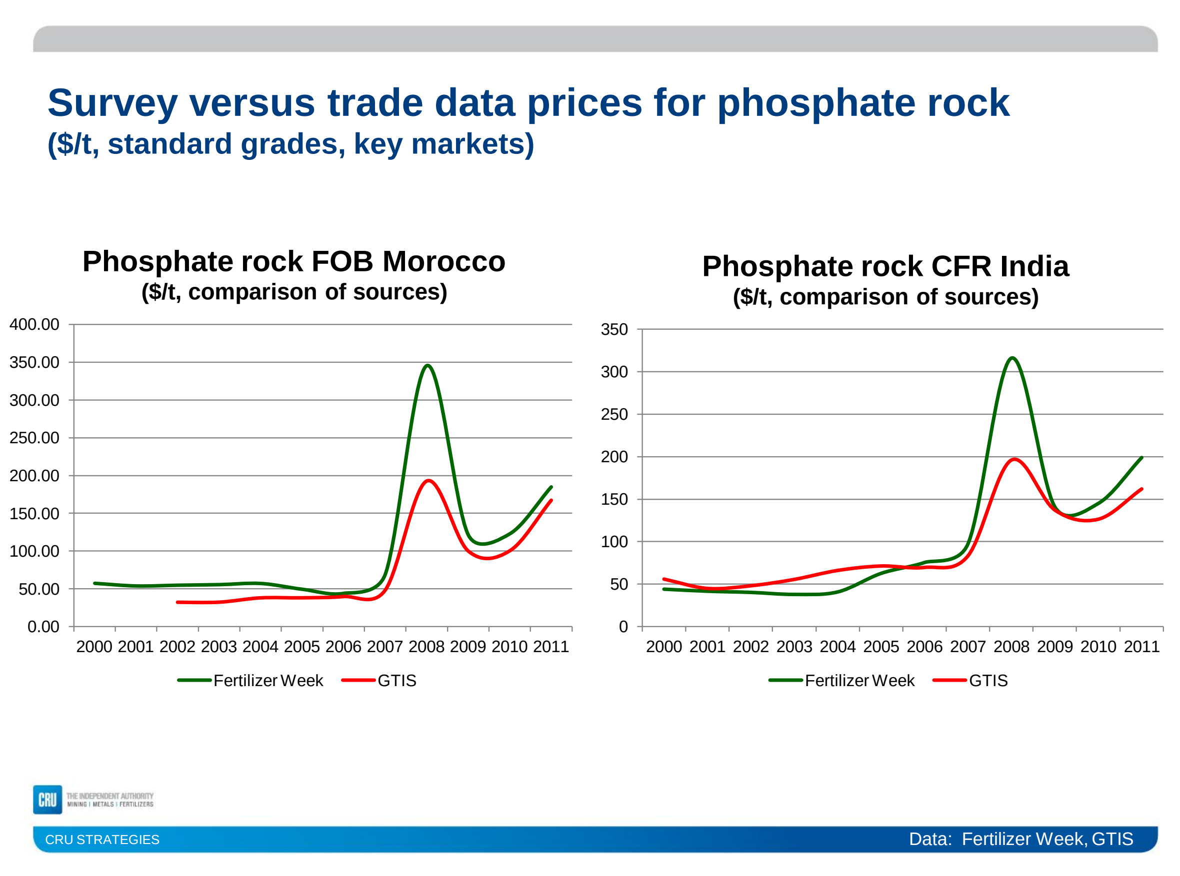
[1] *Fertilizer Week* is owned by CRU International Ltd.

The trade data is available from the Global Trade Information Services (GTIS) database. In 2011, GTIS reported that Moroccan and Indian[2] prices were in the range $162-167/t.

Prices reported by the trade press are based on regular weekly telephone surveys of producers, consumers, and traders. They reflect the consensus opinion of the market on the price at which new business can be contracted as of the date of the survey. The trade press employs specialists with industry knowledge so that the actual prices reported are adjusted to a standard or benchmark from the perspective of such things as product quality, future delivery date, credit terms, and so forth.

During 2011 *Fertilizer Week* reported that the average Moroccan export price was $185/t, while the average price for high quality rock imported into India was $199/t. The following chart compares price data from the *Fertilizer Week* surveys with trade data for Moroccan exports and Indian imports.



Survey versus trade data prices for phosphate rock

($/t, standard grades, key markets)

Phosphate rock FOB Morocco
($/t, comparison of sources)

Phosphate rock CFR India
($/t, comparison of sources)

Data: Fertilizer Week, GTIS

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[2] Morocco is a major exporter of rock to most markets. India is a major importer and uses multiple suppliers.

The data tracks quite well except for the 2008 market price spike, which is discussed in more detail below. This can be readily explained partly by the effect of long-term contracts on reported values in the trade data and partly by the fact that very low volumes of rock were transacted at the peak prices.

The phosphate rock business generally accepts that the prices reported by *Fertilizer Week* and two of its direct competitors are the most reliable publicly available data sources. These prices are often used as reference indices in long-term contracts. For this reason, references to any "phosphate rock price" in the discussion presented in the remainder of this chapter refer to the spot price of rock as reported by the trade press.

6.2 Historical price trends

The phosphate rock industry has long been dominated by Morocco, which accounts for 33% of the world's known phosphate resources. The Moroccan phosphate industry is a major net exporter to the rest of the world at all three levels in the industry – phosphate rock, phosphate chemicals, and fertilizers. The Moroccan industry is concentrated into a single, government-owned company, OCP, which has traditionally acted as a market leader. It has demonstrated a willingness to adjust production volumes to market fluctuations in all but the most extreme circumstances. Morocco is a supplier to virtually all the major importing markets. Thus, the generally accepted benchmark price in the industry is the FOB Morocco price, expressed in dollars per tonne ($/t). This price refers to a standard quality product that grades 32% P_2O_5 (70 BPL) and has low levels of undesirable elements.

Phosphate rock prices were stable in the 1990s and reflected what may best be described as a "cost plus" pricing model. OCP set rock prices at a level that earned them a reasonable, utility-style return on their mines. This meant they earned a much more substantial but less stable profit in its downstream businesses. Rock prices were basically flat in nominal terms, implying a continuous reduction in real terms that reflected the steady improvement in mining equipment and technology and the embedded cost of the established rail and port infrastructure, which could be expanded as required at relatively low incremental cost.

All this changed in 2007. In July of that year phosphate rock prices had almost doubled from $45/t to $80/t, and further increases occurred in December of that year through the first half of 2008. The rock price ultimately peaked at $430/t in August 2008. Phosphate rock was not in short supply at this time. Rather, it was caught up in the general commodity boom. Nitrogen prices rose in response to genuine tightness in oil and gas markets, and there was also pressure on potash supplies arising from the culmination of a long period of relatively modest investment and supply growth. The rise in phosphate rock price was essentially an opportunistic participation in an overall spike in NPK prices.

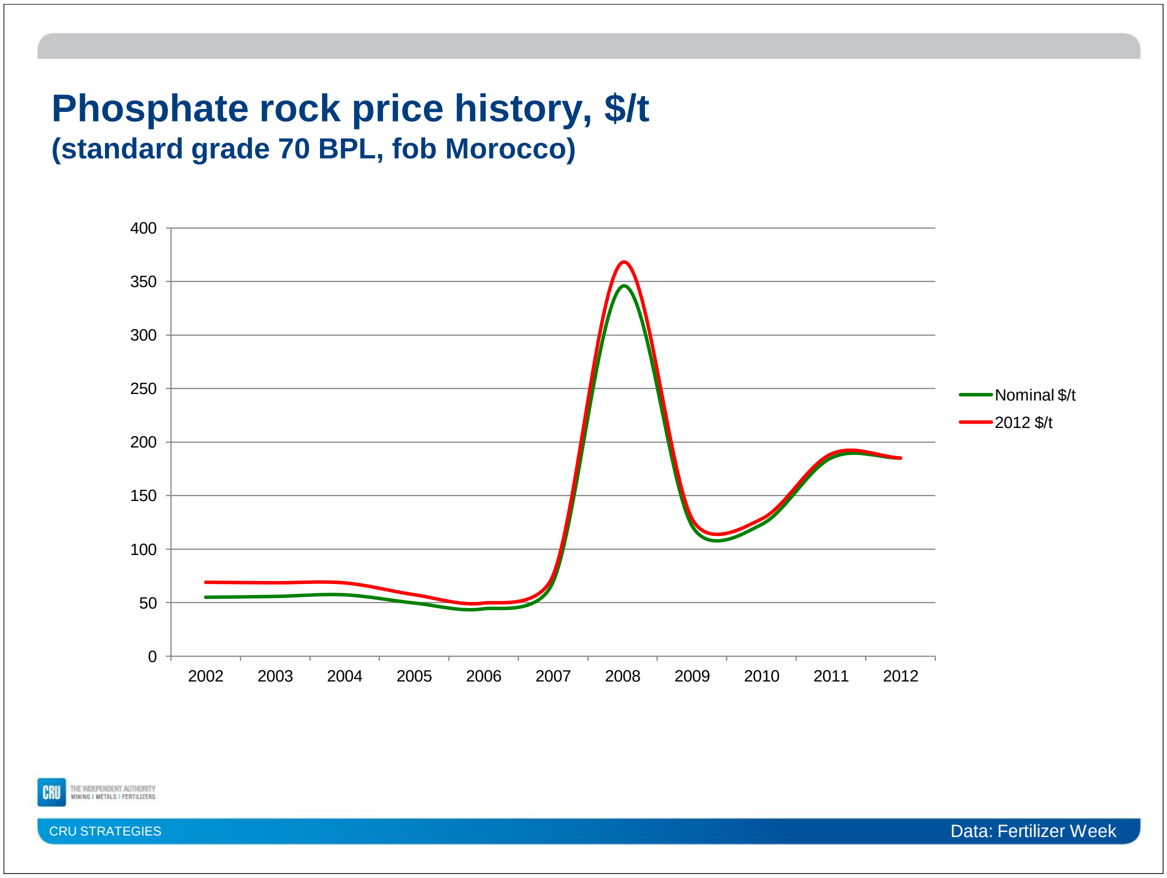
The boom was short-lived. Crop prices did not rise to the same extent, and NPK fertilizers rapidly became unaffordable, leading to a sharp drop in demand. This was particularly the case in India where the government was subsidizing the difference between fixed domestic prices and world market prices. The subsidies ballooned to financially unacceptable levels, leading to sharp curtailments in import authorizations. Phosphate rock prices collapsed to $90/t by the middle of 2009.

Despite its unsustainable nature, this cycle had a lasting effect on the pricing of phosphate rock. It promoted a fundamental change in philosophy at OCP. They have moved from a “cost plus” pricing philosophy to one based on market prices in which the pricing of phosphate rock has begun to track DAP, the price of which is established in a more competitive and transparent market. OCP also produces DAP, and the company has determined that it makes no sense to sell rock at low prices to its competitors. By increasing the price of phosphate rock, OCP is able to generate increased profits at this stage of production where it enjoys a larger market share than it does at the phosphate chemical stage of production.

There are, of course, some constraints on this process. OCP cannot maintain rock prices at levels that are excessive in the long term without attracting new competition at the rock level. Moreover, OCP must be conscious of the affordability issues its customers face. While it does not want these customers to be so profitable that they can undercut OCP in the chemicals business, it does not want them to be so unprofitable that they cease to be reliable customers for rock.

The shift in pricing philosophy has led to increased volatility in phosphate rock prices since 2009. Those prices rose slowly during 2010 and more rapidly in 2011 to a peak of $202.50/t. Prices then declined to $175/t by mid-2012. Recently, there has been a modest upward trend. This increase in price, however, has been fundamentally more sustainable than the 2008 spike in that it has taken place in the context of significantly increased crop prices.

The following graph summarizes the history of the phosphate rock price in both real and nominal terms over the last ten years.



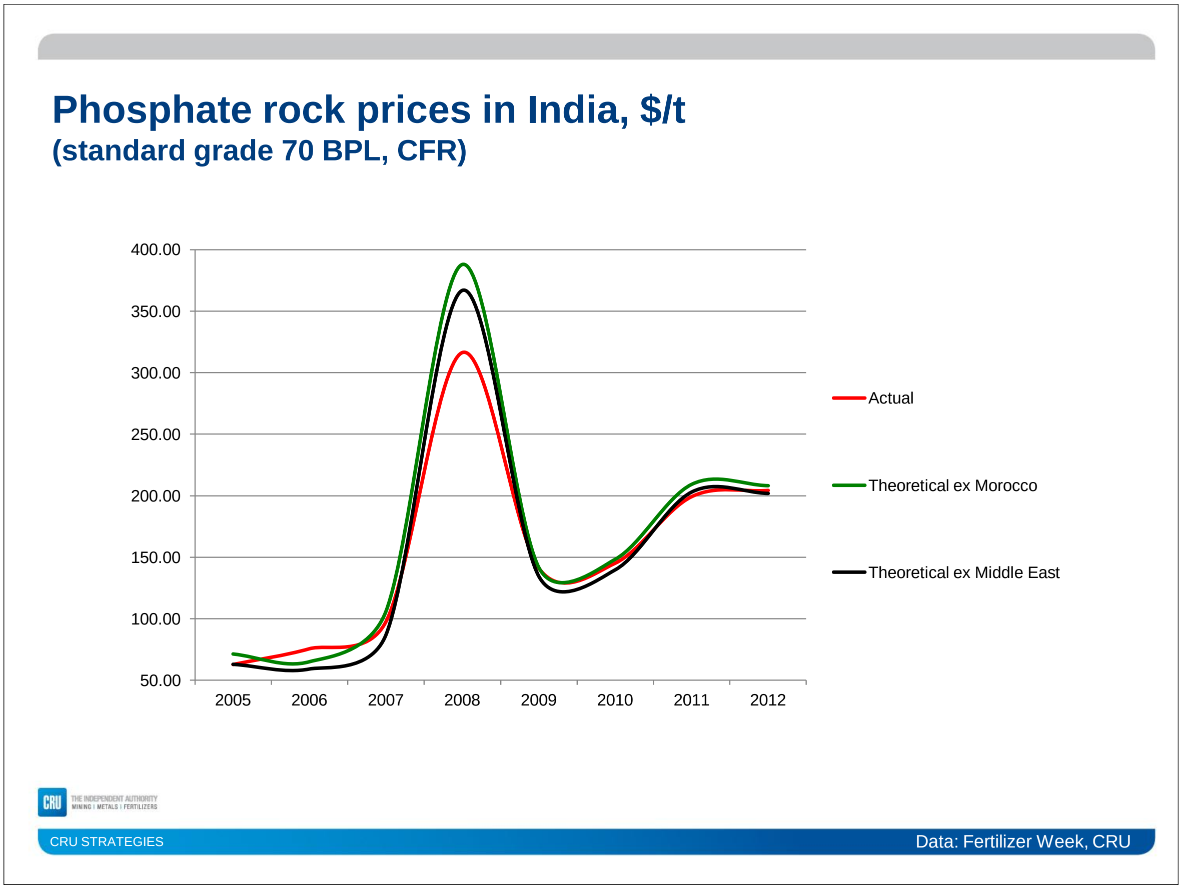
Phosphate rock price history, $/t
(standard grade 70 BPL, fob Morocco)

Data: Fertilizer Week

It should be noted that the cyclical low after the 2008 price spike was considerably above the price levels reported in the early-2000s. Phosphate rock is not unique in this regard. The same phenomenon has occurred in the potash industry and in other mining sectors like iron ore, copper, and aluminum. Although we have not experienced a complete business cycle since 2008, it appears highly likely that there has been a structural upward shift in commodity prices across the board.

6.3 Current market structure

As discussed in Chapter 2, Morocco is the net supplier of phosphate rock to almost all other importing regions. Prices in these areas are therefore set by FOB Morocco prices plus freight costs. The second most important export region is the Middle East (Egypt, Israel, Jordan and Syria), which competes particularly with Morocco in the important India market. CRU has analyzed the structure of ocean freight rates and calculated a netback FOB value for Middle East phosphate rock on the hypothesis that it competes with Moroccan rock in the Atlantic Basin (particularly Europe and Brazil). We have then calculated a theoretical CFR India price from both the FOB Morocco and FOB Middle East prices by adding the appropriate ocean freight. The following chart compares these theoretical calculations with the observed CFR India price.



Phosphate rock prices in India, $/t
(standard grade 70 BPL, CFR)

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Data: Fertilizer Week, CRU

The chart shows that the reported price in India is usually slightly less than the theoretical price from Morocco and slightly more than the theoretical price from the Middle East. This supports a conclusion that, in practice, OCP may slightly discount its price to India and that the Middle East producers may slightly discount their price in the Atlantic Basin in order for each to be competitive with the other on a delivered basis in the respective markets. This is a reasonable implication that reflects the commercial reality that market share is important and that diversity in the customer base has some value from a marketing risk management perspective.

CRU has further tested the proposition that phosphate rock approximates an efficient commodity market by calculating a theoretical price for phosphate rock FOB Peru on the basis of the CFR India price less freight. Peru is currently the major supplier to the United States, and this approach reflects Peru's alternative opportunity to sell phosphate rock to India (or some other Asian market). This price can then be used to calculate a CFR New Orleans price by adding freight. We have also calculated a CFR Tampa price based on the FOB Morocco price plus freight. The average value of the difference between the Tampa and New Orleans prices calculated in this way since 1994 has been $2.02/t. The current difference is around $0.50/t, both of which figures are clearly less than any freight cost between Tampa and New Orleans.

These checks confirm that the global phosphate rock market is, for all practical purposes, an economically efficient commodity market in which the price of standard quality rock in different places around the world reflects ocean freight rates.

6.4 Industry long-run marginal costs

Although short-term phosphate rock prices are set by such factors as the strength of the ultimate demand for phosphate fertilizers and affordability considerations at chemical plants, in the long run they are determined by the economics of new phosphate rock supply. New mines somewhere in the world are required to offset depletion of existing mines and to meet overall market growth. CRU believes that the latter is around 2.5% per year, which reflects the role that fertilizers play in improving crop yields and the necessity for such improvements in order to meet a rising global population while at the same time improving the diet of most of the third world's population.

In order to form a reliable basis for long-term price forecasting, CRU has therefore surveyed the new phosphate rock projects that are currently being proposed around the world. There is not likely to be any absolute shortage of phosphate rock in the foreseeable future. Global resources are thought to be around 240 trillion tonnes compared with 2011 consumption of 191 mn tonnes. CRU's most recent survey has identified 21 separate projects amounting to 54.2 mn tpy to which the industry is either committed[3], probable[4] or possible[5]. There are other projects with economics similar to those in the sample. Adding these projects increases the universe to 62.5 mn tpy. Together with the industry's existing capacity of 245.5 mn tpy, the grossed-up sample increases industry capacity to capacity to 308 mn tpy. Assuming a sustainable operating rate of 85%, they would support consumption of 262 mn tpy, a level that is 38% higher than that reported in 2011.

Although the process of actually constructing and starting a new phosphate mine may take only two to three years, the industry's effective lead time is considerably longer due to the feasibility study and permitting processes that are required before all relevant approvals can be given and financing

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[3] Committed means that funding and permits are in place and construction has begun.

[4] Probable means that the feasibility studies are at an advanced stage, substantial engineering has been completed, and financing negotiations are under way.

[5] Possible means that the pre-feasibility studies intended to identify the preferred development option have been fully funded and are in progress.

authorized. This process may take seven to ten years in some cases. However, even by this standard, the potential project pipeline identified by CRU is adequate to meet demand. Roughly speaking, half the projects in the universe need to be implemented by 2020 to satisfy demand.

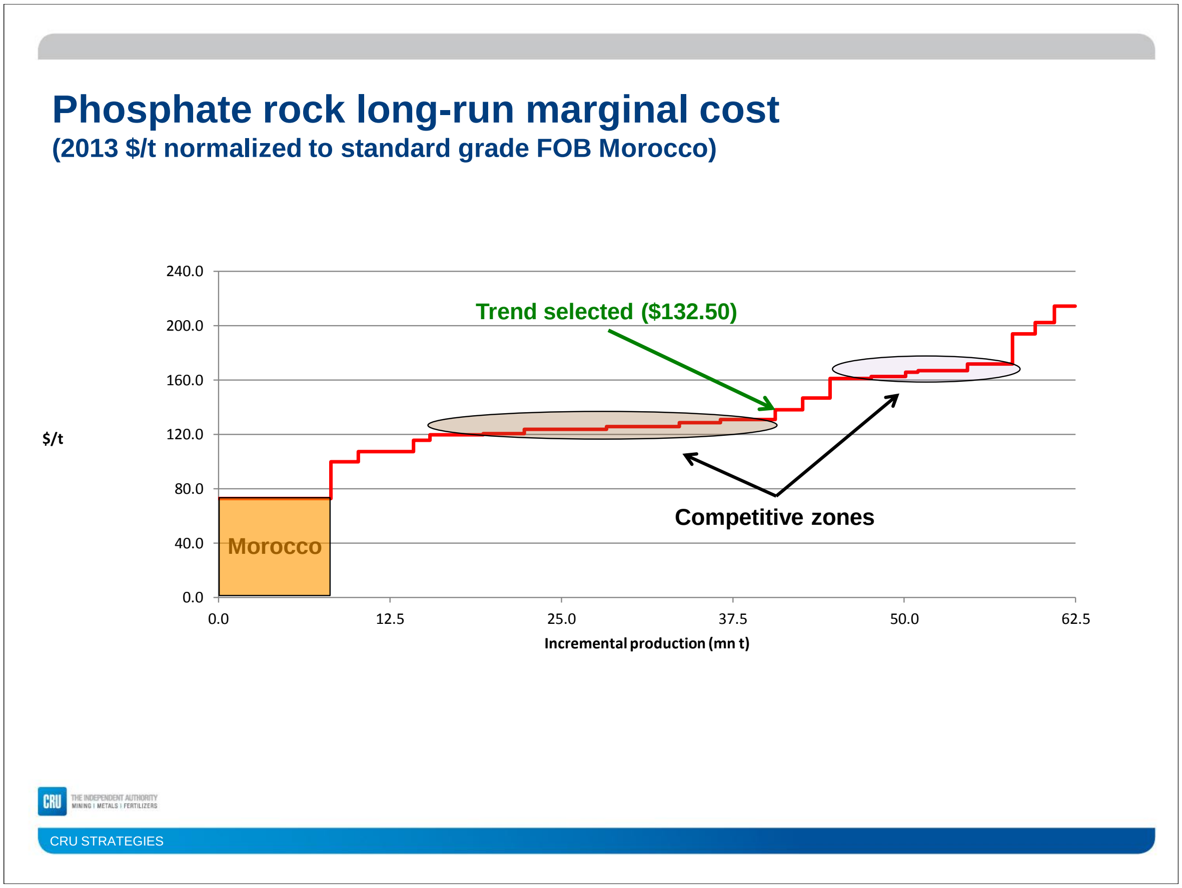
CRU has used its phosphate rock production cost model to estimate the full production costs of these projects. This model works out the equipment that is required to extract ore and convert it to deliverable rock based on fundamentals such as ore grades, recoveries, stripping ratios, and the like. In some cases CRU has access to prefeasibility studies, feasibility studies, corporate presentations and similar public domain documents that allows us to conduct some cross-checks on the output of the model. This process has to recognize, however, the uncertainties that are implicit in such studies.

CRU's costing methodology involves comparing projects with one another on a conceptually consistent basis. This requires us to make a number of adjustments to the data, the most important of which are the following:

- reported capital and operating costs are adjusted to 2012 dollars, taking into account inflation and movements in exchange rates since the original estimates were prepared;
- capital costs are converted into a required capital charge per tonne by amortizing the initial investment over the life of the mine using CRU's estimate of the industry weighted average cost of capital plus a country risk premium; this calculation also considers the effect of taxes;
- an allowance is added for sustaining capital expenses; these are maintenance-type expenditures that are typically capitalized and depreciated in conventional accounting;
- interest on working capital is added to operating costs;
- freight costs to the loading port are added;
- off site ocean freight, sales and marketing, and inventory and receivables financing costs are added; and
- any quality related price discounts are treated as an additional cost, and any quality related premiums are treated as a credit against costs.

The application of these principles usually means that CRU estimates long-run marginal costs (LRMC) to be somewhat higher than the figures reported by engineers in their feasibility studies, particularly where lower grade products are involved.

The following chart shows the relationship between the quantities of phosphate rock and the quantity that may become available from these projects. In the case of this curve, the quantities associated with some projects have been increased to reflect the fact that other projects with similar economics are available. The curve therefore presents a picture of the phosphate rock industry's long-term supply curve. This chart reflects 2012 dollars.



Phosphate rock long-run marginal cost

(2013 $/t normalized to standard grade FOB Morocco)

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The low cost producer in the industry is Morocco. The country has a well developed transportation infrastructure for phosphate mining and has a huge reserve base. There are already three different mining complexes linked to downstream chemical plants and ports. Morocco has the flexibility to expand rock production as the market requires. However, its growth is constrained by two basic factors. First, to sell this product in a downstream form, considerable investment in chemical plant is required and there are capital constraints. Therefore, Morocco has been joint venturing several of its projects in the recent past. Second, any effort to export substantially more rock runs into the limited size (about 15% of total consumption) of the third party rock market and risks disrupting the price. The volume assumption for Morocco on this curve reflects the continuation of OCP's historically demonstrated preference for expanding primarily via sales of downstream chemicals and declining to disrupt the rock market.

The chart shows that there are two broad areas of competitiveness. The first occupies the range \$120/t to \$130/t and runs from the 25th to 65th percentile of distribution. It includes many projects in sub-Sahara Africa and Latin America that have relatively modest infrastructure investment requirements. A second competitive zone is located at about \$160/t and runs from the 70th to 85th percentiles. These projects often face larger infrastructure barriers to implementation. CRU's conclusion is that the long-run trend price is likely to be set by one or other of these competitive zones.

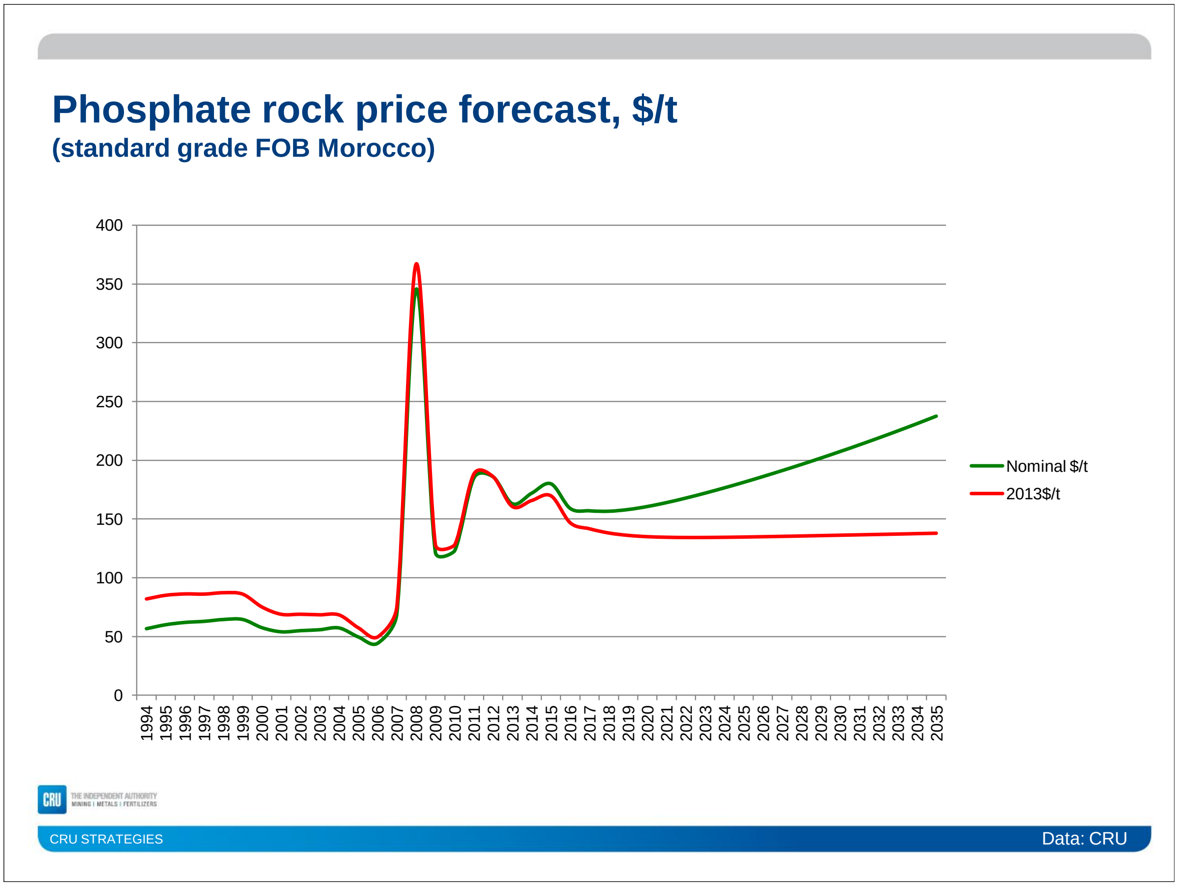
Currently, the OCP benchmark price reflects the upper of these two zones. This makes about 85% of the project inventory economically attractive and it makes 65% of the inventory extremely profitable. Such projects recover 150% or more of their cost of capital (after adjustment for risk). Since we only need about half the projects in the universe, CRU has concluded that the current pricing level of OCP is unsustainable and that the long-run trend will be set by the lower competitive zone.

However, because of the concentrated nature of the industry we believe that the trend will be set at the upper end of this zone on the argument that OCP has some market power to influence this outcome, by varying its phosphate rock export rate. We think they will therefore allow prices to fall to eliminate the risk of the market being entirely swamped by new projects. Consequently, the long-run trend value adopted by CRU is \$132.50/t expressed in 2013 dollars. This refers to a price normalized to standard grade products FOB Morocco. This is then adjusted for projected inflation and ultimately used as the trend to which prices converge over time.

6.5 Phosphate rock price forecast

CRU's forecasts for phosphate rock prices start by analyzing market conditions in the short term. This is defined as the period during which we can reasonably compare known capacity with demand, which is independently determined by such factors as the crop acreage planted and fertilizer application rates, which in turn reflect such fundamentals as crop prices and farm incomes. In practice this period is about three to five years. Thereafter, our price forecast converges to the path set by long-run marginal costs.

The following chart graphically illustrates CRU's long-term price forecast for phosphate rock FOB Morocco and places it in the historical context. CRU's current assessment is that the phosphate rock sector is enjoying above-normal profitability, which implies that almost all the projects in the pipeline should be financially attractive. Consequently, we expect average prices could be some 15% to 20% below current levels in the long term. However, as the chart shows, this will still be significantly higher in real terms than the price levels prevailing prior to the 2007-2008 cycle.



CRU notes that this outcome is very similar, in broad order-of-magnitude terms, to what can be observed in many other sectors of the mining industry. There has been a quantum upwards shift, in real terms, in the underlying costs structure of this industry between the first and second halves of the past decade, which reflects the impact of demand pressure from China and the need to restore the profitability of the industry's supply chain after almost two decades of persistent margin squeezes on suppliers of equipment and services between approximately 1982 and 2002.

The following table provides additional data on the implications for prices in various key markets around the world in both real and nominal terms. It should be noted that all the prices in this table refer to standard quality 70 BPL rock with no deleterious elements. Rock from specific producers may be sold at quality related discounts or premiums to these prices.

Table 6.1: Phosphate rock prices (70 BPL), nominal $/t

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Benchmark prices									
Morocco, FOB	57	50	44	69	346	122	123	185	186
% change	2.7%	-13.4%	-10.9%	56.9%	398.0%	-64.8%	1.1%	50.4%	0.5%
India, CFR	74	67	62	96	377	138	144	206	205
Constructed prcies									
Middle East, Syria, FOB	51	44	38	59	333	116	115	177	179
Latin America, Peru, FOB	47	41	37	51	325	114	113	177	179
Europe, Rotterdam, CFR	68	62	57	87	367	133	138	201	200
S-E Asia, CFR	86	79	73	115	399	150	158	220	218
Brazil, CFR	77	68	62	101	382	139	145	206	205
USA, Tampa, CFR	77	68	62	101	382	139	145	206	204
USA, New Orleans, CFR	78	69	63	102	384	140	146	207	206
Vancouver, CFR	96	91	87	132	420	162	164	225	223

	2013	2014	2015	2016	2017	2018	2019	2020	2035
Benchmark price									
Morocco, FOB	163	172	180	159	157	157	158	161	238
% change	-12.3%	5.5%	4.7%	-11.7%	-1.3%	-0.2%	0.9%	1.6%	
Exporters									
Middle East, Syria, FOB	156	165	173	151	149	149	150	153	223
Latin America, Peru, FOB	155	164	172	151	149	148	149	152	221
Importers									
Europe, Rotterdam, CFR	177	186	195	174	172	172	174	177	264
India, CFR	182	192	201	180	178	178	180	183	275
S-E Asia, CFR	196	205	215	194	192	192	194	198	299
Brazil, CFR	183	192	201	180	178	178	180	183	275
USA, Tampa, CFR	182	192	200	180	178	178	180	183	275
USA, New Orleans, CFR	183	193	202	181	179	179	181	184	277
Vancouver, CFR	201	210	220	199	197	198	200	204	309

Source: CRU

Table 6.2: Phosphate rock prices (70 BPL), 2013 $/t

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Benchmark price									
Morocco, FOB	68	57	49	75	367	128	128	188	186
Exporters									
Middle East, Syria, FOB	61	50	43	64	354	122	120	181	179
Latin America, Peru, FOB	55	47	41	56	345	121	118	180	179
Importers									
Europe, Rotterdam, CFR	81	72	64	95	390	140	144	204	200
India, CFR	88	77	69	105	401	145	150	210	205
S-E Asia, CFR	103	91	82	125	424	158	164	224	218
Brazil, CFR	92	79	70	110	406	146	151	209	205
USA, Tampa, CFR	92	79	69	109	405	146	150	209	204
USA, New Orleans, CFR	93	80	71	111	408	147	152	210	206
Vancouver, CFR	114	105	97	143	446	171	171	229	223

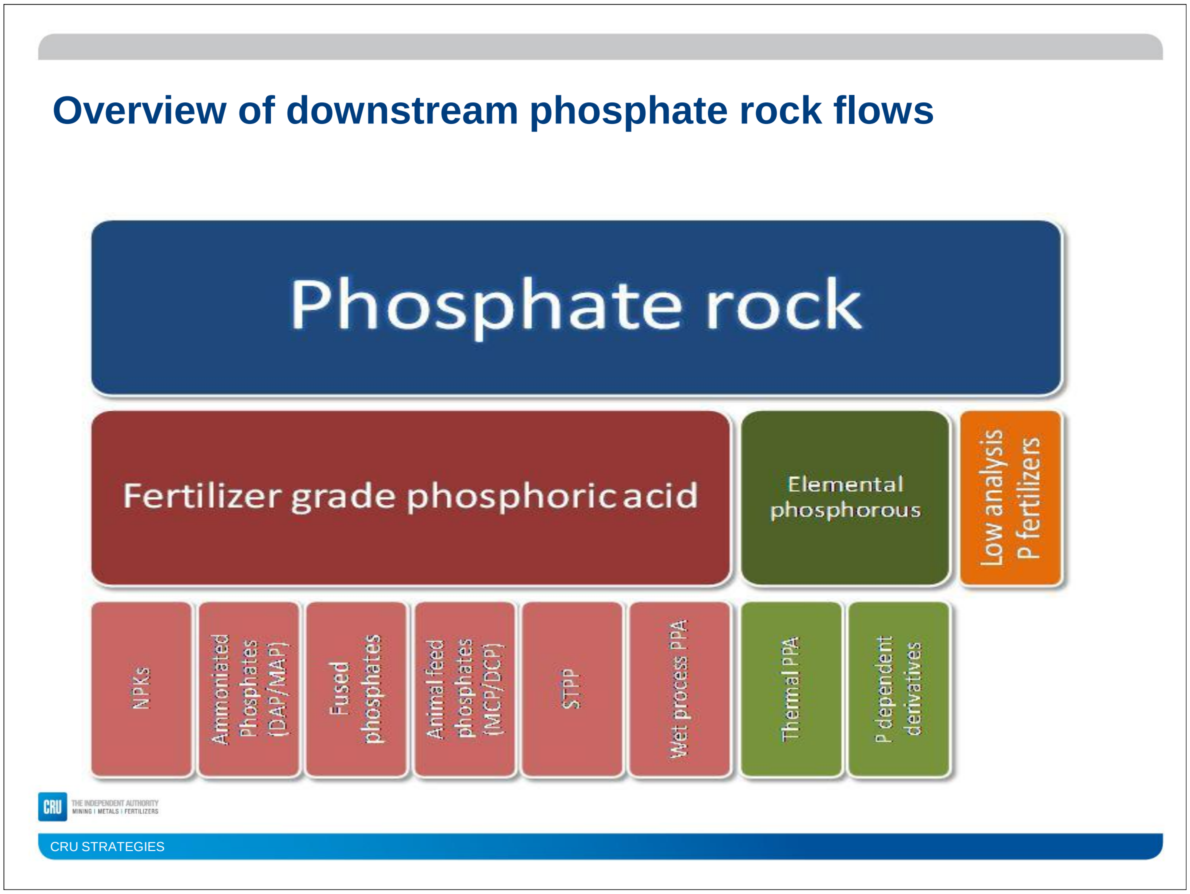
	2013	2014	2015	2016	2017	2018	2019	2020	2035
Benchmark price									
Morocco, FOB	160	166	170	147	142	138	136	135	138
Exporters									
Middle East, Syria, FOB	153	159	163	140	135	131	129	128	130
Latin America, Peru, FOB	153	158	162	139	134	131	128	127	128
Importers									
Europe, Rotterdam, CFR	174	179	184	161	155	152	150	149	153
India, CFR	180	185	189	166	160	157	155	153	159
S-E Asia, CFR	193	198	202	179	173	169	167	166	174
Brazil, CFR	180	185	189	166	160	157	155	154	160
USA, Tampa, CFR	179	184	189	166	160	156	154	153	159
USA, New Orleans, CFR	181	186	190	167	161	158	156	154	161
Vancouver, CFR	198	203	207	184	178	174	172	171	179

Source: CRU

Chapter 7 – Marketing strategy

7.1 Overview of marketing opportunities

The following diagram shows the major components of the phosphate rock market. Approximately 70% of P_2O_5 delivery from the mining sector goes through wet-process phosphoric acid production facilities (making fertilizer grade acid), approximately 15% goes through thermal plants (which make elemental phosphorous and then hydrate this when acid is required) and the remaining 5% involves the direct production of low analysis P fertilizers like SSP (single super phosphates).



Overview of downstream phosphate rock flows

Phosphate rock

Fertilizer grade phosphoric acid

Elemental phosphorous

Low analysis P fertilizers

NPKs

Ammoniated Phosphates (DAP/MAP)

Fused phosphates

Animal feed phosphates (MCP/DCP)

STPP

Wet process PPA

Thermal PPA

P dependent derivatives

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In addition to these major flows, there is a small volume of other fertilizer products, such as nitro-phosphates and NPK fertilizers (referred to as complex fertilizers). NPK fertilizers are blended products that contain all three primary nutrients, and are often consumed in developed markets such as Europe and North America. Nitro-phosphates (NPs), on the other hand, are complex phosphate fertilizers obtained by the reaction of phosphate rock with nitric acid. Advantages of this route include avoiding the production of gypsum as a by-product and being independent of sulphur.

However, the complexity of the process and its high capital costs continue to confine it to a niche role.

Ground phosphate rock is also used as a source of phosphorus for direct application, particularly in acidic soils which can allow for the release of phosphorus in a form that can be absorbed by plants. Direct applied rock is also a source of the secondary nutrient calcium, which helps soil health by its liming effect, increasing the soil's pH level. However, the use of phosphate rock for direct application has declined significantly in the last three decades as technical improvements in the fertilizer industry made more refined products available to farmers worldwide.

In CRU's opinion, these markets do not offer the prospects of significant sales volume to Lac a Paul. The only market of potential significance outside apart from the wet process phosphoric acid (WPA) plants is the SSP market. This fertilizer product is made by directly treating phosphate rock with sulphuric acid and avoiding the intermediate production of acid. Igneous rocks typically produce high grade concentrates with relatively low levels of deleterious impurities and are, therefore, particularly suited to this process (which is less effective at removing impurities).

SSP is one of the most important P fertilizers in terms of crop application by farmers, particularly in countries such as Brazil, India, and China. On the other hand, its significance in international trade is much lower than other phosphate fertilizers such as granulated fertilizer or TSP. Low capital expenditure and non-reliance on ammonia are important advantages of SSP production, making it easy to be produced and supplied locally. Compared with other products, SSP manufacturing shows little economies of scale. This feature allows for a number of small plants to operate profitably even at low utilization rates. 80% of the production of this product occurs in developing countries. China and India are major producers, along with Brazil, where new igneous rock projects are being developed, and Argentina.

Although SSP has a lower P2O5 content, its lower price makes it an attractive product from the perspective of farmers. Its calcium and sulphur content is also a source of differentiation from other common phosphate fertilizers. SSP behaves as what economists call an "inferior good", that is, a commodity which has a decline in demand when income grows so that premium substitutes are affordable. From the perspective of phosphate rock producers, the counter-cyclical behaviour of SSP represents a safe haven, as it reduces losses in periods of negative market performance.

Unfortunately, the market for SSP has shown a long-run downward trend over several decades. Consequently, although it is theoretically suitable for the type of product that Lac a Paul plans to produce, we believe that the project will only be able to make opportunistic sales into this market niche.

The implication is that this project will need to be underpinned by sales to the traditional WPA market which constitutes the bulk of the P_2O_5 volume in the world economy. Moreover, the already large share of this process is likely to further increase during the forecast period. Consequently, the remainder of this chapter focuses on the prospects for sales to WPA plants and the implications that this has for overall marketing strategy.

7.2 Regional analysis of potential markets

This section of the report provides a narrative description of the marketing environment in the major consuming regions. Specific regional phosphate rock balance tables are contained in appendix B.

7.2.1 North America

North America accounts for approximately 20% of global acid capacity. The US-based operations are concentrated in the south-east of the country, primarily across Florida, North Carolina and Louisiana. Plants in Florida and North Carolina are all integrated with upstream mining capacity, whereas those along the Gulf Coast (Louisiana and Mississippi) operate using purchased rock. In total, there were eleven operating plants in the USA during 2011, with a combined acidulation capacity of 9.2 mn tpy P_2O_5 in 2011.

Four of the North American plants are operated by Mosaic, which also runs the region’s largest, New Wales. As a whole, the company’s acidulation capacity stood at 4.3 million tonnes P_2O_5 in 2011, making it the second largest acid producer around the world (behind OCP).

PotashCorp is North America’s second largest P producer, accounting for about 25% of its capacity. Its operations are spread across Florida, Louisiana and North Carolina. The latter (Aurora, North Carolina) is PotashCorp’s largest, accounting for half its total phosphoric acid capacity. PotashCorp had been planning to further enhance the plant by developing a new sulphur melting facility at Morehead City; however due to widespread public opposition, the plan has subsequently been scrapped. At present, CRU is not aware of any additional developments at PotashCorp’s plants. Thus we expect its capacity to remain constant at 2.4 million tonnes P_2O_5 acid.

Most North American operations are integrated vertically with phosphate rock capacity. As much of this is good grade, located close to their respective phosphoric units, they have remained competitive even as existing plants/mines have aged. In fact, most of the region's capacity falls within the first two quartiles of the global production cost curve.

There are three US plants that use imported rock. Mosaic uses Peruvian rock from its Bayovar JV, in its acid plant in Louisiana (Uncle Sam/Faustina complex). Similarly, PotashCorp uses high grade rock from OCP's Bou Craa mine in North Africa at its Geismar complex. CRU believes these plants have a secure future. However, we are less certain of the prospects at the third importer, Mississippi Phosphates' plant in Pascagoula. The plant has encountered various operating problems in recent years, and most recently an explosion in June 2012, led to a forced shut-down by the US OSHA. Although the plant is back in operation, and even reported an operating profit for Q2 2012, conditions are likely to remain tough. The plant is old, and in need of new capital investment.

In Canada, there are likely to be changes at Agrium's Redwater plant. The plant produces MAP and a host of nitrogen products. The rock feedstock is currently sourced from Kapuskasing (Ontario), but is set to shift to Moroccan rock, as Kapuskasing is scheduled for closure in H2 2013. The contract with OCP is a "take-or-pay" agreement, running from H2 2013 through to 2020, with an option to extend for a further two years. Although details have not yet been made public, pricing is reportedly a formula based calculation based on global DAP prices. One certainty, though, is the new supply arrangement will result in a considerable increase in the relative cost position of this plant. Redwater is a long way away from Morocco (Vancouver is 8,300 nautical miles from Casablanca and Redwater is an additional 1,200 km by rail). That said, CRU's base case forecast is that Redwater will continue to operate over the medium term. Clearly, it represents a marketing opportunity for Lac a Paul once the OCP contract expires (or indeed potential exists for a swap transaction).

North America's remaining capacity is shared between CF Industries (Florida), Simplot (Wyoming and Idaho) and Agrium (Idaho), all of which are vertically integrated. One of the more significant developments at these locations includes Simplot's proposed expansion of its liquid and dry phosphate production at Rock Springs, which may be completed as soon as 2014. Although no further capacity expansions are expected at these locations, further product developments are to be expected. CF Industries, for example, has already developed its own sulphur enhanced phosphate fertilizer (11-40-0-12S) using Shell's Thiogro process technology.

Despite its location advantage, North America offers limited marketing opportunities for Lac a Paul. WPA capacity is expected to be flat and the majority of the plants are integrated. The main opportunity is clearly in Canada with Agrium. There may be limited US opportunities by shipping to the Gulf Coast. Another opportunity may open up if some of the Florida based plants are unable to secure environmental permits for the new mines they require to replace those that will deplete by 2020. In particular, Mosaic is facing challenges in this regard.

7.2.2 Europe

Europe (outside a very small quantity of rock produced in Finland) is entirely dependent on imported phosphate rock. It obtains most of this from Morocco. However, European rock consumption has diminished dramatically in recent years. This has particularly been the case in Western Europe where acid production has ceased in Denmark and been dramatically curtailed in France and Spain. Prior to 2005 Western European rock consumption had been running at 7-8 mn tpy. It was under 5 mn tpy in 2011 and CRU expects it will decline further to 4 mn tpy by the 2015-2020 period. The main rock consuming countries are Belgium, Netherlands, Norway and Finland. However Finland is vertically integrated and is actually a small net exporter of rock.

In Eastern Europe, rock consumption has remained more stable at around 3.5 mn tpy and CRU expects this to continue for the medium term. The largest sources of demand are Poland and Lithuania which each imports 1.25- 1.5 mn tpy of rock annually. **Eurochem** is the leading company in Lithuania and supplies its plant with phosphate rock from the Koydorky GOK apatite mine, located in the Kola Peninsula. However, Lithuania also imports some rock from Morocco.

It is CRU’s opinion that Lac a Paul can potentially sell rock into the European market. All of the countries mentioned import rock from both North Africa (Morocco and Tunisia) and Russia and a number of them also import from the Middle East (Israel and Syria). However, this is arguably the most competitive part of the market. Moreover, European rock demand is unlikely to increase so it is a matter of displacing an incumbent supplier, which is always challenging. It seems clear that most European chemical producers are likely to meet growth in their markets by investing in downstream joint ventures with offshore mining companies and, in fact OCP has already engaged in several transactions of this nature.

7.2.3 Russia/CIS

The phosphate industry in the CIS is dominated by Russia which remains one of the largest markets for finished fertilizer products. In total, operating plants within the country had a combined phosphoric acid capacity of 3.1 million tonnes P_2O_5 in 2011, and the corresponding MAP and DAP capacities were estimated at 1.6 million and 0.8 million tonnes P_2O_5 respectively. In recent years, Russian producers have been exporting increasing volumes of finished fertilizer products to the USA, which has raised concerns among American producers.

PhosAgro is the largest vertically integrated phosphate enterprise in Russia. The company comprises a number of subsidiaries and two vertically integrated phosphate complexes – Balakovo and Ammophos – enabling flexibility within the production lines. Balakovo is the second largest fertilizer plant in Russia, located in the south of the country. Due to its close proximity to Kazakhstan, the complex imports phosphate rock from neighbouring country, which lowers supply costs. October 2012 saw PhosAgro increase its share in the Russian phosphate rock producer Apatit to almost 80%, following the purchase of the Russian government's stake. The company has also announced plans to take over several of Apatite's minority shareholders which are scheduled for completion by Q1 2013. CRU believes this is a positive development for PhosAgro, as it will enable the company to consolidate its position as one of the world's largest vertically integrated phosphate producers. Furthermore the deal secures future rocks supplies to PhosAgro's fertilizer complexes, allowing the company to increase production capacity of downstream DAP, MAP and NPK.

In comparison to PhosAgro, which only has operations within Russia, **Eurochem** has infrastructure in Russia, Ukraine, Estonia and Lithuania. Eurochem's interests are diverse, though its primary interest lies in the N and P industries. The company has three integrated phosphate plants, two in Russia and one in Lithuania. These are supplied with phosphate rock from the Koydorky GOK apatite mine, located in the Kola Peninsula. The Belorechensk and Phosphorite plants also produce NPS fertilizers of differing grades.

Going forward, expansions in both Russia and Kazakhstan are set to increase the CIS phosphoric acid granulation capacity total by 0.6 million tonnes to a total of 5.2 million tonnes P_2O_5 in 2017. **Eurochem** has outlined brownfield expansion plans of its Kingisepp phosphoric acid plant. The development, which is secluded to be completed by 2014, will increase the operation's overall phosphoric acid capacity to 0.5 million tonnes/year P_2O_5. We expect **Meleuz Minudobrenia** to increase its nameplate capacity by 13% to 0.3 million tonnes P_2O_5 in 2013. Across the Kazakh border, **Sunkar Resources** has outlined extensive plans to start up phosphate operations at the include a 0.2 million tonnes/year phosphoric acid train, evenly split across two downstream granulation plants for DAP and MAP, each capable of producing 0.1 million tonnes/year P_2O_5.

Although substantial and growing, the CIS is not a market that is available to Lac a Paul. It has a phosphate rock export surplus and its downstream facilities are essentially 100% integrated.

7.2.4 Latin America

Latin America phosphate rock consumption is on a rising trend. Regional demand is now around 10.5 mn tpy, up from 8 mn tpy in the early 2000s. CRU expects it to reach 12 mn tpy by 2015 or shortly thereafter. Almost all of this is in Mexico (around 2.5 mn tpy) and Brazil (7 mn tpy). Brazil is growing much faster than Mexico. Both countries have domestic rock supply but, at the margin, are net importers. These imports are currently running at 1.5 mn tpy in the case of Brazil and 0.8 mn tpy in the case of Mexico. In both cases, supply is contested between Peru and Morocco.

Brazil has ambitious plans to reduce its current dependence on imported MAP by an expansion in domestic production. CRU has identified four key projects in this regards:

- **Vale** completed a brownfield expansion project at its Uberaba plant in Q3 2012.
- Vale also plans to build a greenfield development at Salitre, Minas Gerais, which includes a 2.0 million tonnes/year rock mine as well as MAP and TSP facilities. Although Vale has recently pushed back the commissioning of the R$2 billion project to 2016. Once the project is completed it is expected to have a total phosphoric acid capacity of 0.6 million tonnes/year P_2O_5, in addition to 0.8 million tonnes/year of MAP and 0.3 million tonnes/year of TSP.
- **Copebras** is planning to revamp production at its Catalao plant, which will be completed through a series of debottlenecking measures, specifically on the phosphoric acid and phosphate rock sides. The project, listed as probable, is forecast to come on-stream by 2015 and will increase capacities at the facility to a total of 0.2 million tonnes/year P_2O_5 phosphoric acid and 0.3 million tonnes of MAP.
- Copebras is also planning a brownfield expansion of its Catalao plant, with the aim to increase rock capacity to 2.6 million tonnes rock by 2013. Although the company is still unclear about what products it will produce, the likelihood is it will focus production on MAP, TSP and/or DCP. If this is the case, and if capacities are increased in their entirety, the project will see phosphoric acid capacity increase to 0.4 million tonnes P_2O_5 in addition to 0.5 million tonnes of MAP and 0.3 million tonnes of TSP.

These increases in Brazilian acid production will, however be met by parallel increases in phosphate rock mine production. Indeed there is the likelihood that Brazil will raise mine production by more than acid production so the current net import rate is forecast by CRU to decline. Consequently, the prospects of placing Lac a Paul product in this region are not considered to be particularly promising.

7.2.5 China

China is the largest phosphate market in East Asia and the world. In total, China's operating plants during 2011 had a combined phosphoric acid capacity of 15.7 million tonnes P_2O_5, and the corresponding DAP, MAP and TSP capacities were 9.5 million, 9.2 million and 0.9 million tonnes

P_2O_5 respectively. The Chinese phosphate fertilizer industry has experienced rapid increases in capacity over the past decade. The country has in excess of 300 chemical fertilizer plants, many of which are small/non integrated operations, making which makes it difficult to estimate the country's phosphate capacity.

Over the medium term, the industry will continue to invest in capacity expansions with phosphoric acid and granulation capacities each increasing 7% through to 2012. Though, it is important that these figures are considered with some caution. Rather than an increase in overall capacity volumes, it is CRU's view that the Chinese market will be subject to consolidation. Old, small and inefficient plants are likely to be replaced or upgraded, due to continued pressure from high raw material costs, and intense competition. The average plant size is set to increase throughout the forecast period, though this will be coupled with planned closures and smaller plants becoming idle. With a relatively flat forecast for national production, CRU anticipates that there will be a significant change to the supply structure over the next five years. Though the country will continue to expand its overall capacity, this will be at a slower pace than the previous decade.

Unlike other commodities, China is largely isolated from the rest of the world when it comes to phosphate rock. There is a small amount of trade with Korea but it is insignificant from a global perspective. China appears to have sufficient domestic mineable reserves to supply whatever WPA demand scenario is considered.

7.2.6 India and other Asia

From a structural perspective, this region is similar to Europe in that it almost entirely dependent on imported phosphate rock. Current imports are running at 12 mn tpy. India accounts for approximately 7.5 mn tpy and Indonesia approximately 1.5 mn tpy of this total. Other significant importers include Japan, Korea and Pakistan. Most of the imports are supplied from North Africa and the Middle East, with the latter region having a larger share thanks to its transportation cost advantage. In terms of rock production, the most important source is Vietnam which mines about 2.4 mn tpy and exports around 0.5 mn tpy.

However, unlike Europe these are growth markets for phosphate fertilizers. Clearly the key market is India, but opportunities exist in other large population markets where agricultural production is expanding. Indonesia is clearly the foremost of these, although one day, if it can resolve its economic and political challenges, Pakistan may be a factor as well.

India accounted for 4% of global phosphoric acid capacity and 8% of global granulation capacity in 2011. The country's main phosphate fertilizer production sites are all located close to coastal ports making it accessible to overseas rock exporters.

India has experienced a decrease in domestic phosphoric acid demand in recent years, though domestic acid production has remained relatively stable, resulting in a decrease of imports. We regard this as a cyclical phenomenon that can ultimately be traced back to phosphate affordability problems during the price spike in 2008. In the long-term, India is a growth market and will probably want to import phosphates in the lowest cost form, namely phosphate rock. Although phosphoric acid and granulation capacity are expected to remain relatively consistent throughout the forecast period, production are set to increase by 4% and 6% respectively by 2017. CRU has identified one Indian project during the forecast period. Paradeep Phosphates expansion of its Orissa plant is listed as probable, and aims to increase phosphoric acid capacity to 0.1 million tonnes/year P_2O_5 by 2014.

Clearly the Asian region, India in particular, represents one of the better markets for new phosphate rock sales. Unfortunately Lac a Paul is at a distinct transportation cost disadvantage when it comes to serving those markets. This is evident from the fact that Morocco, which is nearer than Canada, has a lower market share in this region than elsewhere in the world.

7.2.7 Africa

Phosphoric acid and granulation capacity currently exists in six African countries. Although rock reserves are plentiful in sub-Saharan Africa (specifically, the potential for marine deposits off the coast of South Africa and Namibia), most of the region's production is concentrated in the north. Morocco and Tunisia jointly accounted for 6.2 million tonnes P_2O_5 of acid capacity and 3.0 million tonnes P_2O_5 of granulation capacity in 2011.

These are not markets that are available to Lac a Paul. Phosphoric acid plants in Africa are all effectively integrated with their mines and, going forward, many of these countries will be net exporters at both the rock and acid/DAP/MAP levels in the supply chain. There is of course, considerable import potential in many African countries for P as a fertilizer component. However, this is most likely to be supplied in the form of fertilizer chemicals like DAP/MAP or even directly as NPK fertilizers made elsewhere.

7.2.8 Middle East

The most important development in this region is occurring in Saudi Arabia. This country had acidulation capacity of 0.8 million tonnes P_2O_5 in 2011, in addition to 1.7 million tonnes of DAP and 0.1 million tonnes of MAP. However, CRU forecasts that by 2017, acidulation and total granulation capacities will increase to 3.0 million tonnes P_2O_5 and 2.9 million tonnes P_2O_5 respectively.

This is due to substantial increases in **Ma'aden**'s production rates. The company has continued to try to ramp-up DAP production volumes at its Ras Al-Khair plant. Although the last quarter started off fairly promising, with monthly production hitting approximately 0.15 million tonnes of DAP, it seems to have fallen back again. Ongoing challenges facing its mining (specifically affecting the crushing and beneficiation stages) and logistical operations (railway) continue to limit rock availability for DAP production. Unofficial reports indicate that these issues are being addressed but that it may still take some time to resolve. We therefore do not expect production will increase, anywhere close to capacity, until at least mid 2013.

Ma'aden is also planning a second world-scale integrated complex at Umm Wu'al, in northern Saudi Arabia. It was originally thought the plant would increase Ma'aden's product portfolio with animal feed phosphates, though now it is assumed to be primarily dedicated to DAP and MAP production. Although it is still in the development stages, it appears that Ma'aden is determined to bring it on stream during the medium term outlook and therefore it is categorised as firm in our database.

The fundamental business case for this huge expansion is that Saudi Arabia possesses a fundamental competitive advantage in the production of DAP/MAP due to its large stranded gas resource, which ultimately supplies the ammonia component of the feedstock. The completion of its railway project unlocks previously isolated phosphate rock resources (in addition to a number of other minerals). In the long run Saudi Arabia may be an importer of potash and a supplier of a full range of NPK products, but it does not constitute a market for phosphate rock. Having said this, CRU does not consider it likely that Saudi Arabia will be a significant rock exporter. For strategic reasons we think that companies like Ma'aden will want to beneficiate this to a higher value added product and sell the latter to the burgeoning India/South East Asia region.

7.2.9 Oceania

In Oceania, Australia and New Zealand are the main producers of downstream phosphate chemicals. New Zealand has no domestic rock resources and imports all of its requirements from small Pacific islands including Nauru and Christmas Island. Australia has its own phosphate rock mining industry but is also a small net importer at the margin.

Incitec Pivot remains the only phosphate producer in **Australia**. The company's largest fertilizer plant is Phosphate Hill, which is next to the company's Duchess phosphate rock mine. The plant is supplied with sulphuric acid from Mount Isa, which uses SO_2 from the neighbouring Xstrata copper smelter. At the beginning of 2012, Xstrata experienced severe mining issues, in addition to maintenance at its concentrator over running and as a result this limited the supply of SO_2 to Incitec Pivot. This resulted in H1 2012 seeing a rise of SO_2 imports from Japan and South Korea, which increased the production cost of sulphuric acid. However, CRU is of the belief that this was a transitory phenomenon which has now been resolved and phosphate fertilizer production levels are unlikely to have been significantly affected. The company has also recently been part of a trade agreement with Mosaic which saw a portion of its tonnage of finished chemical products exported to the Indian subcontinent to fulfil Mosaic's contract agreement with India.

Legend International is seeking to gain market share of the Australian phosphate industry through the construction of a greenfield development at Mount Isa. The project, listed as probable, is due on-line in 2015 and will include a 0.2 million tonnes/year P_2O_5 phosphoric acid plant, as well as capacity for 0.2 million tonnes/year of DAP and 0.3 million tonnes/years of MAP. Should this project become operational, it will help increase Australia's total P_2O_5 capacity by approximately 24% by 2017, and mitigate the effects of increasing demand in the area, hence sustaining the country's export capability.

The **Wonarah** project in the Northern Territory is also in the pipeline. Initially proposed as a phosphate rock export project, it seems likely that if it progresses it will integrate downstream into acid and DAP/MAP production given the logistical implications of rock exports and reflecting the local availability of gas.

The implication is that Oceania is not a potentially promising region for Lac a Paul. In fact it may be a longer-term competitor.

7.3 Implications for marketing strategy

The fundamental challenge facing the Lac a Paul project is the integrated nature of the phosphate rock industry. Only 30 mn tpy of the almost 200 mn tpy market in non-integrated. The other mines are closely linked in either proximity or hardly grown at all over the past decade. For instance CRU's estimates of total global trade in phosphate rock shows a figure of 29.8 mn tpy in 2011 compared to 30.2 mn tpy in 2002. Understanding why this is so is, in our opinion, critical to developing a credible marketing strategy for Lac a Paul.

The ideal location for a phosphate rock project is in a country that not only has a competitive natural resource but also has relatively inexpensive sulphur (to reduce the cost of making phosphoric acid), relatively cheap natural gas (to reduce the cost of making the ammonia required for DAP) and access to large and preferably growing fertilizer markets. Very few places have all of these ingredients. However Saudi Arabia is perhaps the best placed of all. It has the phosphate deposits, it has a huge gas surplus, it has some by-product sulphur from petroleum activities and it has easy ocean access to the large growing markets in India and eventually Indonesia and other parts of south-east Asia.

The rationale for the development of the Florida phosphates was not simply low mining costs but also relatively easy access to gas and elemental sulphur from the US gulf coast and, of course, proximity via low cost intra-coastal and Mississippi barging to the agricultural heartland of the Mid-west. This industry has lost competitiveness in the past two decades because, until recently, the US had quite high natural gas prices and there are growing environmental constraints in Florida. The first step was for Florida to stop exporting rock to the rest of the world. The next step was to stop shipping it to the Gulf coast and to have those plants start importing from Peru instead.

The upper mid-west is now starting to emerge as one of the low cost natural gas regions of the world. The shale boom in the United States and parts of Canada, along with the sulphur availability as essentially free by-product from tar sands mining makes the production of DAP potentially competitive. Layer in Saskatchewan’s huge potash resources and all the strategic markers are in place for a highly competitive global NPK version of “Silicon Valley”. The missing ingredient is, of course, the phosphate rock. The western US mines are small and relatively high cost. In our opinion the main opportunity for Lac a Paul is to supply this region and the specific opportunity is to replace the Moroccan rock that will be purchased to offset the closure of the Kapuskasing mine.

Other North America opportunities exist but they are mainly along the gulf coast where the project will be competing with rock from Morocco and Peru. This industry is highly concentrated and does not offer a very liquid spot market. Consequently a strategic relationship with a phosphate chemical manufacturer willing to enter an offtake agreement is probably going to be needed.

The one part of the world that does offer considerable spot market sales potential is India and South East Asia but Lac a Paul is at a considerable disadvantage in serving these markets from a freight perspective.

Finally, entry into the European market can be considered. The most promising opportunities probably lie with supplying specialty phosphate companies like Thermophos. However, it must be appreciated that these are not growth markets and Lac a Paul will not only be competing with other high quality rock suppliers like Russia but also with standard grade product coming out of Morocco. Again a strategic relationship involving a longer-term offtake agreement is, in our opinion, the best way to mitigate the volume risk which we believe is otherwise present in these markets.

In summary, CRU does not believe that there is any evidence that the non-integrated phosphate rock market is likely to grow. We expect the historical pattern whereby growth has been concentrated mostly in the integrated market will continue during the forecast period. This strongly suggest that a downstream integration strategy, whether through joint venture, long-term offtake agreement or even investment in acid capacity is the best way to secure a market for Lac a Paul's output.

Chapter 8 – Value in use issues

8.1 Technical background

Commercially mineable phosphate rock falls into two broad types of deposit, namely sedimentary and igneous. The vast majority of phosphate rock, approximately 85%, comes from sedimentary deposits, which were formed from decaying marine and animal matter in basins located in warm climates and areas of upwelling water. The two most important commercially exploited examples are the deposits of Morocco/Western Sahara and Florida. Igneous deposits, by contrast, were formed by volcanic activity. The main examples of these are the deposits of the Kola Peninsula in Russia, Palaborwa in South Africa, and parts of Brazil.

These two types of deposit yield different grades of phosphate rock and have somewhat different processing implications. Igneous rocks typically produce high grade concentrates with relatively low levels of deleterious impurities. However, they are somewhat harder to process than concentrates from sedimentary deposits. However, both types of deposit have been successfully exploited and appropriate technologies are well known and documented.

In its natural condition, phosphate rock concentrates are insoluble and therefore unsuitable for direct application as a fertilizer. The most common way in which they are processed into a form that can be used as fertilizer is through a two stage process. The first involves converting the phosphate rock to “merchant grade” phosphoric acid (MGA). The second converts the acid into a wide variety of fertilizer products of which the most important is diammonium phosphate (DAP). To make animal feed and industrial phosphates, the MGA is usually further processed into “purified” phosphoric acid (PPA).These process often take place in the same chemical complex. However, there is also considerable trade in phosphoric acid. It should be mentioned that as an alternative, phosphate rock can be reacted with nitric acid to produce so-called nitro-phosphate fertilizers directly in a single step.

Although there are several alternatives to the conversion of phosphate rock into phosphate chemicals, and although there are many products additional to DAP, CRU considers that the economics of the two stage phosphoric acid – DAP production route are what dictates the value that chemical companies place on rock of different quality. From the volume perspective, this is by far the most popular route by which phosphorous makes its way from the mine to the farm.

The critical first step in along this route is the manufacture of phosphoric acid. A typical wet acid phosphoric acid plant has four distinct sections, as follows:

- the feed preparation section; this usually involves blending ores from different sources and, if necessary further grinding the rock to the optimal size for subsequent reaction with sulphuric acid;
- the reactor section; this is the point at which phosphate rock is mixed with sulphuric acid and converted into phosphoric acid; some other elements go into solution but others remain in solid form; the most important of these is the gypsum that is formed from the calcium content of the rock when the P_2O_5 goes into solution;
- the filter plant; this is where the liquids and solids are separated; in most instances the solids are a waste that must be placed in a permanent storage area; and
- the evaporation section; this is where the concentration of the acid is increased to the range of 52-54% P_2O_5. which is the standard for merchant acid.

Rock quality affects three of these four processes, as described below.

Grinding requirements are a function of the hardness of the rock and its reactivity. In this respect sedimentary rocks are generally softer and more reactive and therefore require less grinding than igneous rocks. The grinding that needs to be done at the acid plant is a function of the particle size and work index of the concentrate, and this will vary from one mine to another.

For igneous rock, the particle size needs to be 80% passing 220 microns for the dehydrate process to work properly. A coarser particle size of up to 1600 microns is acceptable in the hemihydrates process. Bench testing of bulk samples has confirmed that the liberation point for acceptable beneficiation of Lac a Paul ore is 80% passing 210 micron. In practice the ore may be ground considerably finer to improve recovery. Therefore, we conclude that Lac a Paul will not face any demand from customers to reduce its price to compensate for additional grinding.

The capacity of the reactor is determined by the volume of rock input. Consequently, a lower-grade rock translates into a lower rate output of phosphoric acid. Many of the costs associated with the reactor, such as labor, maintenance and power are a function of operating time. Therefore lower ore grades increase unit cost. However, the most important cost impact in the reactor relates to sulphuric acid whose consumption is also determined by the rock quality, specifically the ratio of CaO to P_2O_5. Theoretically 1.75 t of acid is required for each t of CaO so the overall acid consumption per tonne P_2O_5 can be calculated by multiplying these ratios.

To make standard grade MGA at 53% and 100% recovery, we need 1.36 tonnes of Lac a Paul Rock compared with 1.66 tonnes of Moroccan rock. That rock contains 0.71 tonnes of calcium which consumes 1.24 tonnes of sulphuric acid. The figures for Moroccan rock are 0.85 tonnes of calcium and 1.48 tonnes of sulphuric acid. Therefore, the consumer saves 0.25 tonnes of sulphuric acid for each tonne of phosphoric acid produced. Expressed in terms of Lac a Paul's rock, this is an acid savings of 0.18 t/t. If we consider it as a saving of sulphur, it is a savings of 0.06 t/t because each tonne of sulphur makes approximately 3 tonnes of acid.

Rock quality also affects the efficiency of the filtration process. Small crystals do not filter as well as large crystals. This is sometimes a characteristic of igneous rock and can lead to a requirement for greater capacity at the filtration plant for any given volume of material. Most acid producers are set up on the basis of filtration rates in the range 5-7 $t/d/m^2$ although some of the plants in Florida are designed to filter at rates in the 9-11 $t/d/m^2$ range because of the particular filtering quality of the local rock. The Jacobs pilot plant test program suggests that Lac a Paul material will achieve 4.72-5.03, which is at the low end of the range but in our opinion acceptable to most consumers without the need for any plant modification. A possible exception may exist in the case of Florida plants (which are not, however, currently expected to be rock purchasers).

Besides these impacts on the amount of capital and operating cost at each process step, impurities in the phosphate rock can also affect process economics in other ways.

High levels of iron, alumina, and magnesium may result in the acid being insufficiently pure to make DAP at the desired 16-46-0 ratio. Since the fertilizer company will always want to maintain consistent quality, additional nitrogen will then have to be added in the form of urea. This is a more expensive form of nitrogen than the ammonia that is normally used. Thus, chemical plants will assess penalties to compensate for this cost. A commonly used formula to detect when this condition is likely to occur is the so-called "Minor Elements Ratio" (MER), specified as follows:

$$\text{MER} = (Fe_2O_3\% + Al_2O_3\% + MgO\%)/P_2O_5\%$$

A ratio above 0.08 may trigger issues. In the case of Lac a Paul, the MER is 0.079, which while above the typical ratio of Moroccan rock, is just below the level at which marketability issues may arise. CRU's value in use model captures the impact of the MER on the downstream DAP/MAP plant's economics.

High levels of fluorine may also be problematic. Some phosphate rock contains fluorine in the form of calcium fluorapatite. The fluorine is released during the acid-making process and will react with soluble silica to form a fluorosilicate, which tends to be corrosive. If silica is present in an inert form, then no reaction occurs. However, this yields an abrasive material that tends to trigger higher maintenance requirements at the plant. Lac a Paul is well below the levels at which these elements are of concern.

Chlorine is another material with an undesirable effect on the operation of a plant in that it, too, is corrosive. In general, chlorine concentration levels above 500 ppm are undesirable and may trigger issues. Lac a Paul's chlorine level is 860 ppm. In the case of sales to a new plant, the plant is normally engineered to handle the expected chlorine level in the rock, and in the context of the overall cost, there is no appreciable cost impact. This is also the case for sales to a plant that is already dealing with high chlorine levels in its feed. However, there could be penalty or marketability issues at some consuming plants that are not properly equipped to manage high chlorine levels.

Sodium and potassium are also problematic elements in that they can combine with reactive silica and fluorine and increase scale formation in cooling water recirculation equipment and phosphoric acid filtration equipment. This increases the frequency of equipment wash cycles and thus reduces productivity. The combined level of these elements at Lac a Paul is 0.37%, which is very low.

The net impact of the impurities in Lac a Paul concentrates is, in our opinion, minimal. It is therefore likely that sales agreements can be negotiated with some consumers that do not include any penalties for impurities. However, it will not be possible to definitively confirm that this is the case until letters of intent have been negotiated with specific customers.

If carbon is present in an organic form, this can also be a problem. Jacobs Engineering reports that the organic carbon level at Lac a Paul is 0.91%, which is considerably above the desirable maximum of 0.2%. However, they note that this may be attributable to residual flotation agents in laboratory samples, and thus not typical of what can be expected in normal production. Moreover, the Jacobs report shows no evidence of acid discoloration, which is the usual consequence of high levels of organic matter.

A final consideration is the level of background radioactivity present in phosphate rock. This tends to become concentrated in gypsum. In many instances the resulting gypsum product is too radioactive for use in wallboard and similar building products and must therefore be discarded as a waste product. If phosphate rock exhibits extremely low radioactivity, there may be some by-product gypsum value at the acid plant. However, in most locations natural gypsum is readily available at modest cost. Therefore, the economic impact of this is likely to be marginal.

To summarize, Lac a Paul concentrates will sell at a substantial premium over the benchmark Morocco export rock due to it higher P_2O_5 content and its lower acid consumption requirements.

CRU believes that the other impurities in the rock are within the normal range at which no marketability issues arise. The CRU model shows a minor level of impurity penalties relative to Moroccan rock, but these amount to less than $2/t in 2013 terms and are not, in our opinion, commercially significant.

8.2 Commercial implications

Acid production is ultimately dictated by the P_2O_5 content of the rock purchased. Fundamentally, therefore, a buyer of rock will pay a higher price for a higher P_2O_5 content. Lac a Paul intends to produce a concentrate with an average grade of 39% P_2O_5 compared with a 32% P_2O_5 standard Moroccan grade. *Ceteris paribus*, this rock will therefore be worth 21.9% more than the benchmark simply on the basis of the phosphate content.

The key question is this: will the market accord a higher value to Lac a Paul's rock reflecting other aspects of its quality? In general, there are two reasons why a chemical plant will be willing to pay a premium over and beyond the P_2O_5 value of a higher grade ore. These are:

- they may save on directly identifiable variable processing costs such as acid; and/or
- they may secure a higher rate of throughput, thereby spreading quasi-fixed processing costs such as labor and maintenance over a greater volume of acid; and/or
- they may be able to make a higher quality acid that in turn can be sold for a premium price in specialized markets.

CRU considers that at this stage of the Lac a Paul project, the latter source of value is too speculative to be taken into account. We note that 88% of the demand for phosphate rock is for fertilizer applications where high purity is not valued[1]. Not all of the remaining 12% of the market will pay a premium price. It is possible that, during the course of securing offtake agreements, the project may be able to sell some of its product to companies that make premium non-fertilizer phosphate chemicals. Absent such commitments and given the size of the available market, CRU's preliminary assessment is that this might represent 250,000 tpy. However, in valuing the rock CRU has taken the conservative approach of ignoring this source of potential value pending the negotiation of letters of intent or offtake agreements.

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[1] What is critically important in agricultural applications is that there are extremely low levels of any toxic residuals in the product.

Likewise, the impact of greater throughput on unit costs is somewhat speculative because phosphoric acid plants are typically part of a wider chemical processing and fertilizer facility in which phosphoric acid production may not be the actual or strategic bottleneck. Again, recognition of any premiums requires, in our opinion, at least a letter of intent from a specific plant.

Therefore and at this stage in the development of the project, CRU is recognizing only the value of the acid consumption savings discussed above and the impact of Lac a Paul rock on the economics of DAP/MAP production. The size of this premium will reflect the price of sulphuric acid in different rock consuming markets. However, most phosphoric acid plants are part of a chemical complex with its own sulphur burning plant. It takes 0.34 tonnes of sulphur to make one tonne of acid. The value analysis is complicated by the fact that sulphur burning plants also generate a large quantity of waste heat that can be used to cogenerate electricity for the complex. CRU's approach to this problem is to charge the entire cost of the acid plant and waste heat recovery/power generation facility – both capital and operating – to the transfer price of sulphuric acid with a credit against this equal to the market value of the electricity produced.

High levels of P_2O_5 usually mean there are lower levels of other elements. As discussed earlier, the MER is a key measure of the impact of iron, alumina, and magnesium on the quality of the acid. The MER of standard Moroccan ore is 0.028, while that for Lac a Paul is 0.079. The affect of this on ammonization is taken into account by CRU and has a small impact on rock value that varies from market to market depending on the price of ammonia.

The quantum of various value in use premiums and discounts in the phosphate rock industry is not at all transparent. There are no generally accepted "normalization" guidelines such as those that are now available for iron ore and metallurgical coal. In CRU's opinion, a great deal depends on the circumstances in which a negotiation is conducted.

In the case of an existing chemical plant that is looking for a new source of materials, it may not be possible for the miner to secure the full value in use premium. These plants tend to be optimized around their existing or expected feedstock quality. This means, for example, that the balance between reactor and filtration capacity was specified with a particular rock source in mind. Likewise, the specification of the plant will have been determined based on the expected corrosion potential of specific feedstock.

What this means is that in those cases where Lac a Paul rock is replacing rock of a fundamentally different quality, the consumer may well need to make changes in equipment or working practices to accommodate the new quality blend going through their facility. The reality is that it takes a chemical company some time to adjust all of its plant and procedures to optimize the process after a new ore is introduced. The company is likely to be looking for a tangible financial benefit to compensate for the time, investment, and risks that this might entail. In the Lac a Paul case specifically, the chemical plant may be looking to retain some of the benefits from lower acid consumption for itself rather than passing them all back to the mining company.

These general caveats should be kept in mind when considering the next section of the report in which we provide estimates of the netback values of Lac a Paul's rock.

8.3 Netback values from selected markets

As discussed in Chapter 6, CRU considers that there are three markets for Lac a Paul, namely North America, Europe, and Latin America. We discuss the netback values from each of these markets in turn.

8.3.1 North America

The natural market for Lac a Paul's rock is in North America. For instance, Agrium has now closed it Kapuskasing mine in Ontario and entered a medium-term contract to import rock from Morocco. Our research suggests that it is probably uneconomic for Lac a Paul to deliver to Redwater, Alberta, by rail. The Moroccans are supplying Redwater by ocean freight to Vancouver. Lac a Paul is actually at a significant logistical advantage over OCP in supplying rock to Vancouver, as it is 1329 nautical miles closer and is shipping 18% less product weight for each delivered unit of P_2O_5. This weight differential will also affect Agrium's rail costs from Vancouver to Redwater.

The following table summarizes CRU's assessment of the netback value of sales made in Vancouver. We assume that 50,000 DWT vessels are used. In CRU's opinion, this is the highest value market for these concentrates, but there is only one possible customer. In a transaction of this nature, a significant bargaining zone will be available and the ultimate price will undoubtedly reflect a sharing of this with the purchaser.

Table 8.1: Netback price from Vancouver, $/t

Year	Std price in market	P2O5 content	Acid demand	Other penalties	CFR value	Freight	FOB value
2012	222.79	48.73	23.42	-1.78	293.17	32.23	260.94
2013	201.12	44.00	22.31	-2.04	265.39	33.30	232.09
2014	210.42	46.03	22.23	-1.79	276.89	33.59	243.30
2015	219.98	48.12	22.51	-1.62	288.99	34.96	254.03
2016	199.48	43.64	22.93	-1.51	264.54	35.39	229.14
2017	197.45	43.19	23.28	-1.41	262.51	35.38	227.12
2018	197.62	43.23	23.70	-1.47	263.09	35.85	227.23
2019	199.94	43.74	24.17	-1.59	266.26	36.62	229.64
2020	203.63	44.54	24.66	-1.69	271.15	37.58	233.57
2021	208.24	45.55	25.07	-1.78	277.08	38.68	238.40
2022	213.48	46.70	25.49	-1.87	283.81	39.89	243.92
2023	219.19	47.95	25.94	-1.95	291.12	41.18	249.94
2024	225.26	49.28	26.39	-2.04	298.89	42.55	256.34
2025	231.63	50.67	26.86	-2.13	307.03	43.98	263.05
2026	238.27	52.12	27.45	-2.22	315.62	45.48	270.14
2027	245.15	53.63	28.06	-2.32	324.51	47.04	277.47
2028	252.27	55.18	28.67	-2.41	333.71	48.67	285.05
2029	259.62	56.79	29.30	-2.52	343.20	50.36	292.85
2030	267.21	58.45	29.95	-2.62	352.99	52.11	300.88
2031	275.04	60.16	30.61	-2.73	363.08	53.94	309.14
2032	283.11	61.93	31.28	-2.85	373.48	55.84	317.64
2033	291.44	63.75	31.97	-2.97	384.19	57.81	326.38
2034	300.02	65.63	32.68	-3.09	395.23	60.86	334.37
2035	308.86	67.56	33.40	-3.22	406.60	63.99	342.62

Source: CRU

The alternatives for North America are to ship rock from Port Saguenay to Tampa or New Orleans. CRU considers the Gulf coast to be more relevant to Lac a Paul, as the plants in Florida are not currently expected to be significant rock purchasers. The avoided acid cost at New Orleans is valued by reference to the liquid sulphur price on the US Gulf coast. In these calculations CRU assumes that shipments are made in 50,000 DWT vessels. Although some ports may be able to handle larger vessels, fertilizer import terminals are for the most part geared to handle vessels only up to Handymax sizes.

Table 8.2: Netback price from US Gulf, $/t

Year	Std price in market	P2O5 content	Acid demand	Other penalties	CFR value	Freight	FOB value
2012	205.60	44.97	22.19	-1.78	270.98	14.00	256.98
2013	183.49	40.14	21.42	-2.04	243.01	14.61	228.40
2014	192.72	42.16	21.32	-1.79	254.40	14.82	239.58
2015	201.66	44.11	21.55	-1.62	265.70	15.53	250.17
2016	180.94	39.58	21.88	-1.51	240.89	15.73	225.16
2017	178.93	39.14	22.22	-1.41	238.88	15.75	223.13
2018	178.87	39.13	22.64	-1.47	239.18	15.97	223.20
2019	180.81	39.55	23.11	-1.59	241.88	16.33	225.55
2020	184.02	40.25	23.60	-1.69	246.18	16.78	229.41
2021	188.07	41.14	24.00	-1.78	251.43	17.28	234.15
2022	192.70	42.15	24.43	-1.87	257.41	17.84	239.57
2023	197.75	43.26	24.86	-1.95	263.92	18.43	245.49
2024	203.13	44.43	25.31	-2.04	270.83	19.06	251.78
2025	208.77	45.67	25.78	-2.13	278.09	19.71	258.37
2026	214.65	46.95	26.37	-2.22	285.75	20.40	265.35
2027	220.74	48.29	26.98	-2.32	293.68	21.11	272.57
2028	227.03	49.66	27.60	-2.41	301.88	21.85	280.03
2029	233.53	51.08	28.24	-2.52	310.33	22.62	287.70
2030	240.22	52.55	28.89	-2.62	319.04	23.43	295.61
2031	247.12	54.06	29.56	-2.73	328.00	24.26	303.74
2032	254.23	55.61	30.24	-2.85	337.24	25.13	312.11
2033	261.55	57.21	30.94	-2.97	346.74	26.03	320.71
2034	269.09	58.86	31.66	-3.09	356.52	27.96	328.56
2035	276.86	60.56	32.39	-3.22	366.59	29.93	336.65

Source: CRU

8.3.2 Europe

CRU has estimated the cost of a voyage from Montreal to a representative port (Rotterdam) from a consideration of annual time charter rates and estimated consumption of bunker fuels.

Netbacks for Lac a Paul in Europe are slightly less than those in North America, because this region is closer to the Moroccan competition, which enjoys a slight freight advantage although the amount of this is sensitive to vessel size assumptions.

Table 8.3: Netback price from Rotterdam, $/t

Year	Std price in market	P_2O_5 content	Acid demand	Other penalties	CFR value	Freight	FOB value
2012	199.83	43.71	18.51	-1.79	260.27	14.78	245.49
2013	177.11	38.74	18.03	-1.94	231.95	15.41	216.54
2014	186.30	40.75	18.36	-1.77	243.63	15.63	228.01
2015	195.16	42.69	19.22	-1.69	255.38	16.36	239.02
2016	174.27	38.12	19.97	-1.67	230.69	16.58	214.11
2017	172.28	37.69	20.60	-1.66	228.91	16.59	212.32
2018	172.15	37.66	21.22	-1.81	229.22	16.82	212.39
2019	173.93	38.05	21.83	-1.93	231.88	17.20	214.67
2020	176.94	38.71	22.43	-2.04	236.03	17.67	218.36
2021	180.76	39.54	22.98	-2.15	241.14	18.21	222.93
2022	185.13	40.50	23.53	-2.25	246.92	18.79	228.12
2023	189.90	41.54	24.08	-2.34	253.18	19.42	233.76
2024	194.98	42.65	24.62	-2.44	259.81	20.08	239.73
2025	200.31	43.82	25.17	-2.55	266.75	20.77	245.97
2026	205.85	45.03	25.73	-2.65	273.96	21.50	252.46
2027	211.59	46.29	26.30	-2.76	281.42	22.25	259.16
2028	217.52	47.58	26.89	-2.87	289.12	23.04	266.08
2029	223.64	48.92	27.49	-2.99	297.05	23.86	273.20
2030	229.94	50.30	28.10	-3.11	305.22	24.71	280.52
2031	236.43	51.72	28.72	-3.24	313.63	25.59	288.04
2032	243.11	53.18	29.36	-3.37	322.28	26.51	295.77
2033	249.98	54.68	30.02	-3.51	331.17	27.46	303.71
2034	257.05	56.23	30.69	-3.65	340.31	29.45	310.86
2035	264.33	57.82	31.37	-3.80	349.72	31.48	318.24

Source: CRU

8.3.3 India and Southeast Asia

This region is largely an import market for sulphuric acid, but it is a long way from the Saguenay region of Canada. CRU's freight model suggests shipments via the Suez Canal.

In this region it is almost certain that acid plants will incorporate sulphur burners because the cogeneration of power is usually necessary for the project as a whole, given typical limitations or high costs of grid electricity.

We have calculated netbacks from the west coast of India and central Indonesia to provide a perspective on the range of netbacks likely to be available from this region as set out in the following two tables.

Table 8.4: Netback price from Mumbai, $t

Year	Std price in market	P_2O_5 content	Acid demand	Other penalties	CFR value	Freight	FOB value
2012	204.83	44.81	21.50	-1.56	269.57	37.11	232.46
2013	182.36	39.89	20.46	-2.15	240.56	38.29	202.27
2014	191.57	41.91	20.05	-1.84	251.67	38.61	213.07
2015	200.62	43.89	20.16	-1.68	262.98	40.13	222.85
2016	179.81	39.33	20.23	-1.60	237.77	40.63	197.14
2017	177.80	38.89	20.76	-1.55	235.89	40.62	195.27
2018	177.73	38.88	21.26	-1.68	236.19	41.16	195.03
2019	179.64	39.30	21.74	-1.78	238.89	42.02	196.87
2020	182.81	39.99	22.21	-1.88	243.13	43.11	200.01
2021	186.82	40.87	22.53	-1.97	248.24	44.36	203.89
2022	191.40	41.87	22.85	-2.06	254.05	45.72	208.33
2023	196.39	42.96	23.15	-2.15	260.35	47.18	213.17
2024	201.71	44.12	23.44	-2.24	267.03	48.72	218.31
2025	207.28	45.34	23.72	-2.33	274.01	50.33	223.68
2026	213.09	46.61	24.26	-2.43	281.53	52.02	229.50
2027	219.11	47.93	24.80	-2.53	289.31	53.78	235.52
2028	225.32	49.29	25.36	-2.64	297.34	55.61	241.72
2029	231.74	50.69	25.93	-2.75	305.62	57.52	248.10
2030	238.35	52.14	26.52	-2.86	314.15	59.50	254.65
2031	245.17	53.63	27.11	-2.98	322.93	61.55	261.38
2032	252.18	55.17	27.72	-3.10	331.97	63.69	268.29
2033	259.41	56.75	28.35	-3.23	341.28	65.91	275.37
2034	266.85	58.37	28.99	-3.36	350.85	69.21	281.64
2035	274.51	60.05	29.65	-3.50	360.71	72.61	288.10

Source: CRU

CRU expects freight rates to increase relative to inflation over time because the freight market is currently extremely depressed. In the Indian market this has the effect of increasing costs to Lac a Paul to the point where by 2035 they virtually cancel out the quality premiums associated with this product.

As the following table shows, the situation is slightly less favourable in Southeast Asia. Although the freight distances are greater, prices are also structurally higher. The net result is somewhat better than in the case of India.

Table 8.6: Netback price from Surabaya, $/t

Year	Std price in market	P_2O_5 content	Acid demand	Other penalties	CFR value	Freight	FOB value
2012	218.12	47.71	25.13	-1.87	289.09	46.28	242.81
2013	195.99	42.87	24.80	-2.39	261.27	47.74	213.53
2014	205.20	44.89	25.16	-1.95	273.30	48.07	225.22
2015	214.67	46.96	25.80	-1.77	285.65	49.98	235.67
2016	194.04	42.45	26.42	-1.68	261.22	50.60	210.62
2017	191.99	42.00	27.27	-1.63	259.63	50.56	209.07
2018	192.09	42.02	28.13	-1.75	260.49	51.21	209.28
2019	194.29	42.50	29.02	-1.86	263.95	52.29	211.65
2020	197.84	43.28	29.93	-1.96	269.09	53.67	215.42
2021	202.28	44.25	30.57	-2.05	275.05	55.25	219.80
2022	207.34	45.35	31.22	-2.14	281.77	56.98	224.79
2023	212.85	46.56	31.89	-2.23	289.06	58.84	230.22
2024	218.71	47.84	32.56	-2.32	296.79	60.81	235.98
2025	224.86	49.19	33.26	-2.42	304.88	62.87	242.01
2026	231.26	50.59	34.01	-2.52	313.34	65.03	248.31
2027	237.91	52.04	34.78	-2.63	322.10	67.28	254.82
2028	244.78	53.54	35.56	-2.73	331.15	69.62	261.53
2029	251.87	55.10	36.37	-2.85	340.49	72.06	268.43
2030	259.19	56.70	37.19	-2.97	350.11	74.59	275.52
2031	266.74	58.35	38.03	-3.09	360.03	77.22	282.80
2032	274.52	60.05	38.89	-3.21	370.24	79.96	290.28
2033	282.54	61.81	39.77	-3.35	380.77	82.81	297.96
2034	290.80	63.61	40.67	-3.49	391.60	86.76	304.84
2035	299.32	65.48	41.59	-3.63	402.76	90.84	311.92

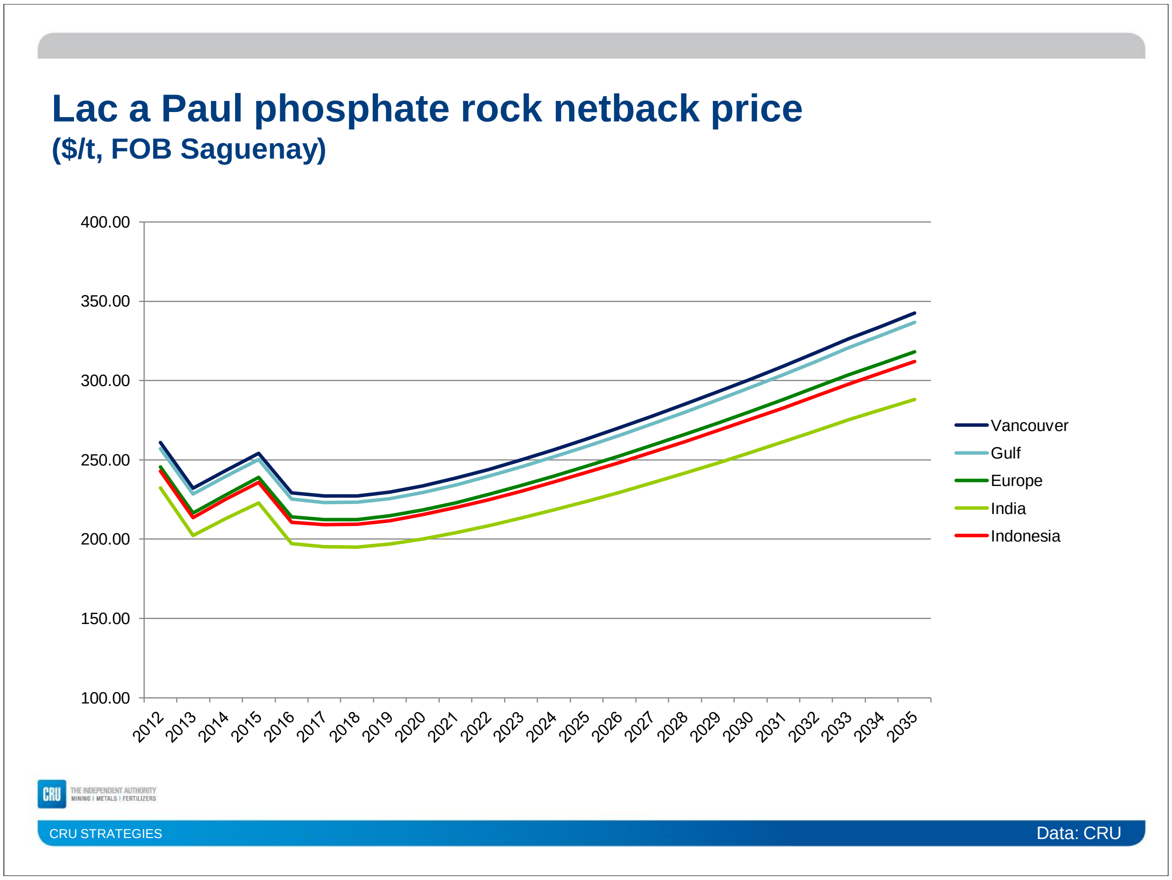
Source: CRU

8.4 Summary

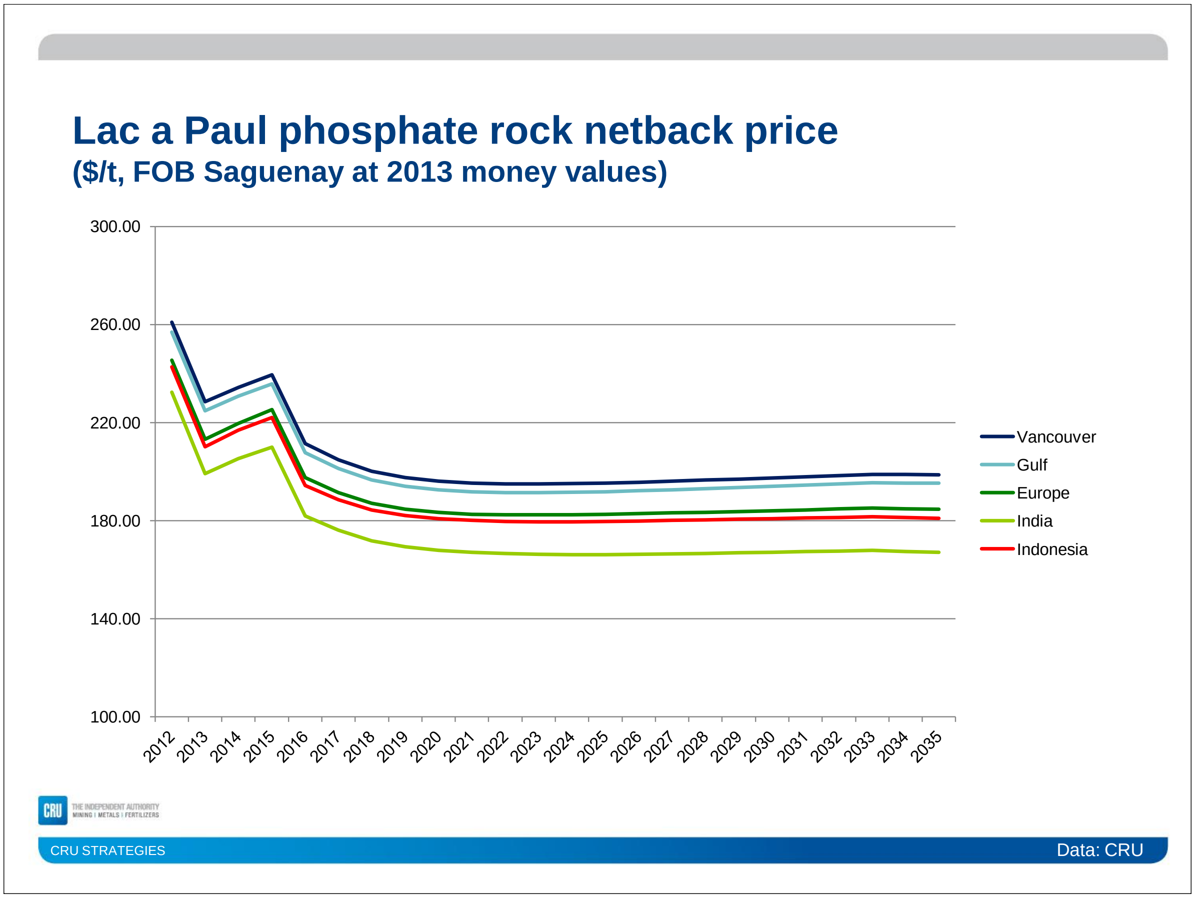
The netback calculations set out in these tables are presented graphically in the following charts, first in nominal terms and then in real dollars at 2012 money values.

The charts show that Vancouver provides the highest netback followed by the US Gulf while the lowest comes from India and South-East Asia. In CRU's opinion, the Vancouver, Gulf, and European markets appear to offer the most reliable estimates of value.

The nominal price forecast shows that Lac a Paul's rock currently commands a netback value of about $250/t which is almost 50% higher than the Moroccan benchmark. Three factors account for this – higher P_2O_5 content, lower sulphuric acid requirements and more favorable location in relation to American markets. This netback should remain comfortably above $200/t unless sales have to be made to India, currently the least attractive market available.



The following real price chart shows that, over the longer-term, Lac a Paul's marketable ore is likely to be valued at around $200/t in real 2013 money values in Vancouver and around $195/t in the US Gulf. The markets of last resort in India offers a price of just under $170/t.



Lac a Paul phosphate rock netback price

($/t, FOB Saguenay at 2013 money values)

Data: CRU

CRU believes that the appropriate netback price that should be used in the Lac a Paul resource assessment is in the range $195-$200/t in constant 2013 terms. This is a price FOB Saguenay. The main uncertainties associated with this assessment are as follows:

- base prices FOB Morocco could be higher than we assume if OCP decides to restrain its future rock production in order to protect the profitability of its rock exports and provide an added competitive edge to its downstream business – this is an upside risk;
- netback for Lac a Paul could be higher if freight rates rise faster than CRU anticipates in response to the current profitability squeeze in the ocean freight business and associated collapse of shipbuilding order books – this is an upside risk because Lac a Paul has a transportation edge over Morocco in the US Gulf and Vancouver markets;
- netbacks for Lac a Paul could be lower if Moroccan exporters can secure backhaul cargo when delivering to the US Gulf and Vancouver; this might take the form of agriculktural or fertilizer products moving to Africa – this is a downside risk; and
- netbacks for Lac a Paul could be higher if resources Arianne is able to secure offtake agreements with producers of specialty and industrial phosphates who may be prepared to pay additional premiums for the high quality of the Lac a Paul rock – this is an upside risk.

Appendix A – Phosphate rock supply database

Country/Company	Mill	Concept	2012	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030
Existing and Committed Capacity													
Europe													
Finland													
Kemira Growhow (Yara International)	Siilinjarvi	Capacity	1.00	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Europe total		Capacity	1.00	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Russia & CIS													
Russia													
Kovdor Mining (Eurochem)	Kovdor	Capacity	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
P.O. Apatit (Phosagro)	Khibiny/Kirovsk	Capacity	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Podmoskovsk	Moscow	Capacity	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
CJSC North West (Acron)	Oleniy Ruchey & Partomchorr	Capacity	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Amur region/Kheikhe authorities	Yevgen'evskoye	Capacity	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Various	Various	Capacity	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
Kazakhstan													
Sunkar Resources (TemirService)	Chilisa	Capacity	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20
Kazphosphate	Kara Tau District	Capacity	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Uzbekistan													
Navoi Mining & Metallurgical Combinat	Kyzylkum Phosphorite Complex	Capacity	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Russia & CIS total		Capacity	20.45	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95
North America													
USA													
Mosaic	Hookers Prairie	Capacity	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2.09	0.00	0.00
Mosaic	S. Fort Meade	Capacity	6.00	6.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mosaic	Wingate Creek	Capacity	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	0.00
Mosaic	Four Corners	Capacity	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	0.00
CF Industries	Hardee Complex	Capacity	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	0.00
Agrium	Dry Valley, Idaho	Capacity	0.00	0.00	1.30	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agrium	North Rasmussen Ridge (Idaho)	Capacity	1.50	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
J.R. Simplot	Vernal (Utah)	Capacity	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
J.R. Simplot	Smoky Canyon (Idaho)	Capacity	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
P4 Production	Enoch Valley, Idaho	Capacity	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	0.00	0.00
PCS Phosphate	Swift Creek (White Springs, Florida)	Capacity	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
PCS Phosphate	Lee Creek (Aurora, NC)	Capacity	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Canada													
Agrium	Kapuskasing	Capacity	1.20	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico													
Fertinal	San Juan de la Costa	Capacity	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
North America total		Capacity	37.51	36.91	36.11	30.11	28.81	28.81	28.81	28.81	28.81	25.47	14.17

Country/Company	Mill	Concept	2012	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030
Latin America													
Brazil													
Galvani Mineracao	Lagamar, Minas Gerais	Capacity	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Galvani	Irece, Bahia	Capacity	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Vale Fertilizantes	Araxa, Minas Gerais	Capacity	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
Copebras (Ouvidor)	Fazenda Chapadao (Catalao), Goias	Capacity	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
MBAC Fertilizers	Itafos Project	Capacity	0.11	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Vale Fertilizantes	Patos de Minas, Minas Gerais	Capacity	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Vale Fertilizantes	Tapira, Minas Gerais	Capacity	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
Vale Fertilizantes	Jacupiranga, Cajati, Sao Paulo	Capacity	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
Vale Fertilizantes	Catalao/Ouvidor, Goias	Capacity	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
Vale Fertilizantes	Salitre, Minas Gerais (Patrocinio)	Capacity	0.00	0.00	0.00	0.00	2.20	2.20	2.20	2.20	2.20	2.20	3.20
Chile													
PCS Phosphate	El Sauce	Capacity	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Columbia													
Empresa Fosfatos de Boyaca	La Cascajera	Capacity	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Fosfatos de Colombia	La Juanita	Capacity	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Abonos Colombianos S.A.	Cartagena	Capacity	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Peru													
Vale Fertilizantes	Bayovar (Sechura)	Capacity	3.96	3.96	5.86	5.86	5.86	5.86	5.86	5.86	5.86	7.86	7.86
Venezuela													
Fosforita de Tachira	Lobatera	Capacity	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Petroquimica de Venezuela	Riecito	Capacity	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Latin America total		Capacity	11.96	12.28	14.18	14.18	16.38	16.38	16.38	16.38	16.38	18.38	19.38
China													
Various	Yunnan	Capacity	23.10	23.10	23.10	23.10	23.35	23.60	23.60	24.60	25.60	27.60	29.60
Various	Guizhou	Capacity	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	23.00	25.00
Various	Hubei	Capacity	27.33	27.33	27.33	27.83	28.33	28.33	28.33	29.33	29.33	29.33	29.33
Various	Hunan	Capacity	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
Various	Sichuan	Capacity	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Various	Hebei	Capacity	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Various	Shaanxi	Capacity	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Various	Chongging	Capacity	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Various	Others	Capacity	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	5.50	8.50
China total		Capacity	85.43	85.43	85.43	85.93	86.68	86.93	86.93	88.93	89.93	99.93	106.93

Country/Company	Mill	Concept	2012	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030
Middle East													
Iran													
Iran Phosphate	Esfordi Phosphate Mineral Complex	Capacity	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Israel													
Rotem Amfert Negev (ICL)	Arad	Capacity	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
Rotem Amfert Negev (ICL)	Oron	Capacity	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Rotem Amfert Negev (ICL)	Nahal Zin	Capacity	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10
Jordan													
Jordan Phosphate Mining Company (JPMC)	Eshidiya	Capacity	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
Saudi Arabia													
Ma'aden	Al Jalamid (Ras Al-Khair)	Capacity	5.30	5.30	5.30	5.30	5.30	5.30	5.30	5.30	5.30	5.30	9.30
Ma'aden	Al Khabra (Umm Wu'al)	Capacity	0.00	0.00	0.00	0.00	2.50	5.00	5.00	5.00	5.00	8.00	11.00
Syria													
Gecopham	Khneifiss - Palmyra	Capacity	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Gecopham	Al-Sharqiyah - Eastern A & B	Capacity	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
Middle East total		Capacity	21.65	21.65	21.65	21.65	24.15	26.65	26.65	26.65	26.65	29.65	36.65
India													
Madhya Pradesh State Mining Corp	Meghnagar	Capacity	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Madhya Pradesh State Mining Corp	Hirapur	Capacity	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Pyrites, Phosphates and Chemicals Limited	Mussoorie	Capacity	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Rajasthan State Mines and Minerals	Jhamarkotra	Capacity	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
West Bengal Mineral Development & Trading Corporation	Purulia	Capacity	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
India East total		Capacity	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06
Asia Pacific Developing													
Pakistan													
Kakul Phosphates	Kakul	Capacity	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Sri Lanka													
Lanka Phopshate Ltd	Eppawala	Capacity	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Indonesia													
Various	Sidimulin, West Java	Capacity	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Philippines													
Philiphos	Leyte	Capacity	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Vietnam													
Vinachem	Lao Cai	Capacity	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
North Korea													
Various	Singpung\Others	Capacity	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Christmas Island													
Phosphates Resources Limited (PMCI)	Christmas Island	Capacity	0.70	0.70	0.70	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nauru													
Repbulic of Nauru Phosphates	Nauru	Capacity	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.20	0.00
Asia Pacific Developing total		Capacity	5.48	5.48	5.48	5.48	4.78	4.78	4.78	4.78	4.78	4.48	4.28

Country/Company	Mill	Concept	2012	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030
Asia Pacific Advanced													
Australia													
Incitec Pivot	Duchess	Capacity	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	0.00	0.00
Incitec Pivot	South Australia	Capacity	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Asia Pacific Advanced total		Capacity	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02	0.02	0.02
Africa													
Algeria													
Somiphos (Ferphos)	Djebel Onk	Capacity	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
Egypt													
Misr Phosphate	Abu Tartour	Capacity	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
El Nasr Mining Company	West Sabaiya	Capacity	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
El Nasr Mining Company	East Sabaiya	Capacity	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
El Nasr Mining Company	Safaga	Capacity	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
El Nasr Mining Company	Quseir	Capacity	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
El Watania	East Sabaiya	Capacity	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
El Watania	Umm Tinidbah	Capacity	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
El Nasr Mining Company	Quseir/El Mashash	Capacity	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Morocco													
OCP	Ben Guerir	Capacity	4.10	4.10	4.10	6.10	6.10	6.10	6.10	6.10	6.10	6.10	6.10
OCP	Bou Craa	Capacity	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
OCP	Khouribga	Capacity	20.50	20.50	20.50	20.50	20.50	26.50	26.50	26.50	26.50	26.50	26.50
OCP	Youssoufia	Capacity	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60
Senegal													
Industries Chimiques du Senegal (ICS)	Taiba	Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industries Chimiques du Senegal	Tobene	Capacity	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Industries Chimiques du Senegal	Pallo	Capacity	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
South Africa													
Foskor	Phalaborwa	Capacity	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85
Tanzania													
Minjingu Mines & Fertilizer Company	Minjingu	Capacity	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Togo													
Societe nouvelle des phosphates du Togo	Hahotoe/Kpogame	Capacity	1.50	1.50	1.50	1.50	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Tunisia													
Compafnie des Phosphates de Gafsa	Kef Eddour (Kef Eddour Central)	Capacity	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Compafnie des Phosphates de Gafsa	Metlaoui/Kef Schfaier	Capacity	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
Compafnie des Phosphates de Gafsa	Moulares/Redeyef	Capacity	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80
Compafnie des Phosphates de Gafsa	M'Dilla/Jalabia & M'zilda	Capacity	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
Zimbawbe													
Zimbabwe Phosphate Industries	Dorowa	Capacity	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Africa total		Capacity	61.09	61.09	61.09	63.09	62.34	68.34	68.34	68.34	68.34	68.34	68.34
World, total		**Capacity**	**249.64**	**250.16**	**251.26**	**247.76**	**250.46**	**259.21**	**259.21**	**261.21**	**262.21**	**270.57**	**274.07**

Country/Company	Mill	Concept	2012	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030
Probable Capacity													
Europe													
Finland													
Yara International	Sokli	Capacity	0.00	0.00	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Europe total		Capacity	0.00	0.00	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Russia & CIS													
Russia													
CJSC North West (Acron)	Oleniy Ruchey & Partomchorr												
	Expansion I	Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.50	1.00	1.00	1.00	1.00
Kazahkstan													
EuroChem	Talas	Capacity	0.00	0.00	0.00	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Russia & CIS total		Capacity	0.00	0.00	0.00	1.50	1.50	1.50	2.00	2.50	2.50	2.50	2.50
North America													
Canada													
Arianne Resources	Lac a Paul/Mirepoix	Capacity	0.00	0.00	0.00	0.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00
Yara International	Mine Arnaud	Capacity	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
USA													
Mosaic (IMC-Agrico)	Ona	Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	4.00
Stonegate Agricom	Paris Hills	Capacity	0.00	0.00	0.21	0.49	0.90	0.90	0.90	0.90	0.90	0.90	0.00
North America total		Capacity	0.00	0.00	0.21	1.49	2.90	3.90	3.90	3.90	3.90	7.90	7.00
Asia Pacific Developing													
Vietnam													
Vinachem	Lao Cai	Capacity	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.20	0.20	0.20
Asia Pacific Developing total		Capacity	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.20	0.20	0.20
Asia Pacific Advanced													
Australia													
Minemakers	Wonorah	Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10	2.20	2.20
Legend	Paradise North & South	Capacity	0.00	0.00	0.50	1.00	1.00	1.00	1.50	2.00	2.00	2.00	3.00
Asia Pacific Advanced total		Capacity	0.00	0.00	0.50	1.00	1.00	1.00	1.50	2.00	3.10	4.20	5.20

Country/Company	Mill	Concept	2012	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030
Africa													
Angola													
Minbos Resources	Cacata	Capacity	0.00	0.00	0.00	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Algeria													
Somiphos (Ferphos)	Bled El Hadba	Capacity	0.00	0.00	0.00	0.00	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Mozambique													
Vale Fertilizantes	Evate	Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.50	3.50	3.50	3.50
Nambia													
Minemakers/Namibian Marine Phosphates	Sandpiper	Capacity	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Morrocco													
OCP	Khouribga												
	Expansion I	Capacity	0.00	0.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Guinea-Bissau													
	Plains Creek Phosphate Corp	Farim	0.00	0.00	0.69	2.76	2.76	2.76	2.76	2.76	2.76	2.76	2.76
Africa total		Capacity	0.00	0.00	5.69	9.06	11.56	11.56	11.56	15.06	15.06	15.06	15.06
World, total		**Capacity**	**0.00**	**0.00**	**7.90**	**14.55**	**18.46**	**19.66**	**20.66**	**25.16**	**26.26**	**31.36**	**31.46**

Country/Company	Mill	Concept	2012	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030
Possible Capacity													
North America													
Canada													
PhosCan	Martison (Hearst), Ontario	Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
North America total		Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
Latin America													
Brazil													
Vale Fertilizantes (formally Bunge)	Anitapolis, Santa Catarina	Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.70
Copebras (Ouvidor)	Fazenda Chapadao	Capacity											
	Expansion I	Capacity	0.00	0.00	0.00	0.00	0.00	1.25	1.25	1.25	1.25	1.25	1.25
MBAC Fertilizers	Santana Project	Capacity	0.00	0.00	0.00	1.13	1.50	1.50	1.50	1.50	1.50	2.50	2.50
Latin America total		Capacity	0.00	0.00	0.00	1.13	1.50	2.75	2.75	2.75	2.75	4.45	4.45
Africa													
Algeria													
Somiphos (Ferphos)	Planned Expansion	Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00
Egypt													
El Nasr Mining Company	Aswan	Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50	5.00
Morocco													
OCP	Khouribga	Capacity	0.00	0.00	0.00	0.00	0.00	5.00	5.00	5.00	5.00	8.00	17.00
South Africa													
Foskor	Phalaborwa	Capacity	0.00	0.00	0.00	0.00	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Tunisia													
Compafnie des Phosphates de Gafsa (CPG)	Tozeur	Capacity	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	2.00	3.50	5.00
Celamin Holdings/TMS	Bir El Afou EP	Capacity	0.00	0.00	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Africa total		Capacity	0.00	0.00	0.75	1.75	2.10	7.10	7.10	7.10	8.10	17.10	30.10
Middle East													
Jordan													
Jordan Phosphate Mining Company (JPMC)	Eshidiya	Capacity											
	Expansion I	Capacity	0.00	0.00	0.00	0.00	0.00	2.00	2.00	2.00	2.00	2.00	2.00
Middle East total		Capacity	0.00	0.00	0.00	0.00	0.00	2.00	2.00	2.00	2.00	2.00	2.00
Asia Pacific Advanced													
Australia													
Incitec Pivot	Duchess Replacement	Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	3.00
APA total		Capacity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	3.00
World, total		**Capacity**	**0.00**	**0.00**	**0.75**	**2.88**	**3.60**	**11.85**	**11.85**	**11.85**	**12.85**	**27.55**	**40.55**
Total Potential													
World, total		**Capacity**	**249.64**	**250.16**	**259.91**	**265.18**	**272.52**	**290.72**	**291.72**	**298.22**	**301.32**	**329.48**	**346.08**

Appendix B – Phosphate rock regional market summary

CRU has incorporated multiple data sources to produce the following market summaries. Each table, measured in million tonnes P_2O_5, gives CRU's best and most recent estimate for the highlighted regions' total phosphate demand, capacity, and production. Total demand is then added to the regions production, yielding an estimate of that region's total exports or imports of P_2O_5.

The source for each element of the table is as follows:

- Fertilizer; comes from CRU's Phosphate Fertilizer Market Outlook October 2012
- Animal feed; comes from CRU's 2006 Animal Feed Phosphate Market Outlook, which was updated in 2011
- Capacity; comes from CRU's internal research. Updated in real time as new information about the status of phosphate rock projects come online
- Production; comes from CRU's internal research. Updated in real time as new information about the status of phosphate rock projects come online

Table B.1: Global phosphate market (mn t P_2O_5)

	2012	2013	2014	2015	2016	2017	2018	2019
Demand								
Fertilizer	46.2	47.7	48.7	49.5	50.4	51.2	52.3	53.4
Animal feed	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.2
Total	49.7	51.4	52.5	53.4	54.4	55.3	56.5	57.6
Rock Equivalent	199.4	201.9	206.8	210.9	215.5	220.0	223.3	226.7
Capacity	249.6	250.2	251.3	247.8	250.5	259.2	259.2	261.2
Production	199.6	201.9	206.8	210.9	215.5	220.0	223.4	226.8
Balance	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1

Source: CRU

Table B.2: Phosphate rock market (mn t P_2O_5) North America

	2012	2013	2014	2015	2016	2017	2018	2019
Demand								
Fertilizer	6.0	6.1	6.1	6.2	6.2	6.3	6.4	6.5
Animal feed	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total	6.4	6.4	6.5	6.5	6.6	6.6	6.8	6.9
Rock Equivalent	25.6	25.3	25.6	25.9	26.2	26.4	26.9	27.2
Capacity	37.5	36.9	36.1	30.1	28.8	28.8	28.8	28.8
Production	27.5	25.1	24.1	24.3	24.0	24.0	23.8	23.6
Balance	1.8	-0.2	-1.6	-1.5	-2.2	-2.5	-3.1	-3.5

Source: CRU

Table B.3: Phosphate rock market (mn t P_2O_5) Europe

	2012	2013	2014	2015	2016	2017	2018	2019
Demand								
Fertilizer	4.3	4.3	4.3	4.3	4.3	4.4	4.4	4.4
Animal feed	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Total	4.9	5.0	5.0	5.0	5.0	5.1	5.1	5.1
Rock Equivalent	19.8	19.5	19.6	19.7	20.0	20.3	20.0	20.1
Capacity	1.0	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Production	0.8	0.7	0.7	0.8	0.9	0.9	0.9	0.9
Balance	-19.0	-18.8	-18.9	-18.9	-19.1	-19.4	-19.1	-19.2

Source: CRU

Table B.4: Phosphate rock market (mn t P_2O_5) Latin America

	2012	2013	2014	2015	2016	2017	2018	2019
Demand								
Fertilizer	6.2	6.4	6.6	6.7	6.9	7.1	7.3	7.4
Animal feed	0.6	0.6	0.6	0.6	0.7	0.7	0.9	0.9
Total	6.8	7.0	7.2	7.4	7.6	7.8	8.1	8.3
Rock Equivalent	27.3	27.5	28.3	29.2	30.1	31.0	32.2	32.7
Capacity	12.0	12.3	14.2	14.2	16.4	16.4	16.4	16.4
Production	10.7	11.6	11.9	12.3	14.4	15.1	15.9	16.1
Balance	-16.6	-15.8	-16.4	-16.8	-15.7	-15.9	-16.3	-16.6

Source: CRU

Appendix 2

Integer Research Limited, July 2013, Study in support of bankable feasibility for Arianne Phosphate's Lac a Paul phosphate rock deposit in Canada

Study in support of bankable feasibility for Arianne Phosphate's Lac à Paul phosphate rock deposit in Canada

CONFIDENTIAL

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Introduction

Arianne Phosphate (AP) is a junior mining company focused on developing its Lac à Paul phosphate deposit in Québec, Canada. The company intends to mine 3 million tpy of phosphate rock starting in 2016.

The Lac à Paul deposit is based on igneous rock, which averages a grade of 7% and can be beneficiated to phosphate concentrate of 39% P_2O_5. The product has below detection content of cadmium, uranium and other heavy metals in the concentrate and a high to P_2O_5 calcium oxide ratio, which allows for low phosphoric acid consumption in the di-ammonium and mono-ammonium phosphates production process.

In this report, we shall explore the opportunities that are open to AP, as it looks to supply high-grade phosphate rock to diverse markets.

In particular, we will focus on three routes to market as follows:

- Sales within Canada (domestic market)
- Exports via Saguenay port (identifying likely export destinations)
- Export shipments to US locations such as the US Gulf

Also we shall analyse the different revenue streams that may be available to AP from the exploitation of the fertilizer and industrial phosphate routes and identify potential partners among buyers looking for alternative sources of igneous rock.

Price implications, premiums and structure analysis will form part of this exercise.

We will also provide supply/demand balances and scenario-based price forecasts covering the life of the mine (25 years), together with Arianne's likely position on the global cost curve now and in 2016, the year the company has identified with start of commercial production.

Project parameters and scope

The Lac à Paul property was discovered in the late 1990s and originally explored for nickel, when phosphate and titanium were also found.

The following stages of the project have been completed:

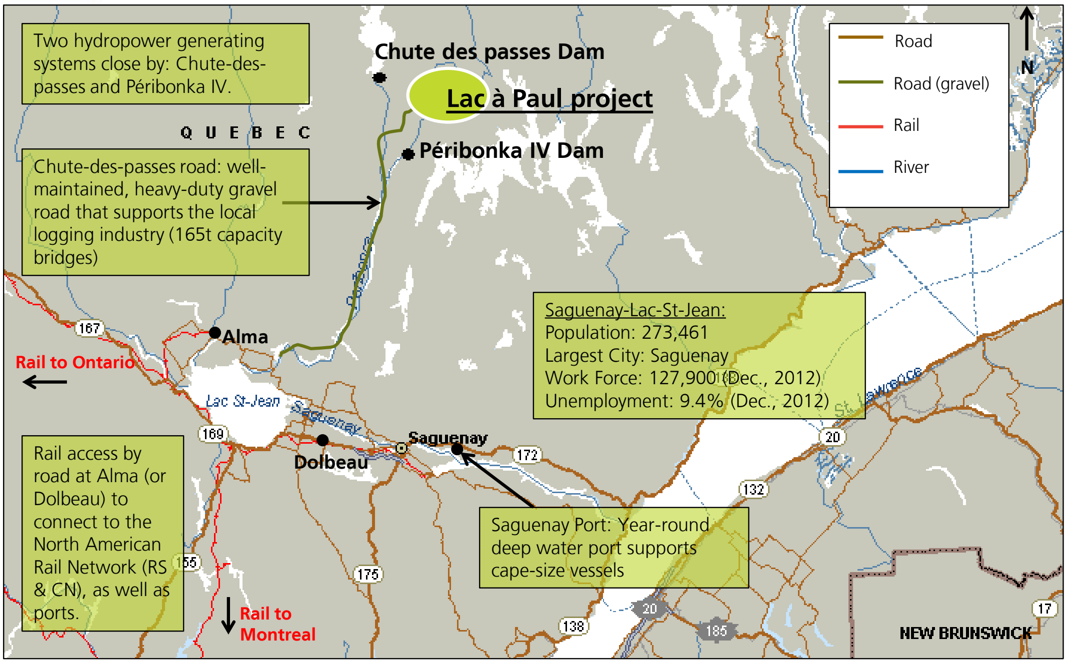
- Scoping study (July 2010)
- Impact assessment (started June 2011)
- Metallurgical testing (2012)
- Pre-feasibility study at 2 million tpy (Nov 2011) and updated at 3 million tpy (May 2012)
- Bankable feasibility study will include expansion of resources from 184 million to 590 million tonnes at 7% P_2O_5 (started August 2012)

The highlights of the project include:

- Existing heavy-duty road, rail line and port, providing access to export markets;
- Existing hydro power nearby (35km);
- High-quality labour pool;
- Investment-friendly climate.

The map below illustrates the location of the Lac à Paul deposit and the surrounding infrastructure.

Arianne Phosphate's Lac à Paul project location and parameters



Two hydropower generating systems close by: Chute-des-passes and Péribonka IV.

Chute-des-passes road: well-maintained, heavy-duty gravel road that supports the local logging industry (165t capacity bridges)

Saguenay-Lac-St-Jean:
Population: 273,461
Largest City: Saguenay
Work Force: 127,900 (Dec., 2012)
Unemployment: 9.4% (Dec., 2012)

Rail access by road at Alma (or Dolbeau) to connect to the North American Rail Network (RS & CN), as well as ports.

Saguenay Port: Year-round deep water port supports cape-size vessels

Source: Integer

Figure 1 Lac a Paul phosphate rock deposit and surrounding infrastructure

The next stages of the project will include the completion of the bankable feasibility study and impact assessments in 2013 as well as completion of project finance.

On 23 April 2013, AP announced it would proceed to sell off its non-phosphate exploration properties in order to become solely a Canadian phosphate producer.

On 22 May 2013, Arianne Phosphate announced that pilot-scale testing confirmed the commercial scale-ability of column flotation in achieving 39% P_2O_5 concentrate with a recovery rate of 90%. In Integer's opinion, these results confirm that column flotation equipment has process advantages and will positively influence CAPEX and OPEX.

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Chapter 1 Potential markets for Lac à Paul phosphate rock

1.1 Potential markets for phosphate rock from Lac à Paul

North America is the world's third largest producer of phosphates after China and Morocco, exploiting the large reserves of phosphate rock concentrated mostly around Florida in the southeastern United States. The large volume of rock extraction is expected to decline slowly due to resource depletion, leaving some phosphate chemical producers in need of new sources of rock and this creates a market for Arianne's project in Lac à Paul, Canada. In addition, the rock from Lac à Paul is of high grade with at least 38% P_2O_5 and low impurity content, as is required by high value specialty phosphate producers in various parts of the world. Supply of high quality phosphate rock is significantly more limited than standard grade phosphate rock, a situation that can add considerable premium for AP's production.

We have listed freight rates to various destinations of interest from Saguenay port in the table below:

Table 1 Ocean freight by destination from Saguenay, US$/tonne handymax*

US Gulf	16
Brazil	21
Belgium (Antwerp)	20
India	39
Japan	52

Source: Integer, shipping broker estimates
*referring to small ships around 30-35,000 DWT

1.1.1 Phosphate rock users in Canada

Canada produces about 900,000 tonnes of phosphate rock every year, which is sufficient to cover its entire needs for downstream phosphate production. Canada is self-sufficient in phosphate rock and has virtually no exports or imports. The sole existing producer, Agrium, which operates the mine, mines similar high-quality igneous rock, and its deposit is expected to be exhausted soon. This creates an opportunity for Lac à Paul to supply a close substitute product with relatively low logistics costs.

The largest consumer of phosphate rock is the Redwater fertilizer production site, under common ownership by Agrium. The Kapuskasing mine is expected to have little economic life remaining with closure expected in H2 2013, but in anticipation of this, Agrium entered into a long term contract with Office Chérifien des Phosphates (OCP) of Morocco in September 2011. OCP is the world's largest supplier of phosphate rock on the open market. The contract is to run until 2020, presumably with enough rock volume to cover Agrium Redwater's production (almost the entire 900,000 tonnes produced in Canada each year, equivalent to about 1.1 million tonnes of lower P_2O_5 rock from Morocco). The Arianne project would not be expected to start before 2016 at the earliest, requiring alternative markets to be found for up to four years of Arianne's initial production.

1.1.2 Phosphate rock users in the United States

The United States is one of the world's largest producers, consumers and export suppliers of phosphates products. Although the large deposits of phosphate rock raw material that feed the industry are not expected to be exhausted in the near future, there is a clear long term trend of declining rock output in the US from 40.9 million tonnes of rock in 1999 to 27.8 million tonnes in 2011. Balancing somewhat the fall in production, phosphate rock imports increased from 2.2 to 3.3 million tonnes over the same period. Most of the supply is from Office Chérifien des Phosphates (OCP) of Morocco, with smaller volumes from the new Bayóvar mine in Peru.

In particular, about half a million tonnes of imports in 2011 consisted of higher quality phosphate rock at 35% P_2O_5 content or above (corresponding to high grade P_2O_5 rock from OCP, the only supplier of such grade amongst exporters to the US), which is a natural target market for Arianne's project.

The main consumers of phosphate rock in the US are Mosaic, PotashCorp Phosphate and CF Industries Phosphate, which are currently mostly self-sufficient, though in most cases their existing confirmed phosphate reserves have a relatively short remaining life (see table below).

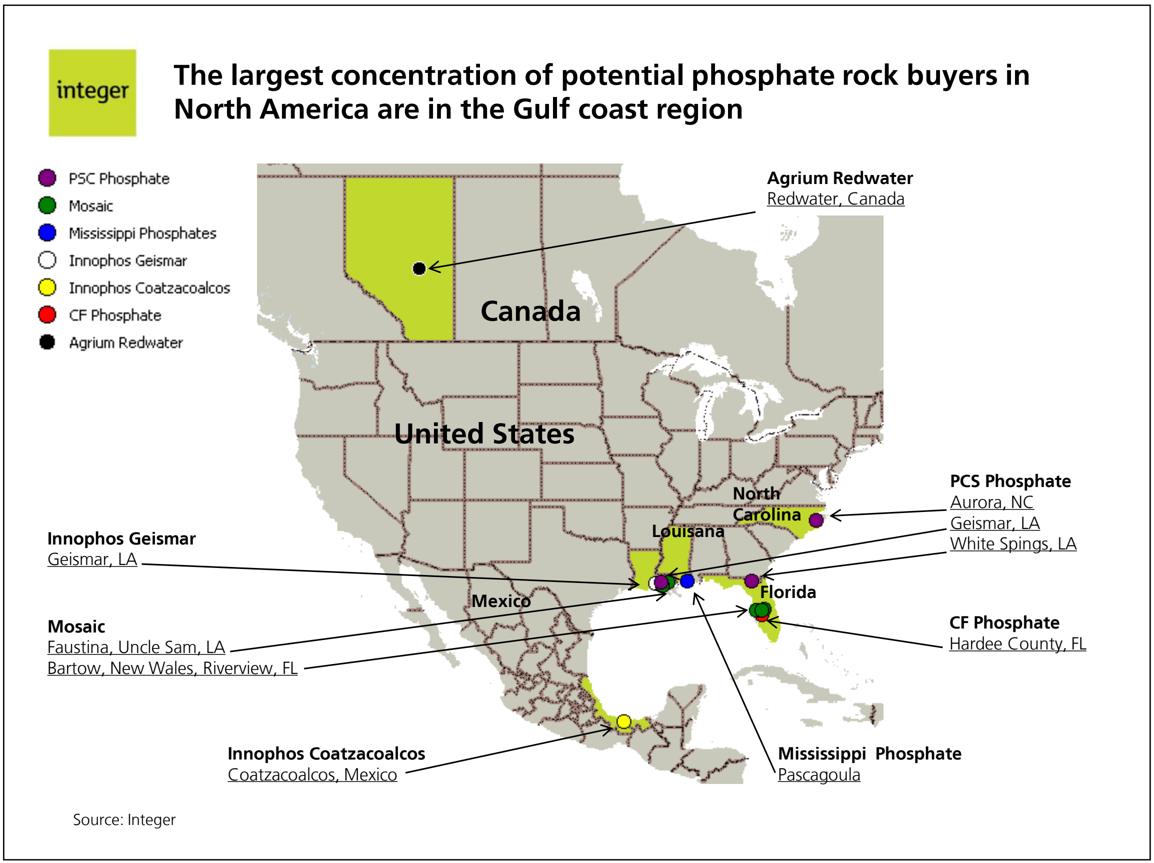
Table 2 Selected American phosphate producers' P_2O_5 balance, (million tonnes)

	2007	2008	2009	2010	2011	2012
Mosaic (FY ending May)						
Rock production	13.7	15.8	13.2	13.3	11.5	12.0
Rock in P_2O_5 terms	4.1	4.7	3.9	4.0	3.4	3.6
Acid production	4.1	4.2	3.2	3.6	3.9	3.9
Shortfall (net of transport/process loss)	0.4	-0.1	-0.4	0.0	0.9	0.7
PCS Phosphate						
Rock production	2.9	3.1	2.8	3.0	3.2	3.2
Rock in P_2O_5 terms	0.9	0.9	0.8	0.9	0.9	0.9
Acid production	0.9	0.9	0.8	0.8	0.9	0.9
Shortfall	0.1	0.1	0.1	0.0	0.1	0.0
CF Phosphate						
Rock production	2.3	2.2	2.1	2.2	2.4	2.3
Rock in P_2O_5 terms	0.7	0.7	0.6	0.7	0.7	0.7
Acid production	0.9	0.9	0.8	0.8	0.9	0.9
Shortfall	0.3	0.3	0.3	0.3	0.3	0.3
Mississippi Phosphate						
DAP production	0.6	0.5	0.5	0.5	0.6	0.6
P_2O_5 content in DAP	0.3	0.2	0.2	0.2	0.3	0.3
Rock requirement	1.0	0.8	0.9	0.9	1.0	1.0
Implied net rock requirement	1.8	1.1	0.8	1.1	2.2	2.1

Source: company data, Integer

The large integrated producers generally make slightly less phosphate than their implied requirement based on P_2O_5 content of phosphoric acid output plus some transport and processes losses of phosphate rock (assumed at about 10%). This is probably due to the requirement for mixing some imported to rock to adjust important chemical characteristics, notably reactivity to sulphuric acid. A significant amount of rock from OCP is required for mixing with American rock for technical reasons, to improve reactivity characteristics.

Igneous rock such as the type to be supplied by Arianne has low reactivity due to its hardness and density, and itself can benefit from mixing with more reactive material. For similar reasons, igneous rock is mostly unsuitable for SSP or TSP producers, who require more reactive sedimentary rock. Igneous rock from Lac à Paul has low reactivity and would not be a substitute for mixing in US phosphate production.


The largest concentration of potential phosphate rock buyers in North America are in the Gulf coast region

Source: Integer

Figure 2 Potential North American phosphate rock buyers

Further ahead in the future, however, large scale capacity closures are expected at various American phosphate mines within the next 10-20 years. This is beyond the period to be covered by this study, but potentially can provide a large market for Lac à Paul production, depending on phosphate producers' access to alternative sources or availability of renewed licences for resources at existing mining sites. Arianne's production from Lac à Paul in this case would be a competitive substitute, with freight cost of around US$16/tonne from Saguenay port to the US Gulf. As US phosphate producers use sedimentary rock as a feedstock, some process modifications would be necessary to use material from Lac à Paul.

There is a significant amount of purified phosphoric acid capacity in the US, a smaller market where higher quality igneous rock can achieve some premiums. PotashCorp reports its acid production at the Aurora site in North Carolina.

Table 3 PPA output at PCS Aurora, ('000 tonnes)

	2009	2010	2011	2012
Production	173	233	247	235
Capacity	333	333	333	333
Utilisation	52%	70%	74%	71%

Source: PCS

In addition, Innophos operates a non-integrated PPA site in Geismar, GA in the US (about 64,000 tpy) and in Coatzacoalcos in Mexico. PCS is integrated upstream, but its phosphate production is not enough to fully ensure self-sufficiency, so both companies are potential targets for rock suppliers. Another large technical phosphate producer is Monsanto in Soda Springs, ID, with about 1 million tpy of 22% rock for use in Monsanto's organophosphate pesticide products. The integrated processing facility uses the thermal process, which is more energy intensive, but able to producer high grade phosphate from lower quality input. The plant's location in Idaho is not ideal as a shipment destination from AP's site near the eastern coast of North America, and may be better served by Stonegate Agricom's project in the same state. Stonegate's planned mine at Paris Hills, ID will produce about 900,000 tonnes of 29.5% concentrate for 19 years if commissioned. Its location in the western USA and lower product grade means the Paris Hills project is not a direct competitor to AP.

1.1.3 Exports outside of North America

There are large markets for high grade igneous phosphate rock outside of North America. To the east of the Panama Canal, Europe is a logical market with large imports of igneous rock for production of nitrophosphates and industrial phosphates. There are similar specialty chemical end markets in East Asia, which logistically is not the best market for Lac à Paul, but can provide an opening due to diminishing supply of similar quality rock. We have a summary below of the volumes and prices achieved for imports of phosphate rock from Russia and South Africa in various end markets, the closest competitors for Lac à Paul in terms of product specification. Note that large volumes of imports to Lithuania reflect EuroChem's supply chain configuration, as its rock mines are located in Russia and its largest downstream processing site is in Lithuania.

Using Moroccan exports to the US for comparison, all trade flows of igneous rock from Russia or South Africa reported much higher value per unit. For example, for 2012, American imports of Moroccan rock recorded an average value of US\$165/tonne (US\$550/tonne P_2O_5) compared with US\$250-323/tonne (US\$658-828/tonne P_2O_5) for South African rock (excluding Russian shipments to Lithuania, which may reflect an internal transfer price for EuroChem). Even when adjusted for higher P_2O_5 content of igneous rock (typically 39% compared with 30-32% for most sedimentary rock), the igneous price is higher than sedimentary rock due to higher purity. This would also partly reflect some differences in freight rates, as the prices are CFR.

The tables below show the main importers of Russian and South African phosphate rock.

Table 4 Main importers of Russian phosphate rock (assuming 38.5% average P_2O_5)

Year	Importer	Value, US$ million	Volume, '000 tonnes	Value, US$/tonne product	Value, US$/tonne P_2O_5
2008	Lithuania	304.7	886.7	344	894
2008	Belgium	139.9	494.7	283	735
2008	Norway	99.1	479.6	207	538
2008	Belarus	135.1	435.0	311	808
2008	Czech Rep.	7.7	20.7	371	964
2009	Lithuania	154.2	1063.4	145	377
2009	Belarus	73.3	502.5	146	379
2009	Norway	76.5	335.9	228	592
2009	Belgium	72.3	265.0	273	709
2009	Japan	41.1	81.7	503	1306
2009	Netherlands	14.7	65.5	225	584
2009	Bulgaria	12.2	48.0	253	657
2010	Lithuania	88.0	741.3	119	309
2010	Belarus	86.6	478.1	181	470
2010	Belgium	75.2	416.2	181	470
2010	Netherlands	12.8	88.6	145	377
2010	Finland	1.0	6.9	150	390
2010	Czech Rep.	1.8	5.2	351	912
2010	Norway	0.6	3.2	194	504
2011	Lithuania	107.0	553.1	194	504
2011	Belgium	109.0	293.9	371	964
2011	Belarus	59.2	238.0	249	647
2011	Netherlands	3.8	20.0	192	499
2011	Czech Rep.	5.2	13.0	402	1044
2011	Norway	0.6	2.3	271	704
2012	Lithuania	99.8	534.9	187	486
2012	Belgium	114.0	335.7	340	883

Source: UN Comtrade, Integer

Table 5 Main importers of South African phosphate rock (assuming 38% average P_2O_5)

Year	Importer	Value, US$ million	Volume, '000 tonnes	Value, US$/tonne product	Value, US$/tonne P_2O_5
2008	Japan	31.7	78.5	404	1063
2008	Belgium	2.4	6.0	406	1068
2008	Australia	0.2	1.2	205	539
2009	Japan	12.1	50.1	242	637
2009	Belgium	2.5	5.8	433	1139
2010	Japan	14.7	54.2	271	713
2010	Mexico	8.6	47.0	183	482
2011	Japan	38.3	136.7	280	737
2011	Belgium	3.0	11.0	272	716
2012	Lithuania	35.9	144.7	248	653
2012	Japan	25.2	78.1	323	850
2012	New Zealand	7.0	26.8	261	687
2012	Belgium	0.9	3.4	251	661

Source: UN Comtrade, Integer

The table below shows US imports from Morocco.

Table 6 Sedimentary rock, US import from Morocco (assuming 30% average P_2O_5)

Year	Value, US$ million	Volume, '000 tonnes	Value, US$/tonne product	Value, US$/tonne P_2O_5
2008	177.7	1835.1	97	323
2009	109.4	1360.9	80	268
2010	148.9	1697.5	88	292
2011	265.8	1642.7	162	539
2012	227.1	1375.4	165	550

Source: UN Comtrade, Integer

1.1.3.1 Latin America

Latin America is a major agricultural region with large fertilizer import requirements, and is located in the East of Panama market, which is logistically most favourable to AP. The two largest markets by some distance are Brazil and Mexico. Fertinal is the producer of virtually all phosphate fertilizer in Mexico.

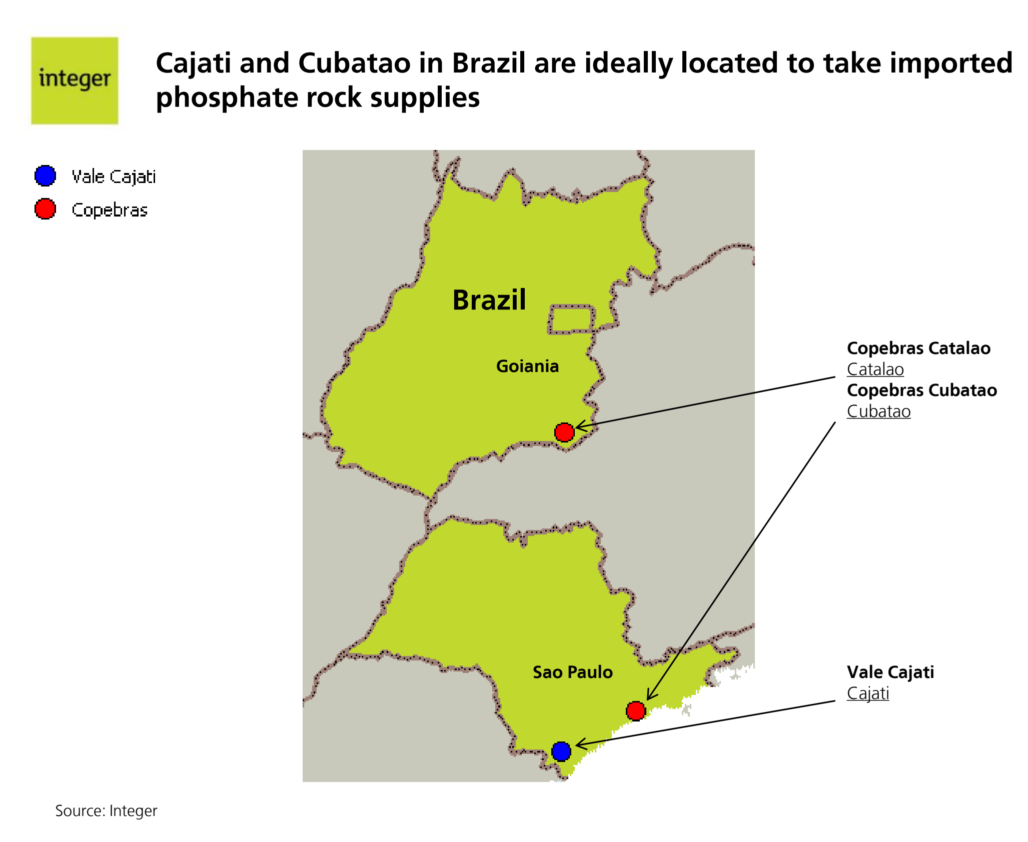
The table below shows imports of phosphate rock into Mexico and Brazil over the past five years.

Table 7 Mexican and Brazilian phosphate rock imports, '000 tonnes

	2007	2008	2009	2010	2011
Mexico	899	1021	91	981	865
Brazil	1996	1288	936	1416	1460

Source: IFA

In Brazil in particular, there are a number of PPA plants at Anglo-American Coprebras' Cubatao site and Vale's Cajati site. Vale Cajati is thought to use about 90% igneous phosphate and 10% sedimentary phosphate (a typical mixture, using some more reactive sedimentary phosphate to increase average reaction rate) from the Bayóvar mine in Peru in which Vale owns a controlling interest. The Anglo-American Coprebras Cubatao plant faces high transport cost for its current rock supply and could be interested in an alternative supply, as it is located close to the sea at Sao Paolo.



Source: Integer

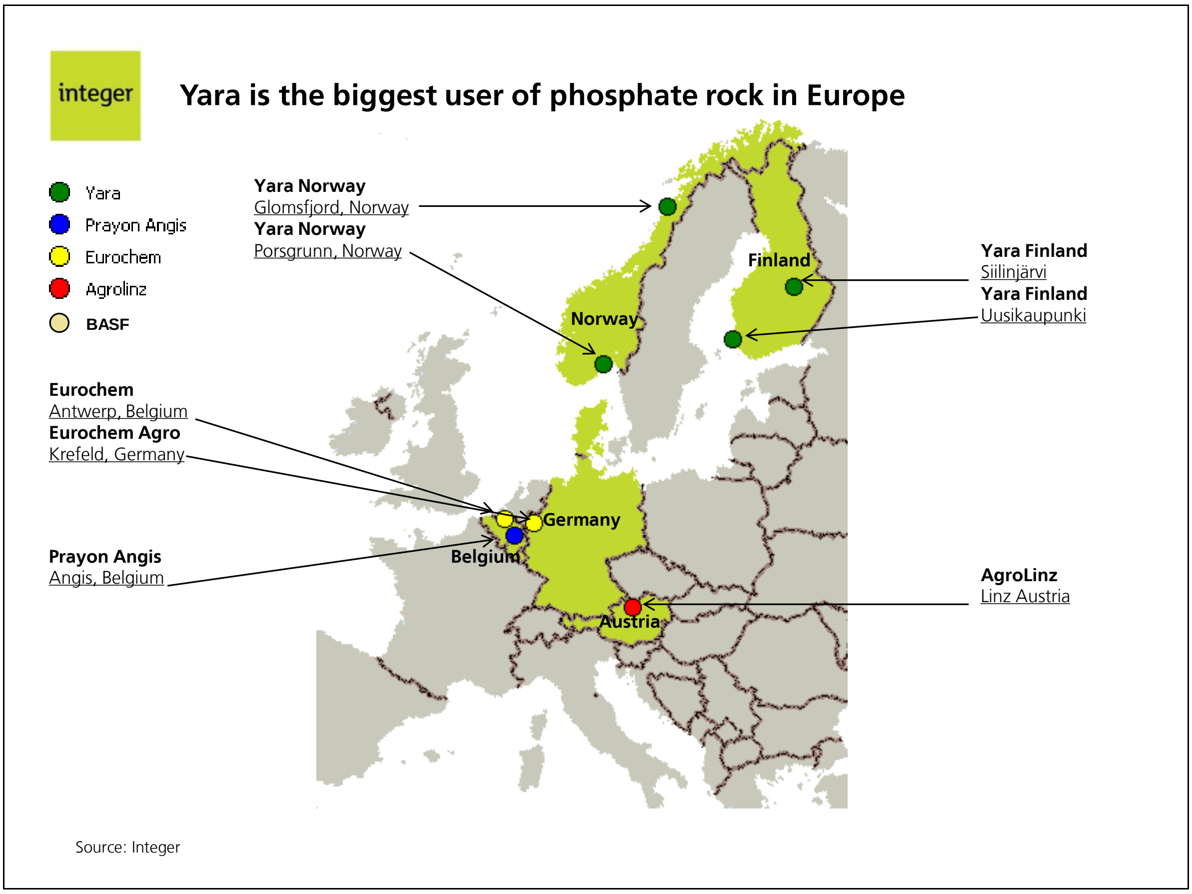
Figure 3 Potential phosphate rock buyers in Brazil

On the other hand, commodity grade fertilizer producers' interest in igneous phosphate in Brazil may be somewhat limited by the country's preference for SSP/TSP fertilizer, which cannot easily use igneous rock (TSP can use it in limited amounts; phosphoric acid produced from igneous rock may be used to acidulate sedimentary rock). This is because a large part of the country's agricultural production consists of soybean, which does not require the N content present in MAP/DAP fertilizer. According to IFA data in 2011, Brazil produced over 1 million tonnes of phosphoric acid, of which about 0.4 million tonnes were used to produce TSP (equivalent to under 0.9 million tonnes of product), with the remainder mostly used for MAP production. SSP capacity in Brazil is about 1.6 million tonnes in P_2O_5 terms, or nearly 9 million tonnes of product assuming 18% grade (SSP can be produced as 16-22% P_2O_5 product).

Examining the Brazilian P_2O_5 balance in 2011, the country produced about 6.1 million tonnes of rock at 35% and imported 1.5 million tonnes at about 32% average P_2O_5 content, equivalent to 2.6 million tonnes of P_2O_5, well above the reported phosphoric acid production of 1 million tonnes. A large portion of the rock not used for phosphoric acid production is accounted for by SSP production. Therefore, potential marketing efforts in Brazil should be focused on PPA and also supplementing the rock supply of Vale, the main producer of MAP in the country.

1.1.3.2 Europe

In 2011, Western and Central Europe imported a total of 854,600 tonnes of phosphate rock with 36% or above P_2O_5 content, of which 604,100 tonnes were imported from Russia, which is the only significant export supplier of igneous rock with typical 38-39% P_2O_5 content. In addition, Yara Finland produced 870,000 tonnes of apatite phosphate rock at its Siilinjarvi mine, a resource that is expected to last at least 20 more years. Given that additional production is likely to become more expensive due to the increasing depth of igneous apatite reserves, as mining progresses, Yara may become increasingly reliant on imports in the future.



Source: Integer

Figure 4 Potential phosphate rock buyers in Europe

The largest single use for high grade phosphate rock in Europe is production of NP/NPK via the nitrophosphate process, which is more sensitive to rock quality than processes using sulphuric acid. We believe this market to be about 0.8-1.2 million tpy of phosphate rock. Yara is the biggest producer of such fertilizer, and its own phosphate rock production in Finland is not sufficient to cover its requirements entirely. For example, Norway imported 255,000 tonnes of phosphate rock from Russia in 2011, according to IFA data. One of the largest nitrophosphate plants in Europe is located in Belgium, and the country imported 414,000 tonnes of apatite rock in 2011.

EuroChem Antwerp, formerly BASF, became part of EuroChem in 2012, giving it better access to EuroChem's igneous phosphate rock production from Kovdor in Russia. However, EuroChem's production of under 2.5 million tonnes of rock per year is only enough to cover 75% of the company's phosphate rock requirement. EuroChem is developing a large deposit of low grade sedimentary rock in Kazakhstan, which can only be used to replace about 20% of igneous rock used for its wet process phosphoric acid production without extensive plant modifications, and which is not likely to be usable in significant amounts for nitrophosphate production.

Therefore, some potential for igneous grade rock shortage exists with EuroChem's enlarged downstream phosphate capacity. EuroChem is likely to source additional phosphate rock from other suppliers in Russia, as the formerly non-integrated NPK producer Acron is developing large captive igneous rock mines, which would free additional volumes from the world's current largest supplier of igneous rock, Phosagro.

Acron's commissioning of captive phosphate capacity in 2012 may have a considerable effect on market balance. By 2013, Acron's concentrate capacity was reported at 1 million tpy, making it self-sufficient in phosphate rock, as this capacity is more than enough to cover consumption volumes (741,000 tonnes in 2011, more than all of Phosagro's exports combined). Acron also has an option to expand production to 2 million tpy by 2018 and could make the company a sizeable supplier of phosphate rock in its own right.

1.1.3.3 Japan

Japan also offers a possibility for small-volume sales of high quality rock. According to IFA data, Japan was the only significant importer of igneous phosphate rock in East Asia in 2011 with all 110,000 tonnes from Foskor of South Africa.

The end use is mostly in specialty chemicals, precision metallurgy and similar industrial applications. Compared with global fertilizer production and trade volumes, this trade flow is not a large amount, but is a more considerable part of the small open merchant market for igneous phosphate rock. The best located supplier for Asia, Foskor of South Africa, has seen its export volumes fall from almost 1 million tonnes a year to less than 200,000 tonnes in 2011 (thought to be due to technical issues with production).

The potential supply shortfall for igneous rock can provide a market for the small volume of highest grade product from Lac à Paul. According to UN Comtrade data, Japan imported 78,000 tonnes from South Africa in 2012 at an average cost of US$323 CFR per tonne, one of the highest prices achieved of all significant trade flows.

Chapter 2 Potential clients for Lac à Paul phosphate rock

2.1 Introduction

We have identified three key end uses and main markets for AP's phosphate rock and we have also named some of the potential customers the company may want to approach, as the opening of the mine gets closer.

As limits on heavy metals content in phosphate rock become tighter in all the main markets, demand for igneous rock is likely to increase. These changes in legislation are already influencing the market in Europe, some of the US states and, more recently, in Brazil. We look at environmental regulation for these key geographies in Chapter 3 of this report.

We describe below in more detail the three main markets and potential clients for igneous rock that could be approached by a new supplier.

2.2 Purified Phosphoric Acid (PPA)

PPA is a pure form of phosphoric acid used in food production.

An independent consumer of igneous phosphate rock is **Prayon** at its PPA unit at Engis, Belgium. The company uses Kola phosphate rock at present.

Another potential client in the PPA market is **Innophos**. The company is a leading producer of specialty-grade phosphate products for the food, pharmaceutical and industrial markets, and operates production sites in Coatzacoalcos, Mexico and Geismar, GA in the USA. Innophos purchases Moroccan rock.

There are other producers of purified phosphoric acid, requiring additional phosphate rock that are already using igneous phosphates.

Anglo American's phosphoric acid unit at Cubatao SP, in Brazil, supplies feed-grade acid to both the PPA unit of FosBrasil and Tortuga – now DSM's animal feed division. Today this phosphoric acid unit is using phosphate rock that has to be transported from Catalao.

At the same time, the **Vale Fertilizantes** phosphoric acid unit at Cajati, also in Brazil, is using a 90:10 mixture of the site's igneous phosphate rock and Bayóvar phosphate rock from Peru. This is another potential market for a new entrant.

In all the above cases, at some later date, contacts will need to be established in these organisations in order to be able to quantify interest in a new supplier of phosphate rock.

PotashCorp is also a potential client as a PPA producer. The company makes PPA in Aurora, NC in the United States.

2.3 The Nitrophosphate (NP) market

This is the largest potential market for high-grade igneous phosphate rock, and the location is principally Northwest Europe.

These high grade igneous phosphates have significant advantages in the production of nitrophosphates. The advantages of igneous phosphate rock are:

- It contains no organic material and no stable foam is formed in the presence of carbonates;
- It allows for reduced NO_x emissions;
- It has lower levels of acid insoluble impurities, therefore requiring smaller filters and less residues to be treated and disposed of;
- It allows for lower specific consumption of nitric acid.

Potential clients in the nitrophosphates market are:

- Abocol – Colombia
- Timac – Austria
- Yara – Norway and Finland
- EuroChem – Belgium & Germany
- Rashtriya Chemical & Fertilizers, (RCF) - India.
- Gujarat Narmada Fertilizer & Chemicals Ltd, (GNFC) - India
- Deepak Fertilizer and Petrochemicals Corp. Ltd - India

The Indian plants should be a target for a new entrant.

Integer estimates the total market size for nitrophosphates to total around 1.0 – 1.5 million tonnes of P_2O_5 per year.

2.4 Merchant-grade Acid (MGA)

This market is more difficult to both define and quantify, but the higher concentration always gives an advantage in the case of freight.

There are existing units such as those that produce super phosphoric acid, (SPA), which is used for liquid – suspension fertilizers – 10:34:0, where the lack of organics and the lower impurity ratio yields a better product.

An advantage for Arianne Phosphate’s specific location is that these markets exist mainly in North America.

Again, to determine the market size it is a question of selecting potential clients and investigating this market in more detail.

2.5 Price implications of Lac à Paul phosphate rock

When selecting a supplier, the market for igneous rock is very price driven.

Here we compare OCP's, Foskor's and Phosagro's achieved prices for high-grade phosphate rock with AP's likely achieved price if it were operating in today's market conditions:

Table 8 Phosphate rock sources and assessment of likely achieved prices – Q1 2013

Rock origin	P_2O_5 content %	Price US$/tonne	US$/kg P_2O_5
Boucraa, Morocco	35	190	5.43
Foskor, S Africa	36.5	200	5.48
*Arianne P, Canada**	*39*	*232*	*5.94*
Kola, Russia	40	265	6.63

Source: Integer
*estimate of Arianne achieved price
Note: All prices are FOB basis for high-grade phosphate rock

The PhosAgro price (Kola) is by far the highest achieved price amongst the grades of rock analysed in the table above and Kola rock is able to command this premium on phosphate rock product of other origins for a number of reasons, which we discuss in detail below.

The high 40% P_2O_5 grade means that Kola rock is the most concentrated phosphate rock commercially available today. This means the Kola rock contains the lowest percentage of impurities, has the lowest unit transportation cost and it is close to its major markets, such as for example Northwest Europe.

The key aspects that consistently deliver a premium for Kola rock are the following:

- Kola rock is igneous and it therefore contains little or no organic materials;
- Its advantages include the fact that little or no nitrogen oxides (NO_x) are formed and released during the attack with nitric acid during the nitrophosphate (NP) process;
- This type of rock allows for smaller percentages of insoluble acid residue during the nitric acid attack;
- The presence of little or no free carbonates reduces acid consumption;
- As Kola rock is igneous, this means heavy metal content is low, especially cadmium, mercury and arsenic content;
- Levels of radioactivity are also low;
- Delivery costs for Kola rock are also low and this is a function of the close proximity to its main markets, such as the European Union, where at times, deliveries can be made by rail.

The table below compares variations in contaminants contained in different rock from different origins, which has significant influence on the final price of the product:

Table 9 Phosphate rock contaminants content position

	Kola standard	Kola super	Foskor Palfos 88	Arianne Phosphate
P_2O_5 %	39.00	40.00	40.10	39.10
CaO	50.60	51.15	54.50	52.10
Fe_2O_3	0.70	0.53	0.20	1.67
$Al2O_3$	0.70	0.40	<0.01	0.84
MgO	0.25	0.10	0.46	0.86
Na_2O	0.35	0.40	0.10	0.28
K_2O	0.25	0.15	<0.01	0.15
F	3.05	3.30	1.15	1.70
Si_2O total	2.30	1.90		2.49
SiO_2 solution				0.59
C Org.				0.91
H_2O	1.00	1.00		0.30
Cd ppm	1.00		0.50	<0.50
As ppm				<0.05
U mg/L				<0.02
Cl total ppm			320	860
Cl solution ppm				108
SO_3 %			0.32	0.12
CO_2 %				2.38
$CaO:P_2O_5$				1.33
F/Sol SiO_2				2.88
Mer				0.089

Source: Integer

A comparison between the Kola rock and the expected Arianne concentrate shows that in nearly all factors, the Kola rock is superior.

2.5.1 Strategic recommendations for Arianne Phosphate

Integer believes that Arianne Phosphate should be aiming to meet the Kola price level, based on kilograms P_2O_5.

This means looking for markets that are closer to the eastern Canada seaboard in order to maximise the advantage of customer proximity, which is one of the main factors influencing phosphate producers' profitability, together with access to low-cost raw materials.

There are some important factors that need mentioning at this point, as they are influential in determining future strategic marketing opportunities for Arianne Phosphate's Lac à Paul deposit.

It must be remembered that the Kola rock price profile is to be found in the European Union's pressure on cadmium limits and the lack of an adequate alternative at this time.

It is also very important to note that the debut of an alternative high-grade phosphate rock supplier on the market is likely to put downward pressure on both Kola and Arianne Phosphate's prices.

It is also important in the context of a sensitivity analysis on a phosphate rock project's viability, to assess the split between fixed and variable costs, in order to determine the minimum level of sales required to yield the desired level of ROI.

The predictable price fall based on the entry of a new supplier could be mitigated by two key factors, which can complicate the analysis of market growth for high-grade phosphate rock:

- The marketing policy and reserves of Kola rock;
- The effect of political pressure on Morocco concerning sales of Boucraa rock

In addition to these two key factors, delays in new mine investments in Brazil and processing problems with mixtures of sedimentary and igneous phosphate rock can also help open up new markets for Arianne Phosphate's product.

Arianne Phosphate may also decide to serve the fertilizer as well as the industrial sector as it ramps up to its total production target of 3 million tonnes of phosphate rock. This would also mitigate the impact on the high-value rock price environment.

Furthermore, there is the big unknown of the issues of a political nature related to instability in Morocco. Morocco is experiencing similar issues as Tunisia and several other North African countries in terms of youth unemployment and strong political tensions.

Any political unrest in Morocco would completely change the world phosphate market.

2.5.2 Future market: demand for igneous rock and Arianne Phosphates

The supply side of igneous phosphate rock is becoming increasingly more difficult to predict.

On one hand, it has now been possible to confirm that the Kola mines in Russia are likely to convert from open pit mining to underground operations within the next two years. This will limit Phosagro's output to 8 million tpy. Meanwhile, Yara has already expanded its Silinjarvi mine in Finland and are studying bringing the Sokli ore body to an operating mine, but even if a decision were to be made shortly, there would not be production at this mine for the next few years at least.

Vale has cancelled its Evate project in Mozambique and has put the Salitre development in Brazil on hold. The only igneous mine that is expected to maintain both its quality and quantity of production is the Phalaborwa mine in South Africa.

Based on this supply-side analysis, we believe that, even at zero growth rate, there will be space for entry and growth for Arianne's phosphate rock, bearing in mind that there will also be changes in the quality of sedimentary phosphate rock. With the exception of OCP's phosphate rock, we believe sedimentary rock will also show declines in P_2O_5 content. This will also increase demand for high-grade phosphate rock.

The two major markets for high-grade 38% plus phosphate rock are limited to purified phosphoric acid (PPA) and nitrophosphates (NP). Potential to build new NP units is generally limited, but PPA production is seen increasing by 3% per year.

Since the number of mines is limited to essentially Kola only, Arianne Phosphates proposes itself as one of few viable alternatives to Kola rock.

Another factor that may affect the market will be the Chinese economy. We expect Chinese production of rock will decrease in line with a more realistic cost and pricing structure in the future.

Against this backdrop, we believe we can assume a stable price premium for high-quality phosphate rock in future years. NP prices are not likely to decline and high-quality rock is scarce on the basis of the scenario described above. The consistency of the quality of the phosphate rock and geography or proximity to quality-sensitive, rather than price sensitive markets will protect a sizeable premium for high-quality product.

Chapter 6 Industry outlook and forecasts

6.1 Industry outlook and forecasts

In this section we explore how the phosphate rock industry will develop in the future. Using an understanding of new capacity developments, expected mine closures and likely demand prospects, we project how the supply/demand balance is likely to evolve. We make forecasts for global phosphate rock demand and supply under different scenarios, which we combine with our understanding of fundamental phosphate rock production costs to derive robust price forecasts.

Our methodology is as follows:

- We use a supply/demand balance based projection for the next 30 years in combination with our understanding of production cost economics.
  - We focus our scenarios by using a base case demand forecast in combination with different supply outcomes, including:
    - Only the most likely and committed projects in our 'upside' scenario (where there will be less new capacity).
    - More speculative projects in our 'downside' scenario.
    - Our balanced 'base case', which includes firm projects and a small number of projects which are not yet finalised.
- For the period beyond five years, where the balance between supply and demand is more uncertain, we focus more on projected production costs and the price needed to incentivize new capacity to guide our price forecast.

6.2 Demand

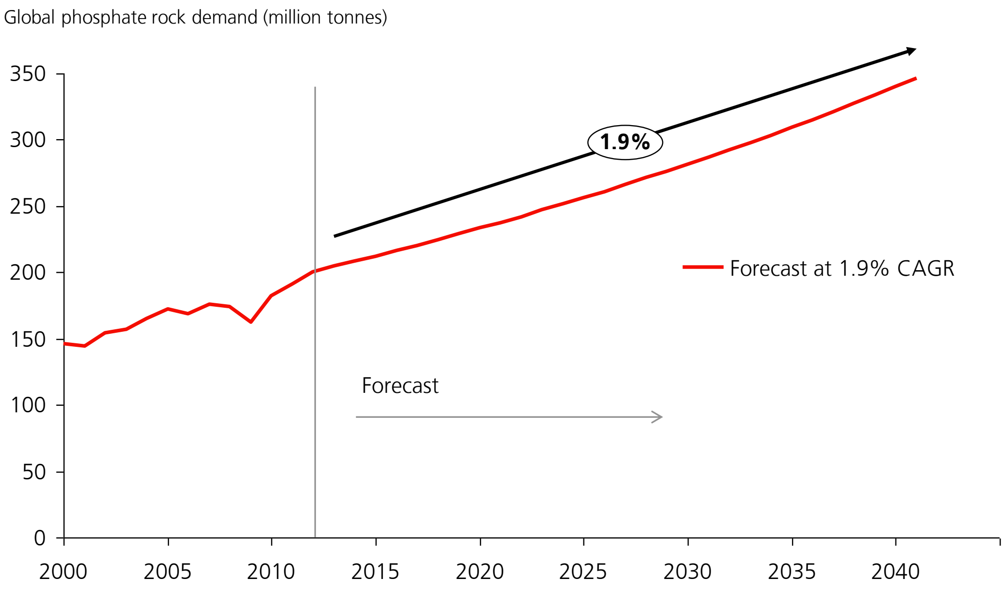
The compound average growth rate (CAGR) of the global phosphate rock market was 2.0% between 2000 -2011, measured by production which grew by 35.7 million tonnes. Looking forward, phosphate demand fundamentals appear to be robust.

- The global population is expected to grow by approximately 300-400 million every five years.
- Income growth in developing countries tends to stimulate a change toward more varied and meat-based, more crop-intensive diets.
- Despite weak growth prospects in developed countries, incomes of developing countries will continue to rise and diets will change and become more crop intensive.
- Phosphate rock prices eased during H2 2012 and continued to fall in early 2013, down 25% year-on-year in June 2013. However, prices remain high by historical standards and supportive of robust demand for agricultural inputs like phosphate fertilizers.

In order to produce more food, crop production must intensify and yields must increase. Arable land area is flat in absolute terms and falling per capita, and opportunities to boost crop production by increasing arable area are limited. Fertilizers are essential to raising crop yields where application rates are below optimal or imbalanced, and insufficient use of phosphate fertilizer is frequently a yield constraint. As such, we are likely to see continued phosphate rock demand growth looking forward.

Integer’s base-case phosphate rock annual demand growth forecast is 1.9% per year between 2013-2041 and on this basis, the phosphate rock market will reach 238 million tonnes in 2021 and 346 million tonnes in 2041. This projection takes into account likely crop prices and agricultural developments, pressures created by population growth and limited additional agricultural land availability.

Global phosphate rock demand is projected to reach 346 million tonnes in 2041



Source: Integer

Figure 5 Global phosphate rock demand at 1.9% annual growth (2013-2041)

6.3 Supply

Since the economic downturn in 2009, the phosphates business has recovered and has experienced strong profitability, which has stimulated many phosphate project announcements in response. Until the last five years, there was relatively little activity outside China with the main exception being Ma’aden’s project in Saudi Arabia.

- Over the last decade or more, China has overwhelmingly been the focus of investment in new phosphate capacity. The Chinese phosphates business has seen a massive transformation over the last two decades in terms of the overall phosphate supply/demand balance, the make-up of production and consumption, the phosphates trade balance, as well as company ownership and supply chain. Chinese phosphate rock production increased from around 30 million tonnes in 2000, to almost 70 million tonnes in 2010 and exceeded 80 million tonnes in 2011.

- Furthermore, Ma'aden Phosphate Company (MPC) added 5 million tpy of phosphate rock capacity and 2.9 million tpy of DAP capacity in Saudi Arabia in 2011. MPC started commercial production in June 2011.

6.3.1 New capacity

New phosphate rock capacity will be required in order to meet demand growth in the long term. There are large phosphate rock expansion projects being developed or under consideration by established producers in China, Morocco, Jordan, Tunisia and Brazil. In addition, high phosphate rock prices have encouraged a number of exploration companies to develop phosphate rock projects around the world.

The major brownfield projects outside of China are as follows:

- **Office Chérifien des Phosphates (OCP)** has an ongoing phosphate rock expansion programme at Khouribga, Benguerir and Gantour in Morocco. It is conceived to gradually add up to 20 million tpy of new rock mining capacity over many years.
- **EuroChem** plans to add 1.5 million tpy of phosphate rock capacity at Kazfosfat's existing operational Karatau site in Kazakhstan in 2014.
- **CPG** of Tunisia is planning to raise phosphate rock production by 3.5 million tpy over the next few years.
- **Vale's** development of the Bayóvar deposit in Peru started commercial production in July 2010 with a ramp up of around 1 million tpy to 3.9 million tpy of phosphate rock expected in 2014.

The major greenfield projects are:

- The fully integrated **Ma'aden** project at Al Jalamid in Saudi Arabia started production in June 2011 and is set to reach 5 million tpy of phosphate rock capacity.
- **Ma'aden's** Al Khabra project in Saudi Arabia will have production of 5.3 million tpy at full capacity.
- Russian company **Acron** is developing non-conventional nephelinite resources combined with some apatite at Oleniy Ruchey in Russia, through its subsidiary North-Western Phosphorous Company. It will add 1 million tpy of capacity in 2013, rising to 2 million tpy by 2018.
- **Arianne Phosphate** would have 3 million tpy of capacity at Lac à Paul with initial production in 2016.
- **Namibian Marine Phosphate's** offshore Sandpiper project in Namibia would have a capacity of 3 million tpy with production commencing in 2015.
- **MBAC Fertilizer's** Itafós project commenced production in 2012 and will reach 330,000 tpy at full capacity.
- **Fospac's** Piura project would add around 2 million tpy in Peru with initial production in 2016**.**
- **Vale's** Salitre project would add 3 million tpy of rock capacity in Brazil, though this project is understood to have been significantly delayed.

There are also a large number of more speculative greenfield projects that are mainly being developed by junior mining companies. The most advanced projects include Sunkar Resources (Chilisai), GB Minerals (Farim), Minbos Resources (Cacata/Kanzi), Stonegate Agricom (Paris Hills), Cominco Resources (Hinda), MBAC Fertilizer (Santana), Vale (Nampula), Minemakers (Wonarah), Celamin Holdings (Chaketma) and B&A Mineracao (Bonito).

The timing of completion of many of the greenfield projects is likely to be highly sensitive to market conditions, how prices and industry profits develop and the availability of finance. It is also important to note that greenfield projects will take a number of years to reach their full operational capacity. Considering these aspects, the table below presents three capacity expansion scenarios:

- In our **upside scenario**, we assume that all of the brownfield expansions by OCP totalling 20 million tpy of capacity proceed, along with brownfield expansions by EuroChem at Karatau (1.5 million tpy in 2014), CPG at Gafsa (3.5 million tpy in 2014) and Vale at Bayóvar (1 million tpy in 2014), Arianne Phosphate (3 million tpy in 2016), whilst Ma'aden ramps up to full capacity of 5 million tpy at Al Jalamid. We also assume that 8 million tpy of capacity is added in China in stages over the next decade.

- In our **base case scenario** we assume all the project activity in the upside scenario proceeds, and in addition:
    - MBAC Fertilizer adds 330,000 tpy of rock capacity in 2013;
    - Acron adds 1 million tpy of rock capacity in 2013;
    - Ma'aden adds capacity at Al Khabra in 2016, which reaches 5.3 million tpy;
    - Namibian Marine Phosphate builds 3 million tpy of capacity with first production in 2015;
    - Fospac's Pieura project becomes operational in 2016 and reaches 2 million tpy capacity.
    - Vale's Salitre mine becomes operational in 2021.

- In our **downside scenario**, where supply turns out to be higher than the base case, we assume all the activity in the base case, and in addition the following projects, which are mostly sponsored by junior mining companies, proceed:
    - B&A Mineracao (210,000 tpy in 2013)
    - GB Minerals (formerly Plains Creek Phosphate) (2 million tpy in 2015);
    - Minbos Resources at Kanzi (1 million tpy in 2015);
    - Cominco Resources (4 million tpy in 2015);
    - MBAC at Santana (300,000 tpy in 2015)
    - MBAC Fertilizer at Santana (300,000 tpy in 2015);
    - Minbos Resources at Cabinda (800,000 tpy in 2016);
    - Stonegate Agricom (1 million tpy in 2016);
    - Minemakers (1 million tpy in 2016);
    - Celamin Holdins (1.5 million tpy in 2016);
    - Sunkar Resources (2.6 million tpy in 2017);
    - Vale at Nampula (2 million tpy in 2020);

Beyond 2018, our supply forecast includes capacity expansions that are not allocated to specific projects, as our potential to predict the emergence of new projects and/or the resurrection of unrealised projects from previous years is limited.

Our forecast predicts that beyond 2018 the industry will respond to market conditions, adding capacity in response and in proportion to industry-wide capacity utilization rates.
We assume higher capacity utilization rates will incentivise higher capacity additions and vice versa, albeit with a time lag to capacity realisation.

We will assume a time lag of three years. Therefore, capacity additions in any year beyond 2018 are determined by utilization rates three years earlier – for 2018, 2015; for 2019, 2016 and so on. This figure has been chosen as it is slightly lower than typical phosphate rock project lead times to account for some anticipation by planners.

In addition, our forecast assumes that capacity will be added in proportion to anticipated phosphate rock demand increases. As demand is projected to rise at a constant 1.9% per year, growth will be exponential.

Overall, the conditions for capacity addition in our forecast beyond 2018 are:-

- If the industry capacity utilization rate is below 75%, no capacity will be added three years later.
- If the industry capacity utilization rate is between 75% and 80%, modest capacity will be added three years later. This is defined as being 66% of demand increase in the year of capacity expansion.
- If the industry capacity utilization rate is between 80% and 85%, moderate capacity will be added three years later. This is defined as being 130% of demand increase in the year of capacity expansion.
- If the industry capacity utilization rate is above 85%, substantial capacity will be added three years later. This is defined as being 200% of demand increase in the year of capacity expansion.

It is assumed that the non-project assigned capacity additions after 2018 would be implemented primarily by OCP and Ma'aden, companies which have the resources, finances and industry experience to support significant capacity expansion going forward. The result of this dynamic is a forecast which sees the phosphate rock industry responding to capacity utilization rates with expansions of broadly appropriate scale within the time lag limitations of the developing phosphate rock expansions. The market is therefore self-correcting, albeit over extended periods.

6.3.2 Mine closures

Each supply scenario incorporates future phosphate rock mine closures that are expected before 2041. For each mine closure, it is assumed that production capacity diminishes in the years preceding the closure. Mine closures are expected over the next 30 years in the USA (21.4 million tpy of capacity), Canada (910,000 tpy of capacity), Brazil (3.1 million tpy of capacity), India (2 million tpy of capacity), Egypt (1.5 million tpy of capacity), Mexico (2.1 million tpy of capacity) and China (9.5 million tpy of capacity).

In addition, a number of greenfield mines are expected to become depleted before the end of the forecasts period.

6.4 Global utilisation rate outlook

The chart below shows total industry capacity under our three scenarios.

- Our upside scenario sees only brownfield capacity additions and Arianne Phosphate’s Lac à Paul project up to 2021. Capacity increases at only 1.6% per year between 2012 and 2021, just less than projected demand increases, reaching 259 million tpy in 2021. As the industry supply scenario tightens over this period, interest in new projects is projected to pick up, resulting in capacity expansions of 2.0% per year from 2021 until 2041. Capacity is expected to reach 391 million tpy in 2041.

- Our base scenario sees moderate capacity expansion in the period to 2021, with industry capacity rising by 1.9% to 266.1 million tpy. Beyond 2021, this trend is continued, with the industry adding 2.1% capacity per year to 2041. The supply situation in this forecast tightens slightly in 2019-2022 before easing towards 2041, reaching 415.6 million tpy.

- Our downside scenario sees a sharp increase of new capacity before 2019 as brownfield and greenfield expansion projects come online. Capacity is projected to rise at a rate of 2.3% per year between 2012 and, reaching 277.7 million tpy in 2021. Beyond 2018, relatively low capacity utilization rates are projected to disincentivize new project activity. By 2023 the capacity expansions pick up as the market tightens once again. Between 2021-2041 global capacity increases by 1.7% per year, reaching 394.5 million tpy in 2041.

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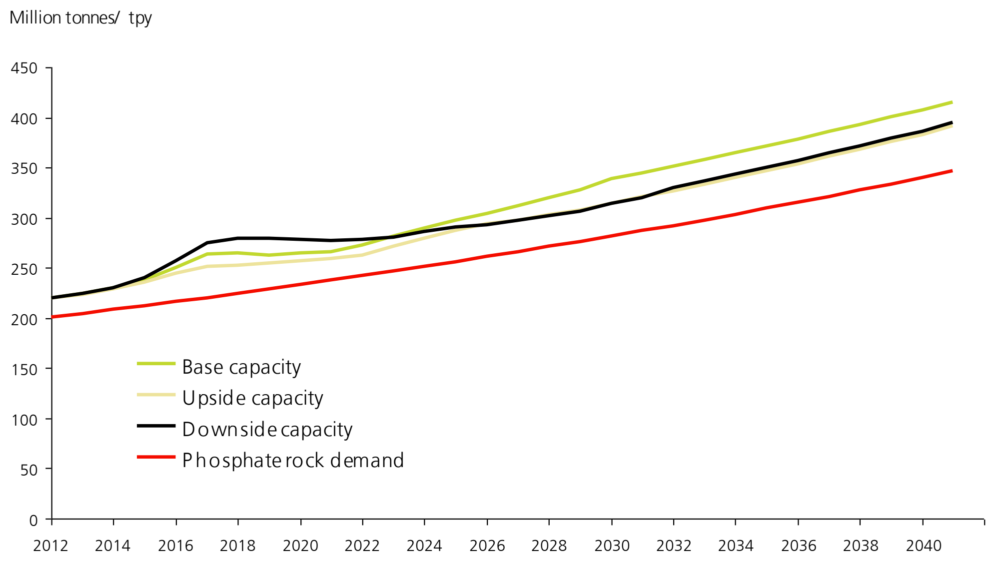
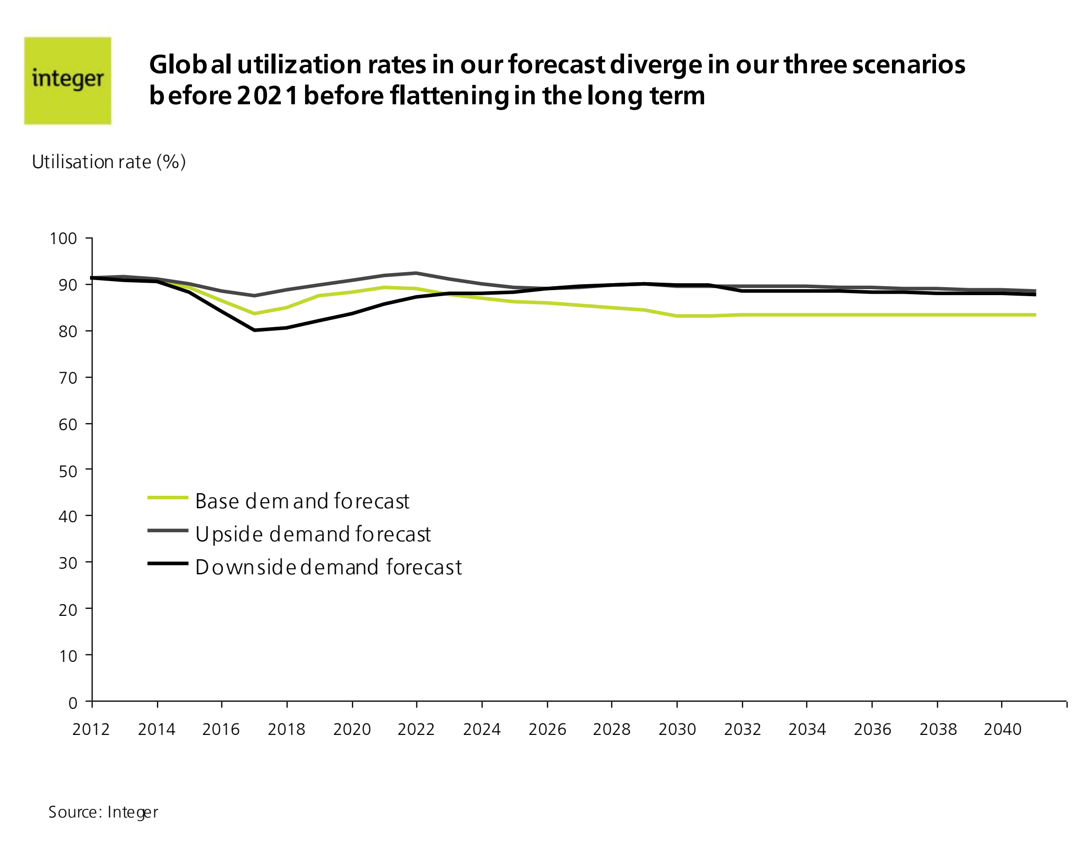
Our phosphate rock supply forecast scenarios see varying levels of capacity expansion in the 2012-2021 period and market rebalancing thereafter



Source: Integer

Figure 6 Global phosphate rock capacity forecast, 2012-2041 (million tpy)

The chart below plots the global phosphate rock nameplate utilisation rate to 2041 under each supply scenario, using our demand growth rate assumption – based on 1.9% growth after 2012. In 2012, the global phosphate rock utilisation rate was 91%. In each scenario, the global utilisation rate drops after 2014 as new capacity is released into the marketplace. It then levels off and rises again after 2018/19 as demand starts to catch up with capacity additions. Beyond 2025, utilization rates in all scenarios flatten up to 2041.



Source: Integer

Figure 7 Global phosphate rock utilisation rate forecast (2013-2041)

Table 10 Phosphate rock utilisation rate forecasts (2012-2041)

	2012	2015	2020	2025	2030	2035	2041
Base	91%	89%	88%	86%	83%	83%	83%
Upside	91%	90%	91%	89%	89%	89%	89%
Downside	91%	88%	84%	88%	90%	88%	88%

Source: Integer

6.5 Pricing outlook

The phosphate rock market was bullish during 2011, as demand drove prices up, but there was a marginal decline in prices in 2012 based on softening demand, which continued into early 2013. The main phosphate price reference for phosphate rock is the Moroccan FOB price as OCP is by far the largest exporter of phosphate rock. The average Moroccan FOB phosphate price during January-June 2013 was US$156 per tonne.

In our view, there are likely to be three major influences on future phosphate rock prices:

- The phosphate rock supply/demand balance.
- Phosphate rock production costs.
- Price and supply strategy by existing suppliers.

In order to forecast prices beyond 10 years, where there is less visibility on the magnitude change in supply and the timing of new capacity:

- We use a model to identify the price level at which there is likely to be an incentive to build new capacity taking into account the costs of developing new projects.
- We look at the costs of production of existing producers, particularly the higher cost or marginal producers to identify a floor price.

Our incentive model makes several assumptions about the cost of developing new phosphate rock mining capacity:

- There are several assumptions about the configuration of the project:
  - Interest rate of 7%
  - Debt/equity ratio of 2 to 1
  - 10 years loan repayment period
  - 15 years depreciation period
- The cost of developing new greenfield phosphate rock capacity is equivalent to around US$300 per tpy. In other words, a 1 million tpy rock mine would cost US$300 million.
- We then consider different phosphate rock prices, and operating cost values which would be required to meet certain investment return targets.

The tables below summarise our findings. In the first table, we look at the price required to justify investment with projects, which have alternative operating costs of US$50 per tonne and US$100 per tonne fob. We observe that most junior mining projects have phosphate rock costs at the high end of this range, and would likely need a rock price of approaching US$150 per tonne fob in order to meet typical financial return targets. Of course, in this model, projects have to assume that the incentive price is achievable for the life of the project, or at least for the debt payback period.

Table 11 Phosphate rock incentive price analysis (US$ per tonne fob)

Internal Rate of Return (IRR) target	Price required for a nominated IRR return with costs @ 100 per tonne of costs to fob	Price required for a nominated IRR return with costs @ 50 per tonne of costs to fob
10%	135	85
15%	143	93
20%	152	102

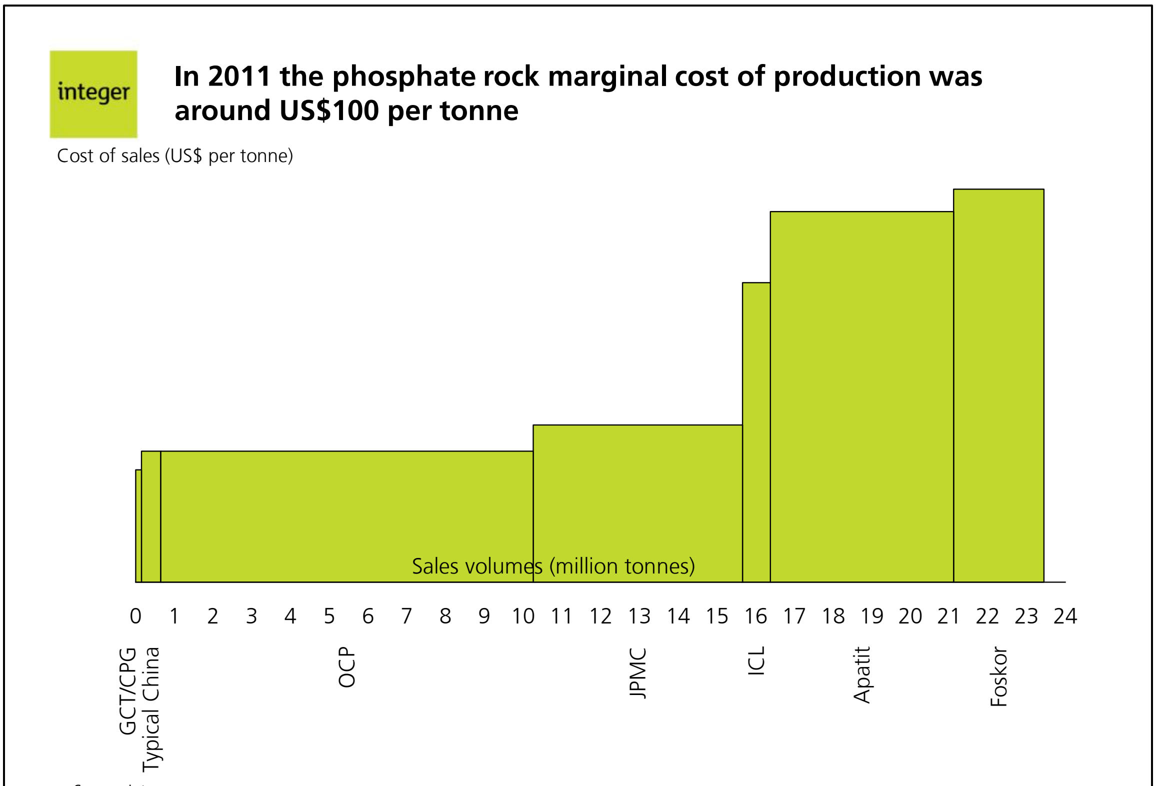
Source: Integer

The next table looks at alternative phosphate rock price outcomes, and considers what operating costs of production need to be achieved in order to meet financial return targets.

Table 12 Phosphate rock incentive price analysis (US$ per tonne fob)

Internal Rate of Return (IRR) target	Rock cost required if fob phosphate rock price is US$50 per tonne	Rock cost required if fob phosphate rock price is US$75 per tonne	Rock cost required if fob phosphate rock price is US$100 per tonne	Rock cost required if fob phosphate rock price is US$150 per tonne
10%	15	40	65	115
15%	7	32	57	107
20%	-2	23	48	98

To help us identify the floor price of phosphate rock pricing, in the event that the industry experiences significant downside, we turn to our cost curve analysis. We show the 2011 cost curve below. This indicates that if ex-works phosphate rock prices were to fall much below US$100 per tonne, producers with around 7 million tpy of capacity, would not be able to cover cash costs and would withdraw supply. This would set the floor price.



In 2011 the phosphate rock marginal cost of production was around US$100 per tonne

Source: Integer
Note: This is a sample and does not represent entire sales volumes, China is a sample quantity, Cost is ex-mine or as close to mine as possible, there may be additional cost to processing sites or export point

Figure 8 Phosphate rock industry cost curve, 2011 (US$ per tonne)

It is also important to understand how industry production costs will develop in the longer term. Integer has collected consensus country macroeconomic data, including inflation rate, labour cost and energy cost forecasts for every phosphate rock-producing country. We have forecasted long-run company production costs based on the macroeconomic indicators and our phosphate rock supply forecasts.

- Labour costs forecasts have been calibrated by applying, where available, consensus and official forecast labour wage inflation rates by country for each producer. Where necessary we have extrapolated existing trends in labour inflation and accounted for any likely changes in this trend over the forecast period.

- Fuel and energy cost forecasts have been formulated using energy market outlooks provided by the US Energy Information Agency, as well as consensus forecasts. We have applied the trends identified by these sources, and where necessary adjusted, them to individual producer’s costs based on their fuel and energy requirements. These forecasts also account for country-level government energy policy and the outlook for individual producer’s fuel and energy requirements.
- The remaining components of production costs have been calibrated by applying, where available, consensus and official forecast inflation rates by country for each producer. Where necessary, we have extrapolated existing trends in inflation and accounted for any likely changes in this trend over the forecast period.

We conclude the following from this analysis:

- Phosphate rock prices will need to remain above US$100 per tonne and likely closer to US$150 per tonne (in 2013 US dollars) in order to incentivise development of greenfield projects.
- Projects with operating costs significantly above US$100 per tonne FOB are unlikely to get off the ground (unless they have much lower cap-ex than we have assumed).
- It seems highly unlikely that we will see phosphate rock prices dip below the US$50 per tonne level seen in the first half of the 2000s.
- Existing producers, many of which have sub-US$50 per tonne operating costs, will continue to generate strong profits with FOB phosphate rock prices above US$100 per tonne. In addition, where feasible, phosphate rock prices at this level are likely to encourage expansion of existing facilities, which have many financial and practical advantages.

The chart below outlines our phosphate rock price forecast under our base case, and the two alternative supply scenarios. We show prices in real and nominal terms using an inflation rate assumed to be 2.2% per year.

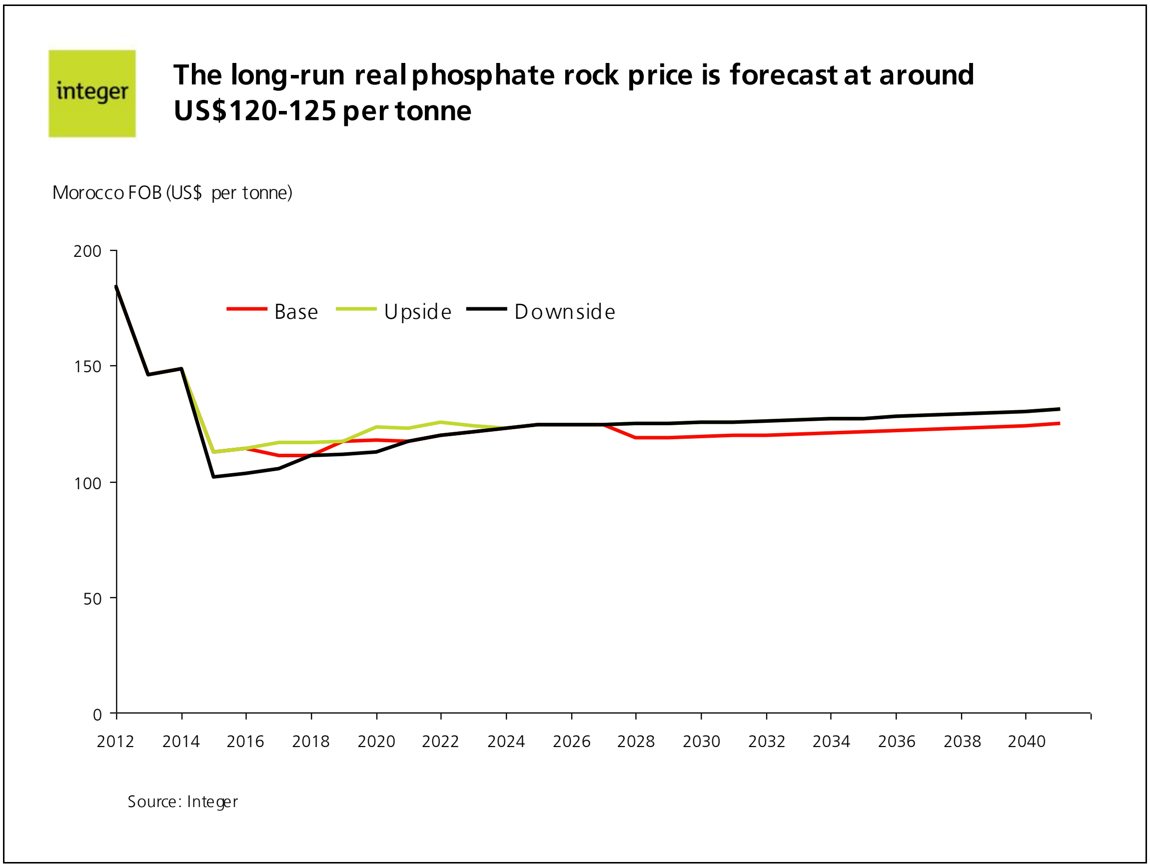


Figure 9 Phosphate rock price forecasts (FOB Morocco), 2013-2041 (US$ per tonne)

The forecast assumes the following:

- We expect phosphate rock prices to moderate somewhat starting in 2013/2014, as tonnes start to materialise from new mine capacity which is likely to be greater in magnitude than projected demand. This will push the global utilization rate lower and this is generally associated with weaker pricing.
    - We note that before 2016, there is no distinction between the scenarios as the new capacity balance is the same in each case.
    - A significant part of the new capacity expansion in 2013 is located in Morocco. OCP has a significant market share in the international phosphate rock market and we assume that the company's approach will be sensitive to market conditions.
- In 2014, we expect prices to continue to weaken as new supply exceeds new demand. We note that there may be a long term incentive for existing producers to see even lower prices in order to discourage new entrant greenfield projects.
- Our base case assumes that prices begin to rise in real terms from 2019, albeit marginally, as demand catches up with supply and the global utilization rate recovers.
- From 2025 onwards, the price remains relatively flat as the market is in balance and the global utilisation rate is constant.

We note that the price of rock is set to drop relative to processed phosphates over the next few years. This reflects the threat of greater supply pressure in the rock market. We also note that over the last few years, the rock price has risen relative to downstream products. Also, we note that there may be some long term incentive for existing producers to allow rock prices to fall to discourage new entrants and maintain market share.

Chapter 7 Production costs and margins

7.1 Phosphate rock costs and margins

In this section we will identify the Lac à Paul phosphate rock project's position on the global phosphate rock production cost curve: as if the project was active today, and we will also present a projection for 2016, its likely start-up date. Our production cost and margin methodology is as follows:

- For each company, we have obtained, wherever possible, phosphate capacity, production and sales volumes, product prices and profit and loss financial results.
    - We use this information to draw out the product volumes and values that underline each company's revenues, cost of sales and gross profits. For some businesses, where there is one product line, or where the company presents detailed product by product information, this is relatively simple exercise.
    - However, in most cases, we have used constructed estimates based on our understanding of product prices, which we use to determine company netback prices and estimated ex-works production costs. These are constructed from our knowledge of production technology, efficiency and others. We have tried to exclude freight wherever possible.

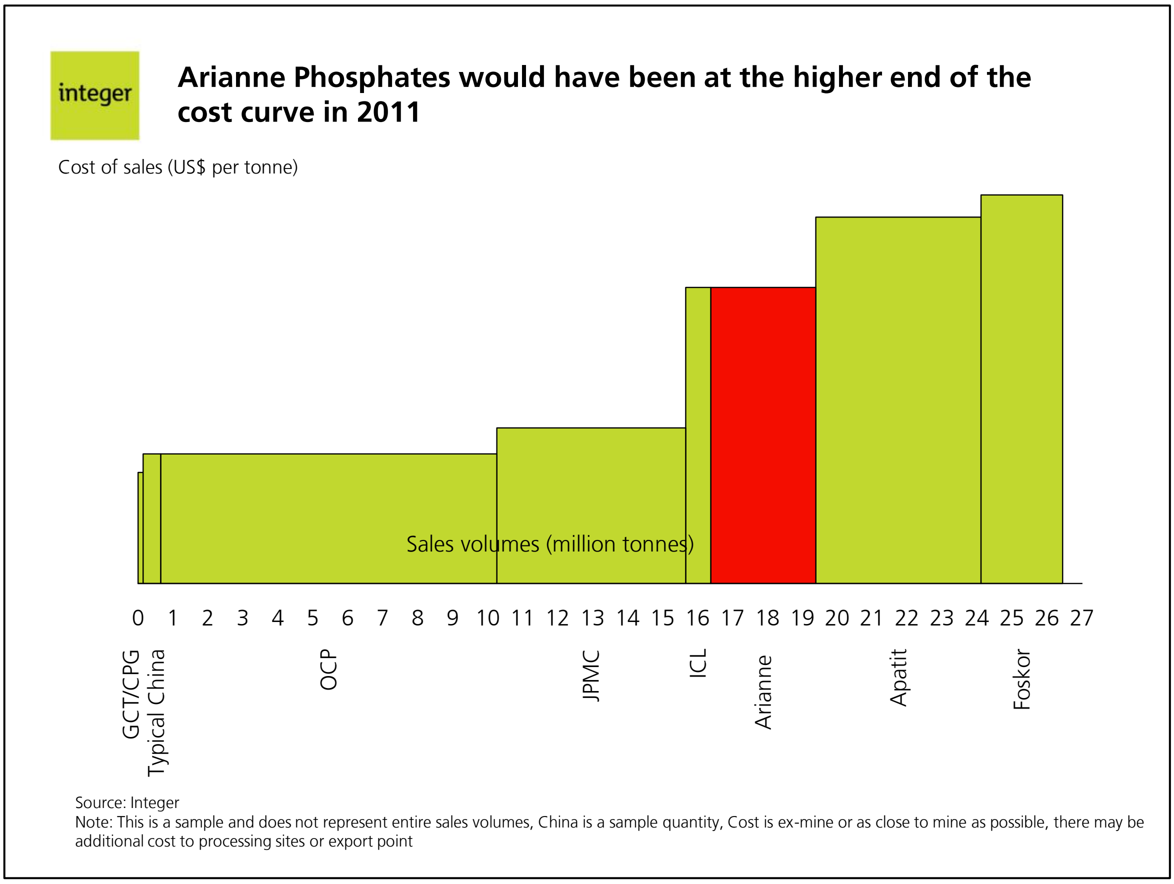
  In some cases, companies produce a suite of different phosphate products and combine the results into one business segment including revenues, costs and profits across the product range. Often in these cases, we have calculated prices for each product and used the whole business segment's profit margin percentage applied uniformly to calculate product by product costs and margins.

The number of companies selling phosphate rock to third parties (as opposed to other business units and/or joint-ventures) is relatively limited. It is dominated by OCP, which typically controls around half of world phosphate rock trade. The number of companies involved in high-grade rock sales is even smaller.

For companies like OCP, we are averaging out costs and prices between mines, which have quite different geographic, geological and product characteristics. Our data for OCP is based on estimates and financial data on the Phosboucraa mining operation, as well as observed changes in OCP's financials for other parts of the business. We believe these to be a fair albeit approximate representation of the underlying phosphate rock mining cost position in each case.

7.2 Current and projected phosphate rock sales cost curves

The chart below shows the 2011 phosphate rock ex-works cost curve, including Arianne Phosphate's position as if the company's mining site were operating at that time. It shows that the company would have been located in the fourth quartile at US$80 per tonne of product. These costs are ex-mine or as close to ex-mine as possible. There may be additional costs to processing sites or export points.



Arianne Phosphates would have been at the higher end of the cost curve in 2011

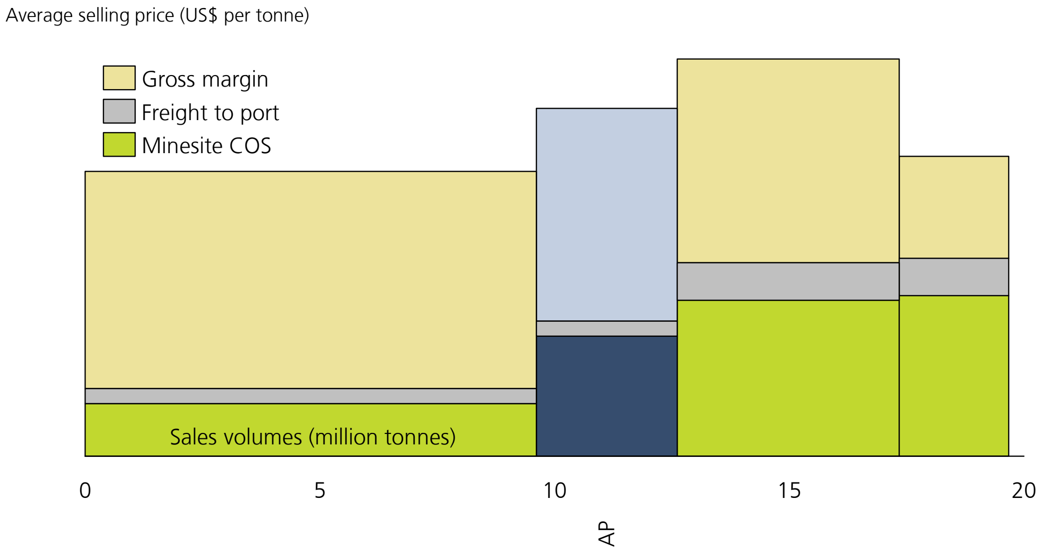
Source: Integer
Note: This is a sample and does not represent entire sales volumes, China is a sample quantity, Cost is ex-mine or as close to mine as possible, there may be additional cost to processing sites or export point

Figure 10 Phosphate rock industry cost curve including Arianne Phosphate (US$ per tonne), 2011

The following chart summarises production costs and average prices realised for the producers, which sell significant volumes of high-grade phosphate rock to third parties. Prices in this chart are FOB prices achieved by current producers in Q1 2013 and an estimate of Arianne Phosphate's possible achieved price if it were operating at this time.

The curve shows that Arianne Phosphate would be able to achieve a price premium and a high margin, despite its position at the higher end of the industry cost curve as noted above.

Arianne Phosphate would have a gross margin of over US$100 per tonne of phosphate rock if it were operating in 2013



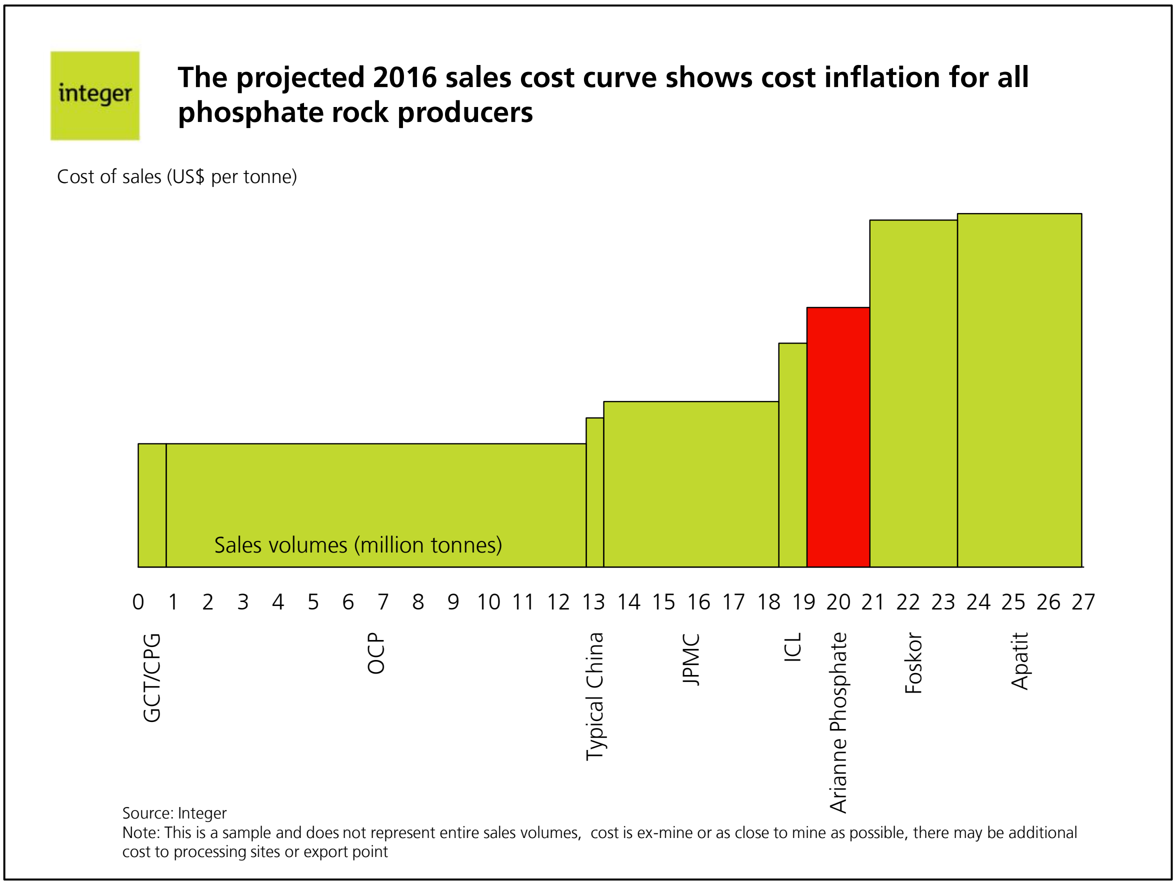
Source: Integer
Note: sales volumes are dated 2011 except for AP and costs are estimated for 2013, while prices are Q1 2013 estimates of FOB for high-grade phosphate rock

Figure 11 High-grade phosphate rock sales cost curve (US$ per tonne), 2013 estimate

Prices achieved partly reflect the difference in the phosphate content of rock as well as other quality factors, geographical position and supply relationships. Phosphate rock is not a commodity product and pricing is a complex area - different grades of P_2O_5, reactivity and purity can make a significant difference to price achieved. There are also often long-term and ownership relationships between sellers and buyers. OCP for example sells some product to joint-venture companies in Morocco and in consuming countries and has different costs and prices for different uses.

As we look at 2016 as the year selected by Arianne Phosphate to start operating its Canadian mine, we present here our projected cost curve for that year.

We have based this off country-specific inflation factors and have applied these to energy and labour costs, which typically represent two thirds of total costs for phosphate rock producers. The projected cost curve for 2016 shows cost inflation for all phosphate rock sellers. Arianne Phosphate would remain in the higher end of the cost curve at this time.



The projected 2016 sales cost curve shows cost inflation for all phosphate rock producers

Source: Integer
Note: This is a sample and does not represent entire sales volumes, cost is ex-mine or as close to mine as possible, there may be additional cost to processing sites or export point

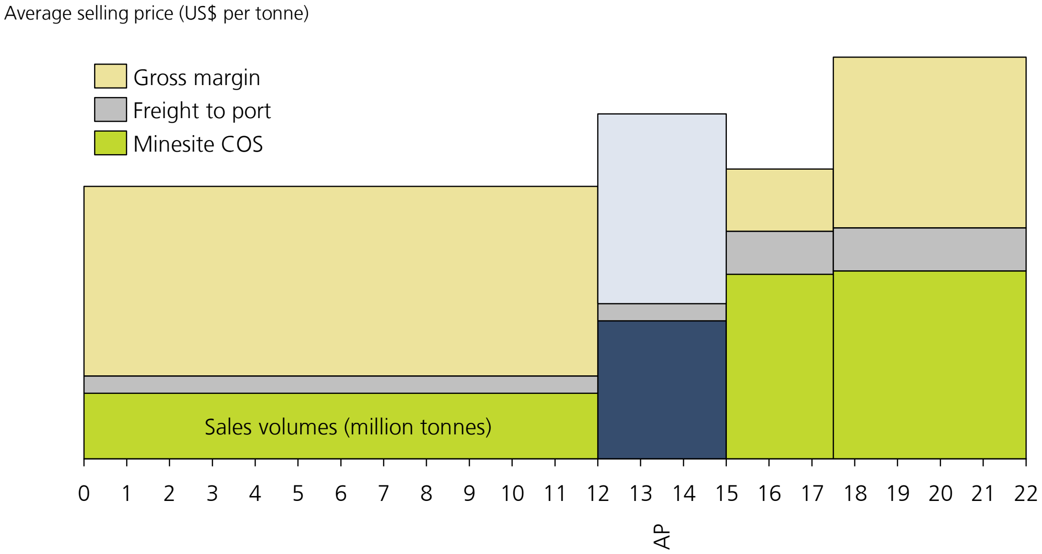
Figure 12 Phosphate rock industry cost curve (US$ per tonne), 2016 estimate

If we look at the situation from an achieved price and margin point of view, we see that prices are expected to come under some pressure in line with our base-case phosphate rock price forecast described in the previous chapter, but also as new players enter the high-grade phosphate rock market.

We have assumed larger sales volumes for Office Chérifien des Phosphates (OCP) in 2016, in line with the projected expansions at the company's mines. However, we note here that political unrest and an economic slowdown in Morocco would likely prompt a depreciation of the Moroccan Dirham and therefore lower production costs in US dollar terms than the ones represented in the 2016 cost curve above. Additionally, we believe volumes may end up being lower than expected if unrest occurs.

Below, we show our projected cost curve for high-grade rock sellers in 2016.

Margins are expected to weaken for rock sellers in 2016, based on lower achieved prices and expected cost inflation



Source: Integer
Note: Sales volumes have been estimated according to capacity expansion, prices are based off base-case scenario forecast and are FOB for high-grade phosphate rock

Figure 13 High-grade phosphate rock sales cost curve (US$ per tonne), 2016 estimate

Arianne Phosphates would be expected to see margins shrinking along with other high-grade phosphate rock sellers, as costs increase and prices decline in line with the base-case scenario presented above, and with the entry of a new player in the high-grade rock market.

7.3 Projected delivered prices to most likely markets for Lac à Paul phosphate rock for 2016 and 2020

We have also projected delivered prices of high-grade phosphate rock into Arianne Phosphate's most likely markets for 2016. These are areas where the company can exploit proximity to customers as an advantage as identified in Chapter 2 of this report. Geographical advantages are an important element of producers' profitability alongside phosphate rock quality considerations.

These markets include the US Gulf and Brazil and compare Arianne Phosphate's likely position compared with other high-grade phosphate rock sellers such as OCP, Foskor and Apatit (Phosagro) in 2016.

Projected delivered prices into the US Gulf and Brazil are represented in the charts below alongside costs:

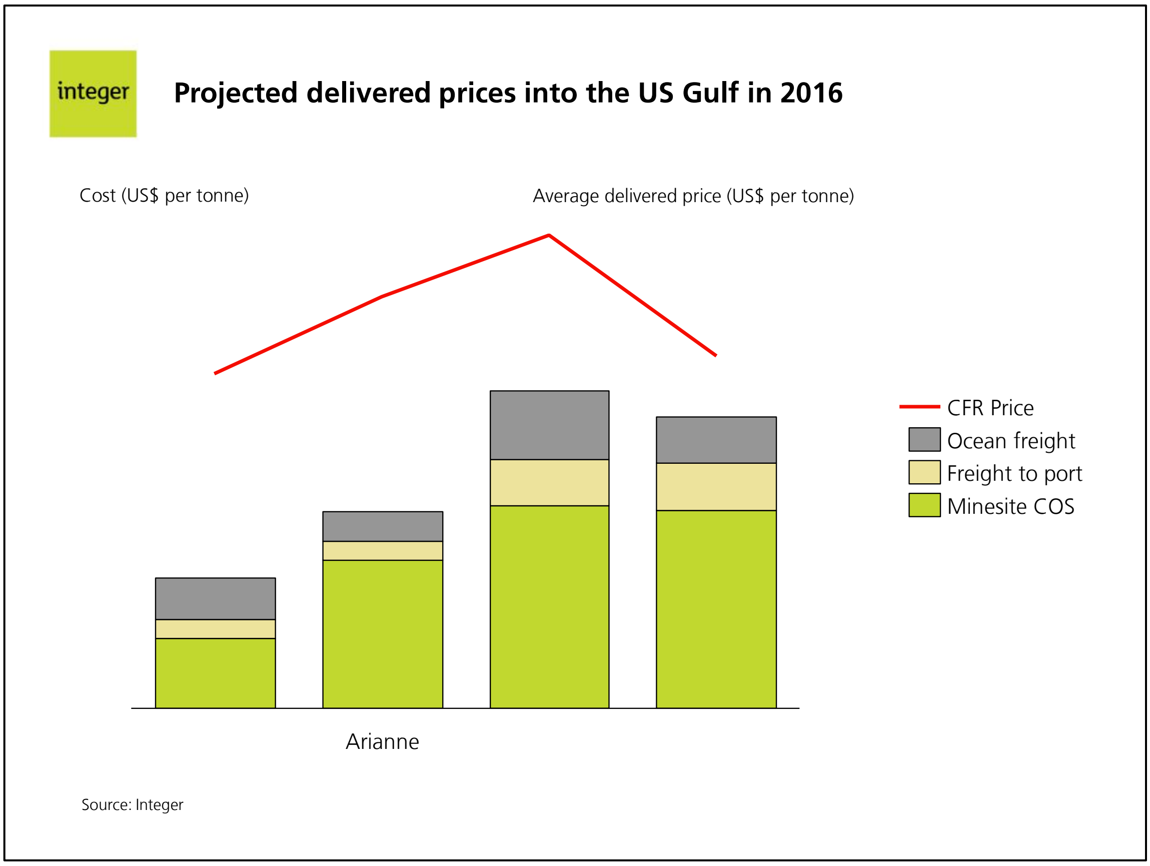


Figure 14 Projected high-grade phosphate rock prices into US Gulf (US$ per tonne), 2016

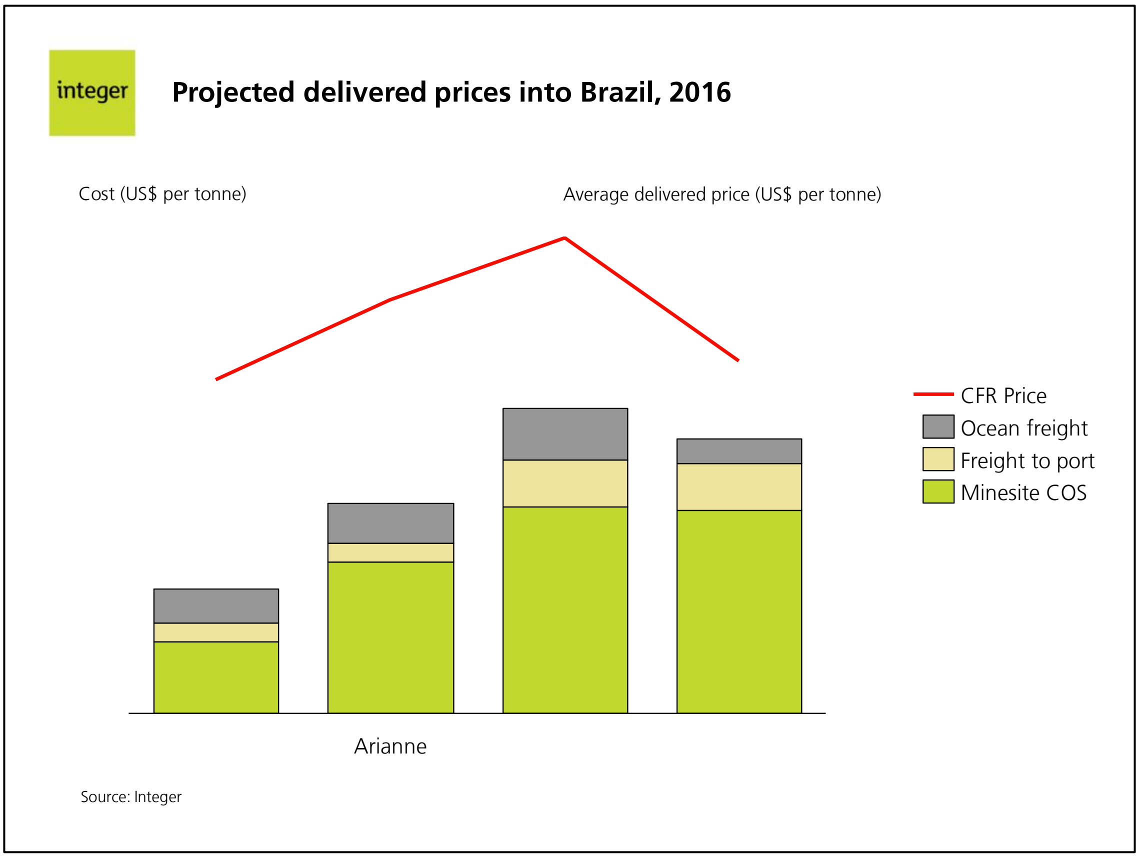


Figure 15 Projected high-grade phosphate rock prices into Brazil (US$ per tonne), 2016

In the charts below, we present Arianne Phosphate's position against its competitors into alternative high-quality markets analysed in Chapter 2 such as Northwest Europe, South Asia (India) and Northeast Asia (Japan).

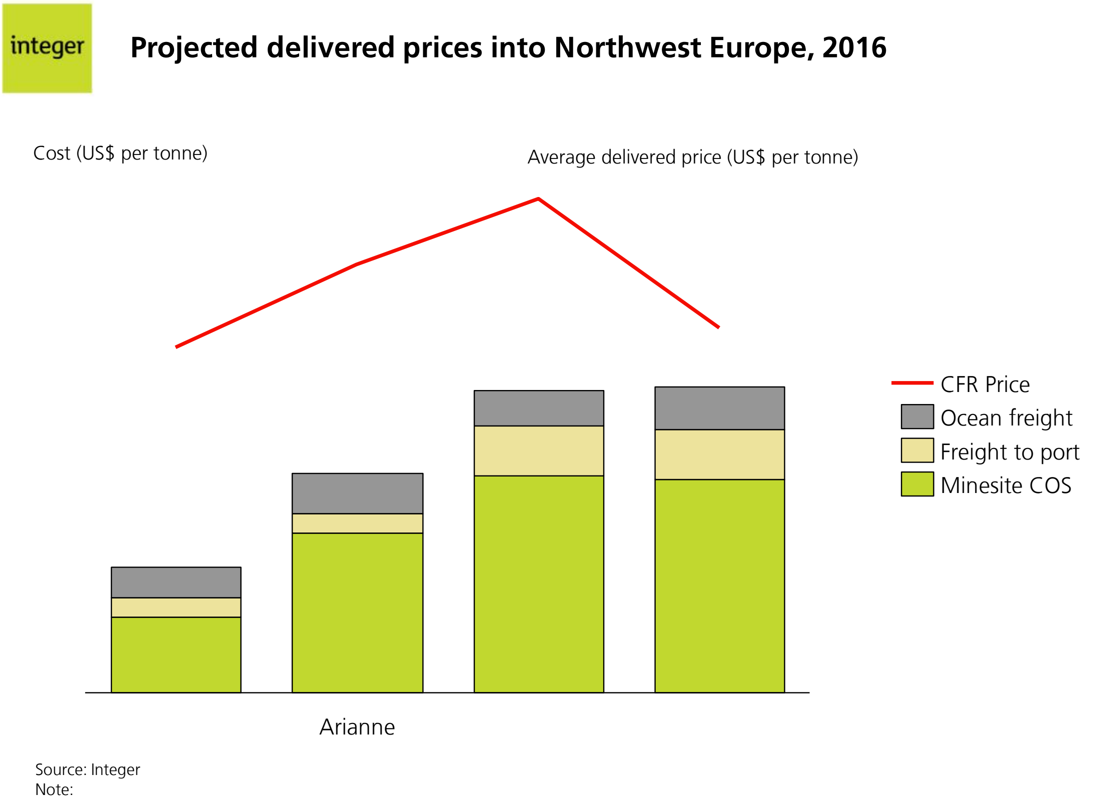
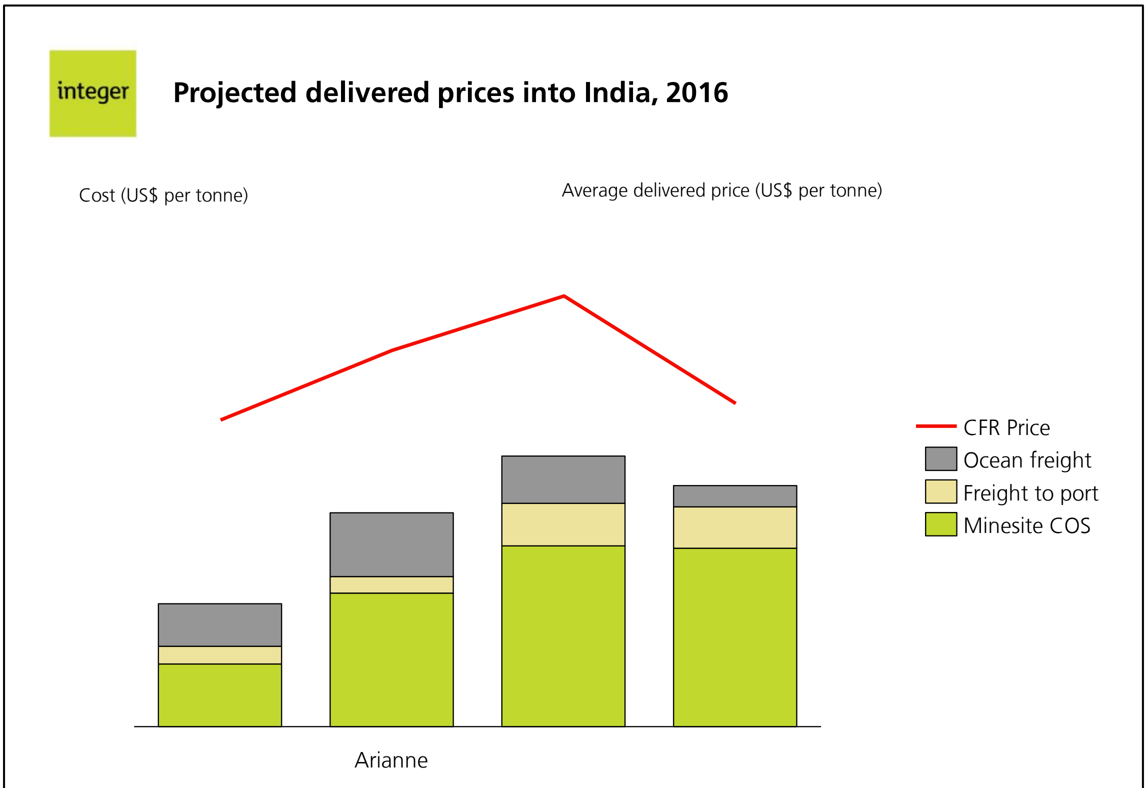
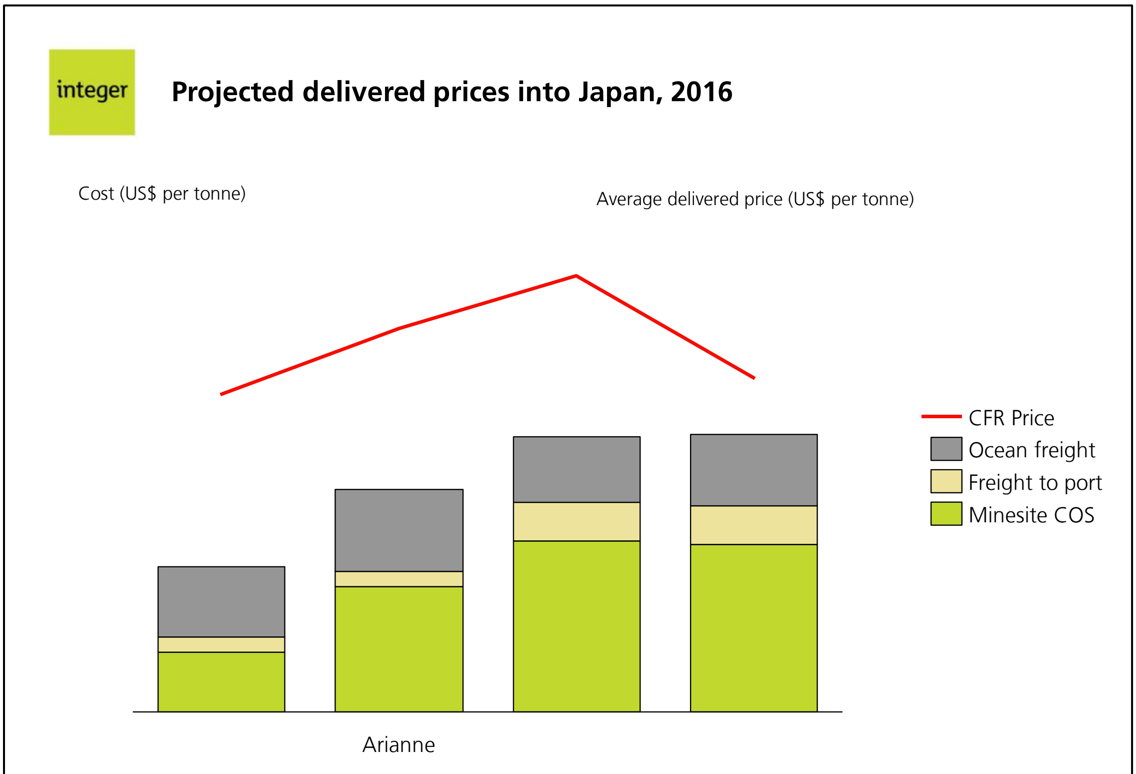


Figure 16 Projected high grade phosphate rock prices into Europe (US$ per tonne), 2016



Source: Integer

Figure 17 Projected high grade phosphate rock prices into India (US$ per tonne), 2016

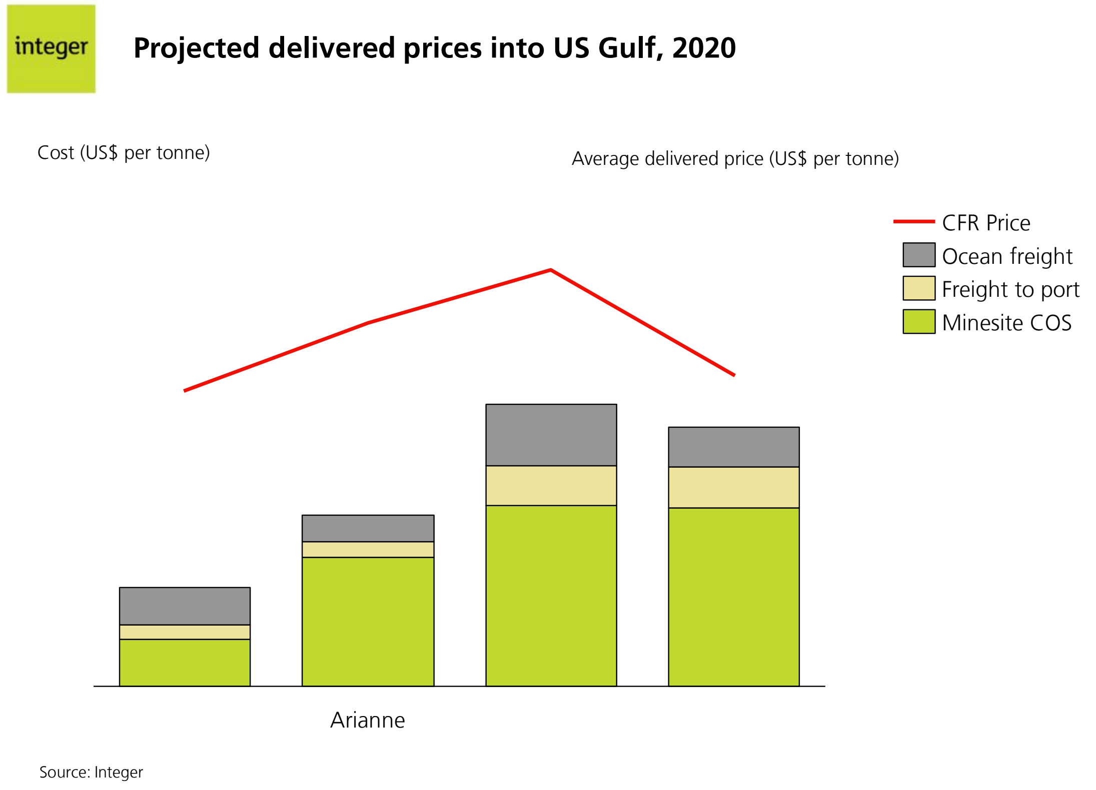


Source: Integer

Figure 18 Projected high-grade phosphate rock prices into Japan, (US$ per tonne), 2016

The estimates represented in the above charts illustrate that the US Gulf market would yield the best margins for Arianne Phosphates, based on proximity to customers and freight advantages, followed by Brazil and Europe, in line with the recommendations outlined in Chapter 2 of this report.

If we project these values further out to 2020, keeping differentials unchanged and tweaking ocean freight, projecting minesite costs and freight rates from mine to port, where we expect changes to take place (i.e. in Morocco with the addition of the slurry pipeline), we achieve a very similar picture and the best margin scenario for Arianne Phosphate continues to be represented by customers in the US Gulf, followed by Brazil, Northwest Europe, Japan and India.



Source: Integer

Figure 19 Projected high-grade phosphate rock prices into the US Gulf (US$ per tonne), 2020

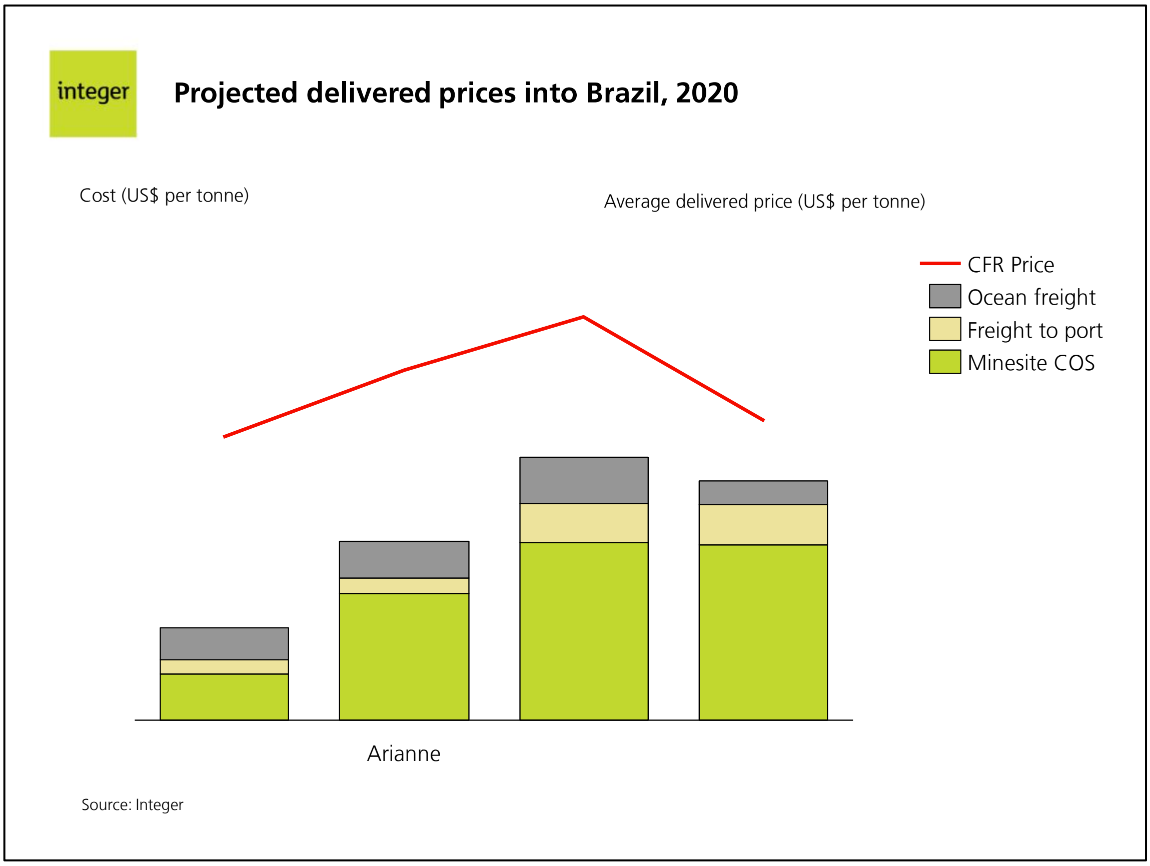


Figure 20 Projected high-grade phosphate rock prices into Brazil in (US$ per tonne), 2020

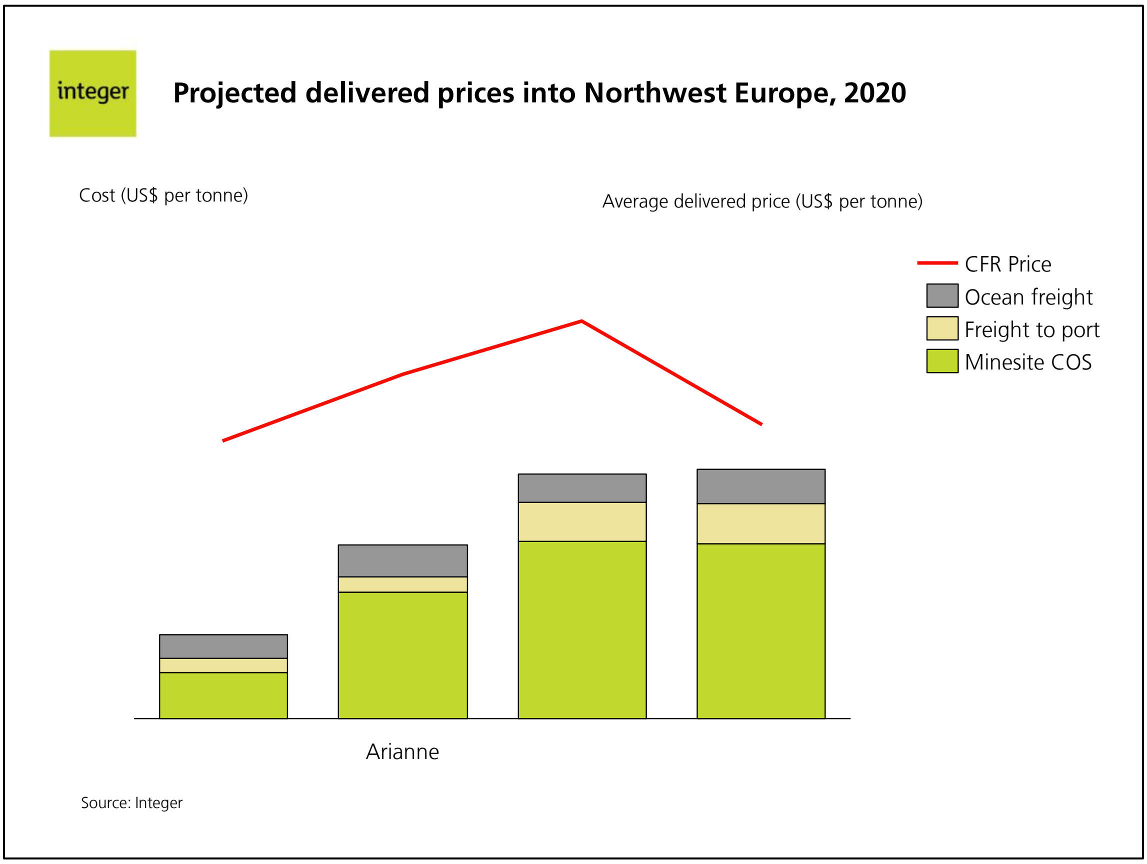
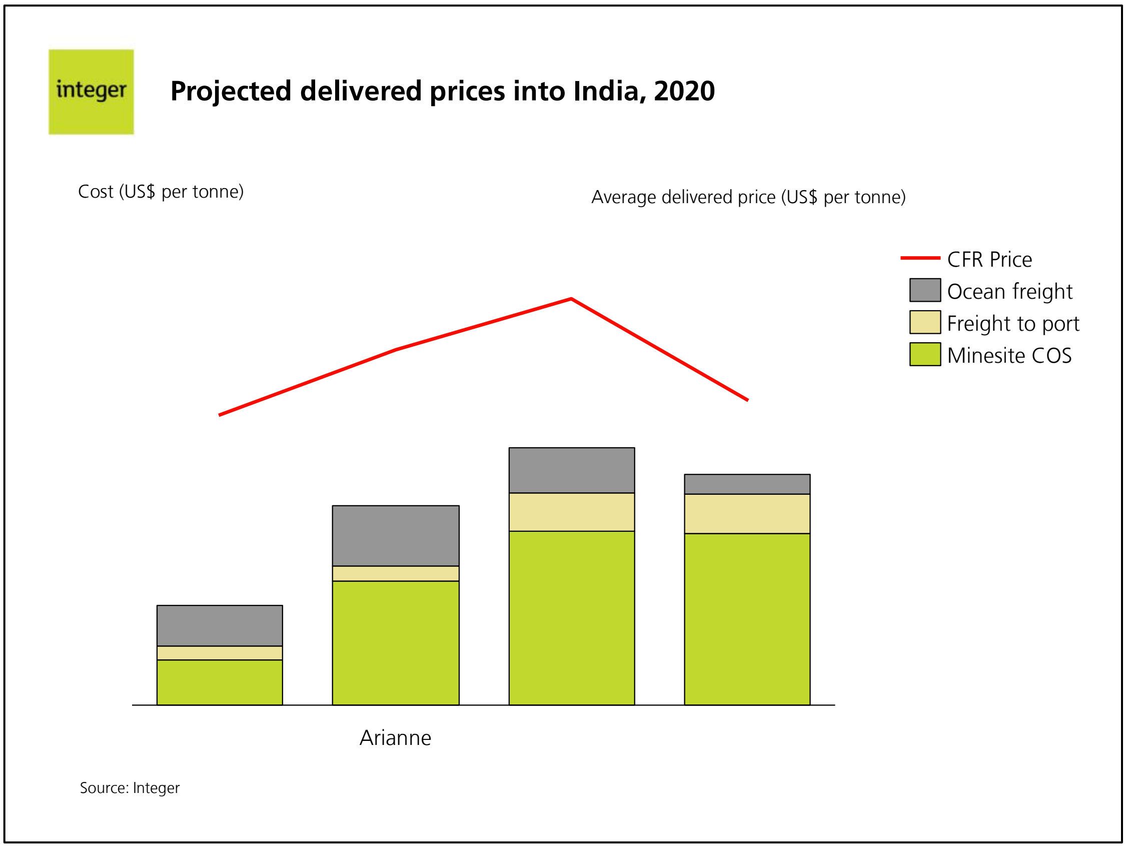


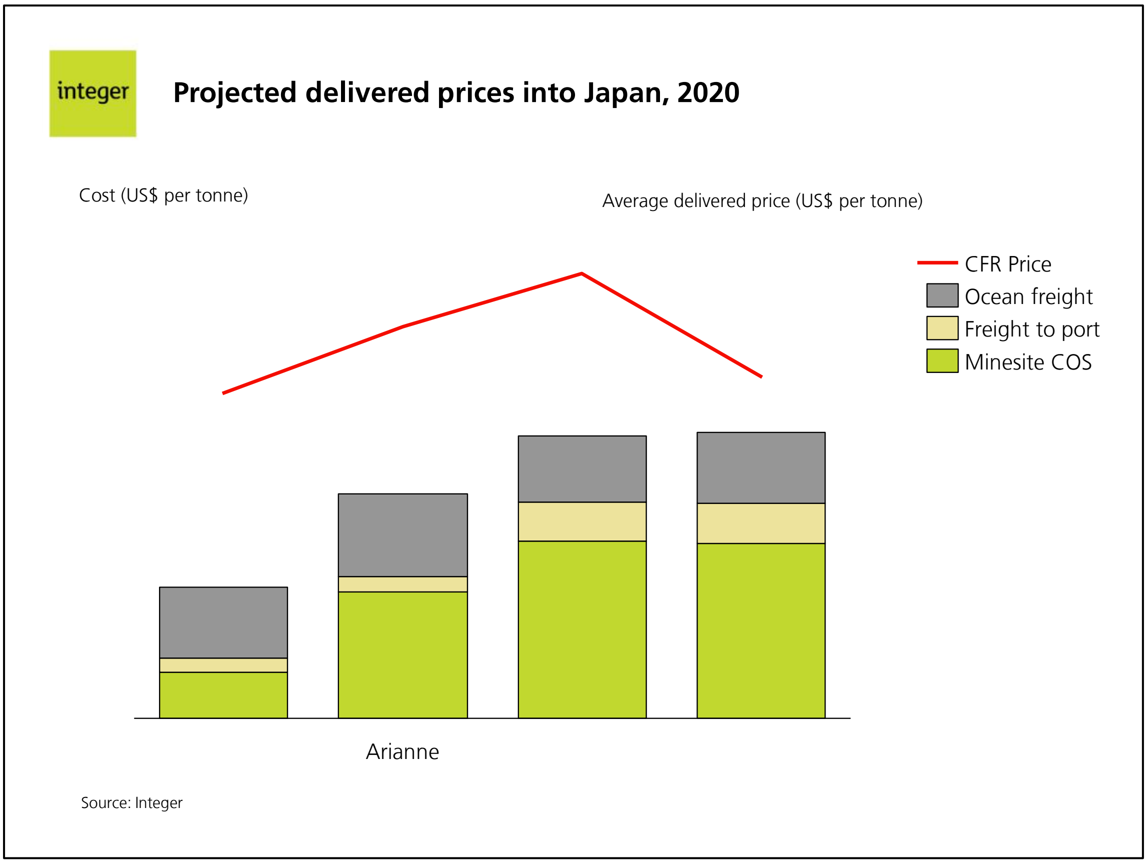
Figure 21 Projected high-grade phosphate rock prices into Northwest Europe (US$ per tonne), 2020



Projected delivered prices into India, 2020

Source: Integer

Figure 22 Projected high-grade phosphate rock prices into India (US$ per tonne), 2020



Projected delivered prices into Japan, 2020

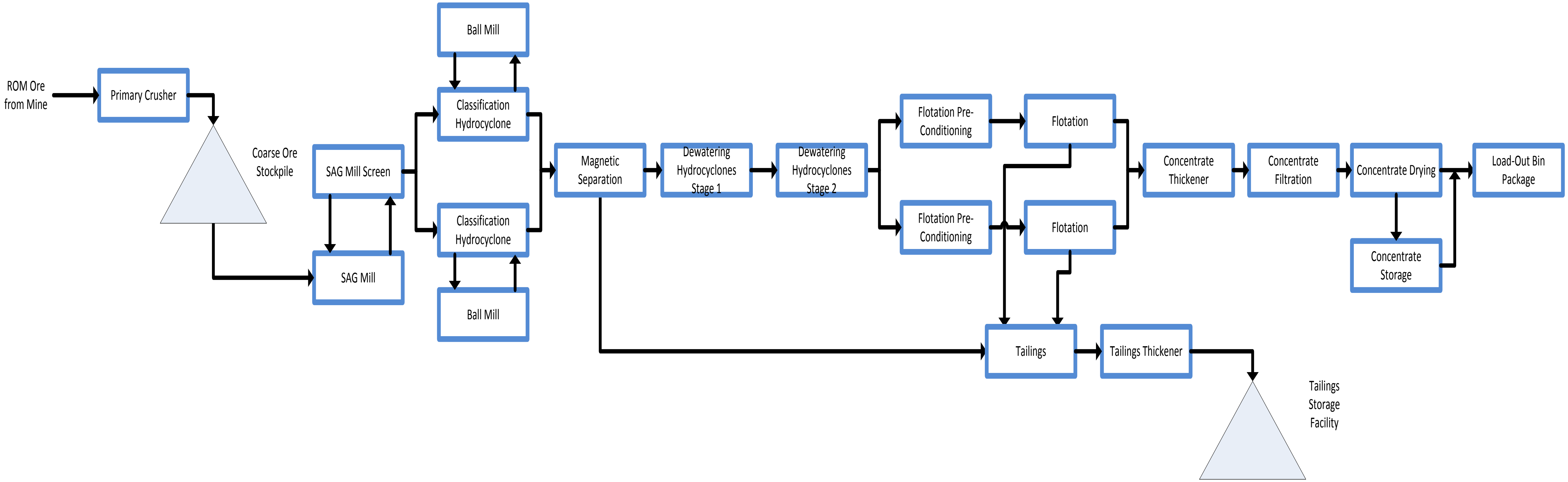
Source: Integer

Figure 23 Projected high-grade phosphate rock prices into Japan (US$ per tonne), 2020

Appendix 3 Mining Equipment Fleet

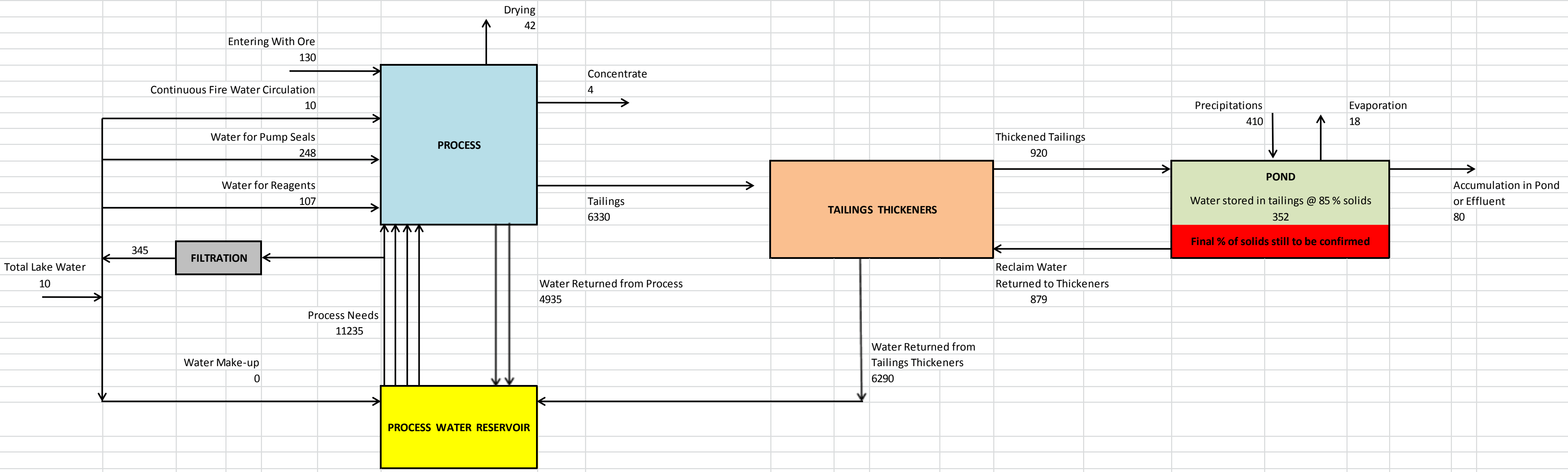
Duration (months)	**18**	**3**	**6**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
Equipment Type	**P 0**	**P 1**	**P 2**	**P 3**	**P 4**	**P 5**	**P 6**	**P 7**	**P 8**	**P 9**	**P 10**	**P 11**	**P 12**	**P 13**	**P 14**	**P 15**	**P 16**	**P 17**	**P 18**	**P 19**	**P 20**	**P 21**	**P 22**	**P 23**	**P 24**	**P 25**	**P 26**	**P 27**
PC2000BH -15.5cubic yards	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
HD785-7 100T Class	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4				
Shovel (PC5500)- Electric		1	1	1	1	2	2	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
Wheel Loader (L-1850)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mining Truck (CAT 793)		6	6	6	6	12	12	14	17	19	19	12	12	12	12	12	12	12	12	12	12	12	11	9	9	9	9	9
Blasthole Drill (Atlas Copco FlexiRoc D65)	1	3	3	3	3	3	3	4	5	5	5	3	3	3	3	3	3	3	3	3	3	3	2	2	2	1	1	1
Total Primary Equipment	**7**	**16**	**16**	**16**	**16**	**23**	**23**	**27**	**31**	**33**	**32**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**22**	**22**	**22**	**20**	**18**	**13**	**12**	**12**	**12**
Wheel Dozer (Caterpillar 844H)	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Track Dozer (D10)	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Motor Grader (Caterpillar 16M)	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Water/ Sander Truck (777G)	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
Total Secondary Equipment	**3**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**7**	**7**	**7**	**7**	**7**	**7**	**7**
Hydraulic Crane (P&H truck mounted 100 t)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Air Track Drill (200 HP 80 to 100mm)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Wheel Loader (Reeler) (Caterpillar 980K)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Articulated Dumper (Caterpillar 735)	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Skid-steer (CAT 242B3)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tow Truck (789D)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Utility Excavator (Caterpillar 320E)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fuel/ Lube Truck (CT660)	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Prime Mover For Low Bed	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Service Truck (CT 660) (250 HP 22,000 GVW)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tire Changer (attachment for 99H)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mini Bus (12 passenger Ford E series)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Pick Up Truck (4x4 crew cab Chevrolet 2500)	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2
Pick Up Truck (4x4 single cab Chevrolet 2500)	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2
Light Tower MLT3060K (1000 w. diesel generator	2	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Dewatering Pump (250 HP electric submersible)	2	3	3	3	3	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Tow Low Boy LPM (120-48-20)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tire Handler (Kalmar DCD200-12lb)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Auxiliary Equipment	**16**	**24**	**30**	**30**	**30**	**30**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**29**	**29**
Total Mine Equipment	**26**	**48**	**54**	**54**	**54**	**61**	**64**	**68**	**72**	**74**	**73**	**64**	**64**	**64**	**64**	**64**	**64**	**64**	**64**	**63**	**63**	**62**	**60**	**58**	**53**	**52**	**48**	**48**

Appendix 4 Simplified Flowsheet for Phosphate Concentration


ROM Ore from Mine
Primary Crusher
Coarse Ore Stockpile
SAG Mill Screen
SAG Mill
Ball Mill
Classification Hydrocyclone
Classification Hydrocyclone
Ball Mill
Magnetic Separation
Dewatering Hydrocyclones Stage 1
Dewatering Hydrocyclones Stage 2
Flotation Pre-Conditioning
Flotation Pre-Conditioning
Flotation
Flotation
Concentrate Thickener
Concentrate Filtration
Concentrate Drying
Concentrate Storage
Load-Out Bin Package
Tailings
Tailings Thickener
Tailings Storage Facility

Appendix 5 Process Water Balance

Nominal Flow Rates [m^3 / h]



Used mining water recycling rate *

Tu: used mining water recycling rate (%)
V1: recycled mining water yearly volume (m^3 / an)
V2: fresh water consumption yearly volume (m^3 / an)

V1 = 4935 + 6290 = 11,225 m^3 / h
V2 = 10 m^3 / h

Tu = V1 * 100 / (V1 +V2) = 99.9%

Mining water recycling efficiency *

Teu: mining water recycling efficiency rate (%)
V1: recycled mining water yearly volume (m^3 / an)
Veff: final effluent yearly volume (m^3 / an)

V1 = 4935 + 6290 = 11,225 m^3 / h
Veff = 80 m^3 / h

Teu = V1 * 100 / (V1 +Veff) = 99.3%

Dewatering of the Mine Pit → **Environment**

passive treatment

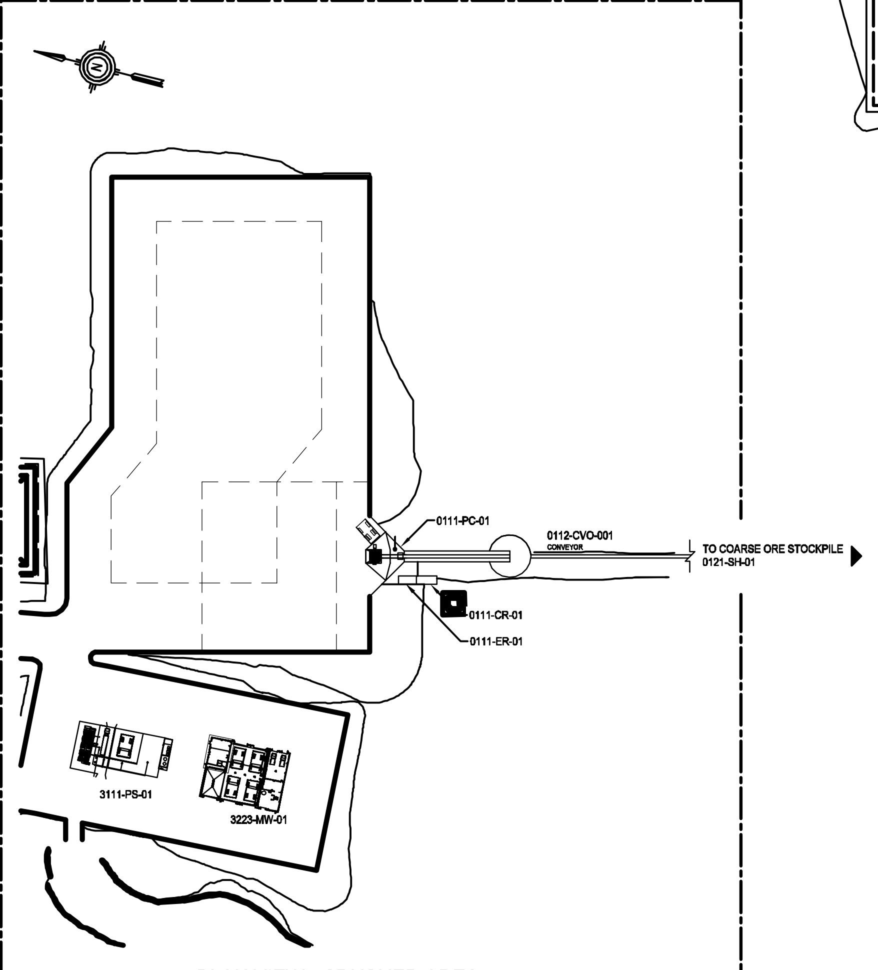
5 ans: 3.63 m^3/min
10 ans: 5.045 m^3/min
15 ans: 6.82 m^3/min
20 ans: 9.09 m^3/min
25 ans: 12.9 m^3/min

* REFERENCE: Directive 019 sur l'industrie minière - mars 2012

FOR INFORMATION ONLY
NOT FOR TENDER
NOT FOR CONSTRUCTION

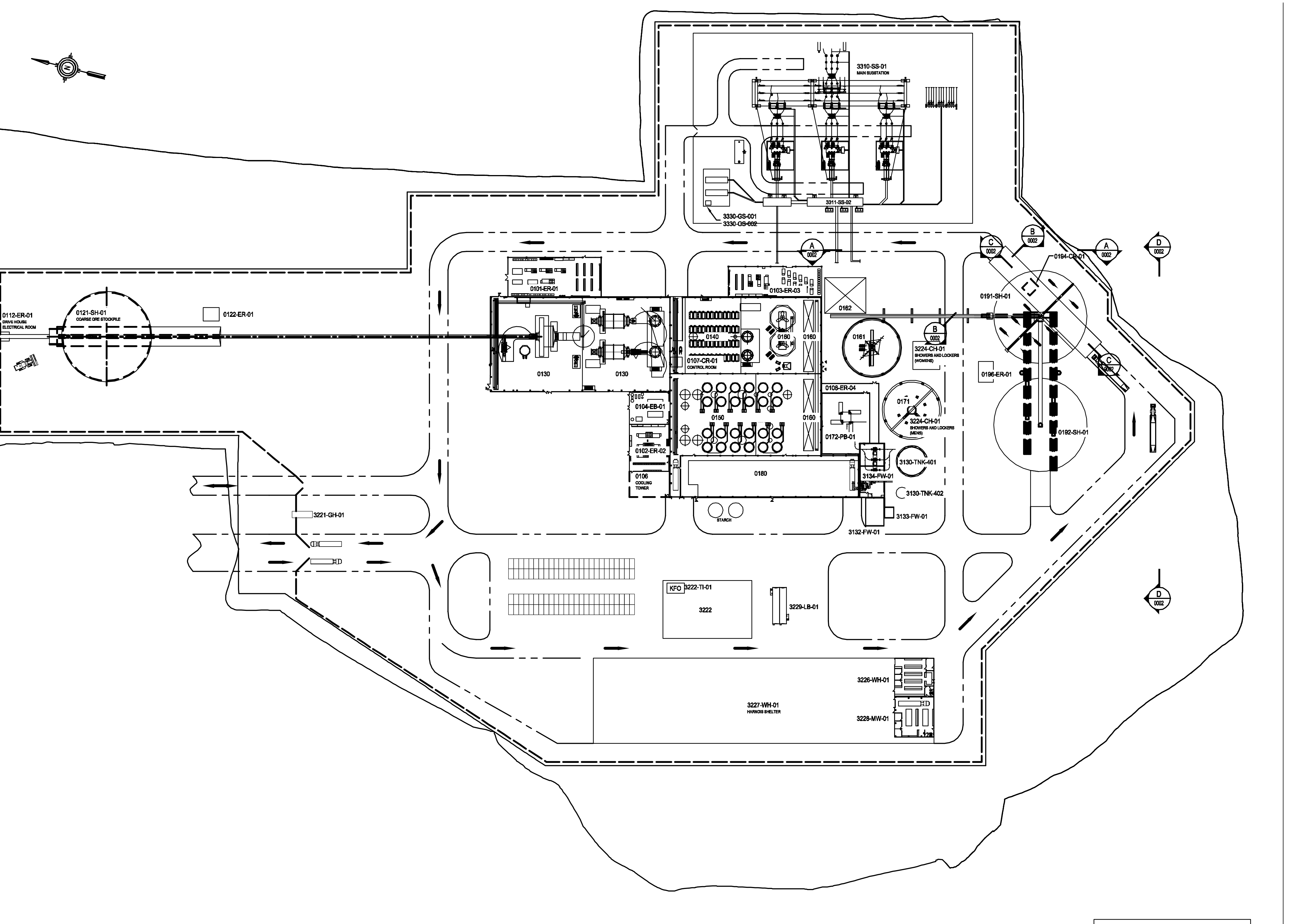
Appendix 6

Crusher and Plant Layout



PLAN VIEW - CRUSHER AREA

SCALE .: 1:2000

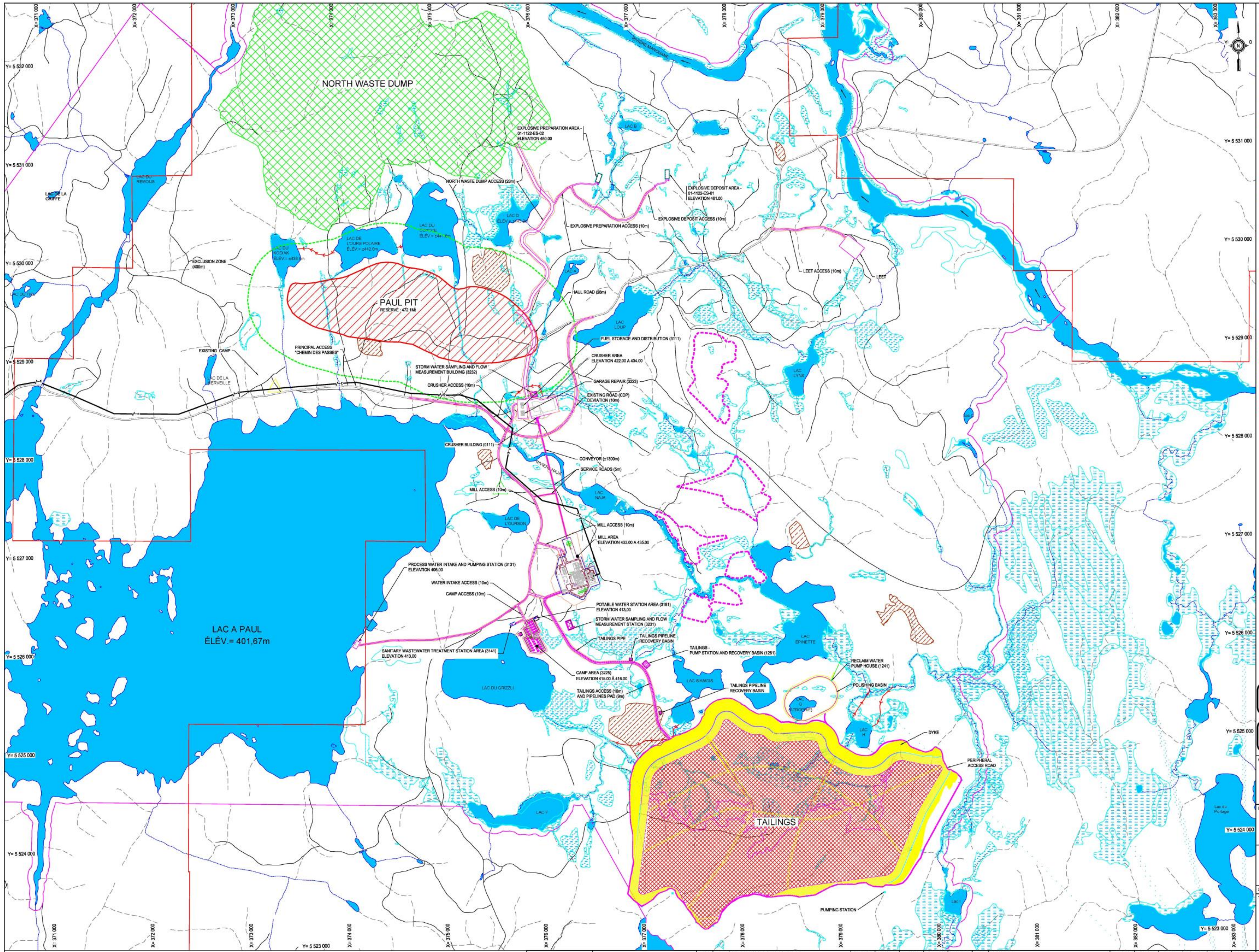


PLAN VIEW - MILL AREA

SCALE .: 1:1000

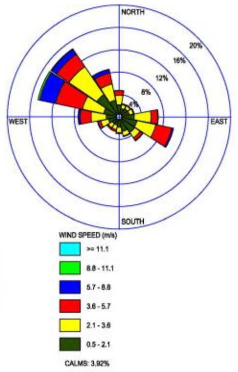
➡ PATH DIRECTION FOR LOADING TRUCKS

Appendix 7 Mine site Layout



LEGENDE

- 🟦 LAKE OR RIVER
- ▤ WETLAND
- - - - INTERMITTENT WATERCOURSE
- - - - PERMANENT WATERCOURSE
- ── ARIANNE PHOSPHATE PROPERTY LIMIT
- ── OUTFITTER LIMIT
- ══ EXISTING MAIN ROAD
- ── EXISTING ROAD
- ══ PROJECTED ROAD (10m WIDE)
- ══ PROJECTED ROAD (28m WIDE)
- ─√─c─ HIGH AND MEDIUM VOLTAGE POWERLINE
- - - - EXCLUSION ZONE
- ══ PERIPHERAL ACCESS ROAD
- ☒ PUMPING STATION
- 🟩 NORTH WASTE DUMP
- ▨ TOPSOIL DISPOSAL SITE
- ▩ BORROW PIT
- ☐ POTENTIAL AREA FOR BORROW PIT
- 🟨 DYKE
- 🟥 TAILINGS



PROJECTION : UTM NAD83

FOR FEASIBILITY
DO NOT USE FOR CONSTRUCTION

POUR FAISABILITÉ
NE PAS UTILISER POUR CONSTRUCTION

Client
ARIANNE Phosphate

Projet
PROJET APATITE LAC À PAUL
ETUDE DE FAISABILITE BANCABLE
207090-19468

Cegertec WorleyParsons

SPECIALITE = INFRASTRUCTURES CIVILES

TITRE
LAC A PAUL APATITE BENEFICIATION PLANT PLAN VIEW

VUE EN PLAN

ECH.: 1:12 500

-125 0 125 250 375 500 625
ECHELLE EN MÈTRE

No	Description

DOCUMENTS DE REFERENCE

REGISTRE D'EMISSION

No	REv.	Description	Date	Ing.	VErif. Ing.	Dessin.	VErif. For.
7	G	FOR INFORMATION/POUR INFORMATION	30/10/2013	G. GRAVEL	G. GRAVEL	D. CARRIER	M. BOUCH.
6	F	FOR INFORMATION/POUR INFORMATION	08/10/2013	G. GRAVEL	G. GRAVEL	D. CARRIER	M. BOUCH.
5	E	FOR INFORMATION/POUR INFORMATION	10/09/2013	G. GRAVEL	G. GRAVEL	D. CARRIER	M. BOUCH.
4	D	POUR INFORMATION	18/07/2013	G. GRAVEL	G. GRAVEL	D. CARRIER	M. BOUCH.
3	C	POUR INFORMATION	05/06/2013	G. GRAVEL	G. GRAVEL	D. CARRIER	M. BOUCH.

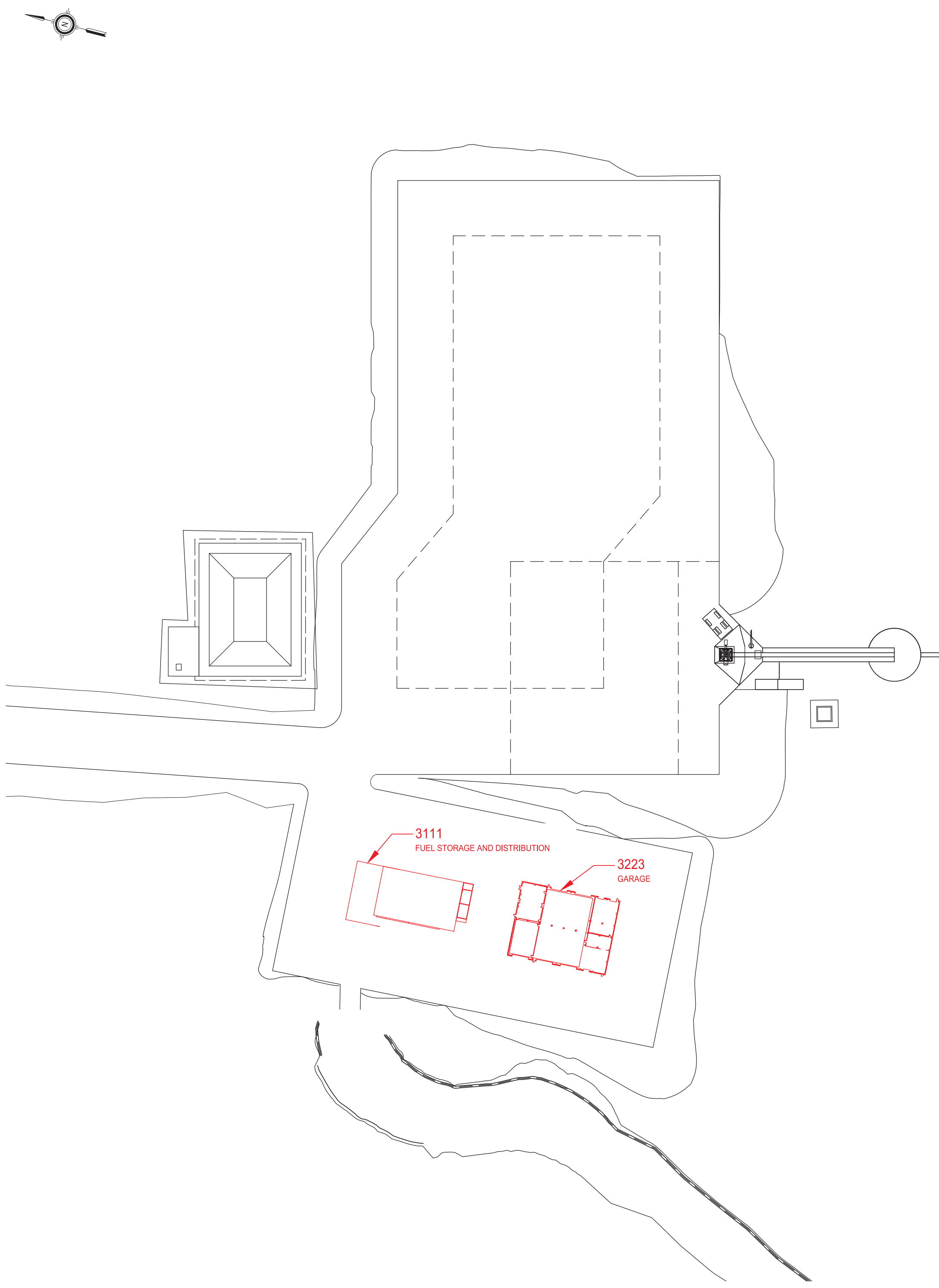
REVISION

No	Description	Date	Ing.	No OIQ	VErif. Ing.	Dessin.	VErif. For.
G	MISE À JOUR	30/10/2013	G. GRAVEL	112804	G. GRAVEL	D. CARRIER	M. BOUCH.
F	MODIFICATIONS USINE ET CRUSHER	08/10/2013	G. GRAVEL	112804	G. GRAVEL	D. CARRIER	M. BOUCH.
E	REVISION GENERALE	10/09/2013	G. GRAVEL	112804	G. GRAVEL	D. CARRIER	M. BOUCH.
D	POUR INFORMATION	18/07/2013	G. GRAVEL	112804	G. GRAVEL	D. CARRIER	M. BOUCH.
C	MODIFICATION PAUL PIT	05/06/2013	G. GRAVEL	112804	G. GRAVEL	D. CARRIER	M. BOUCH.

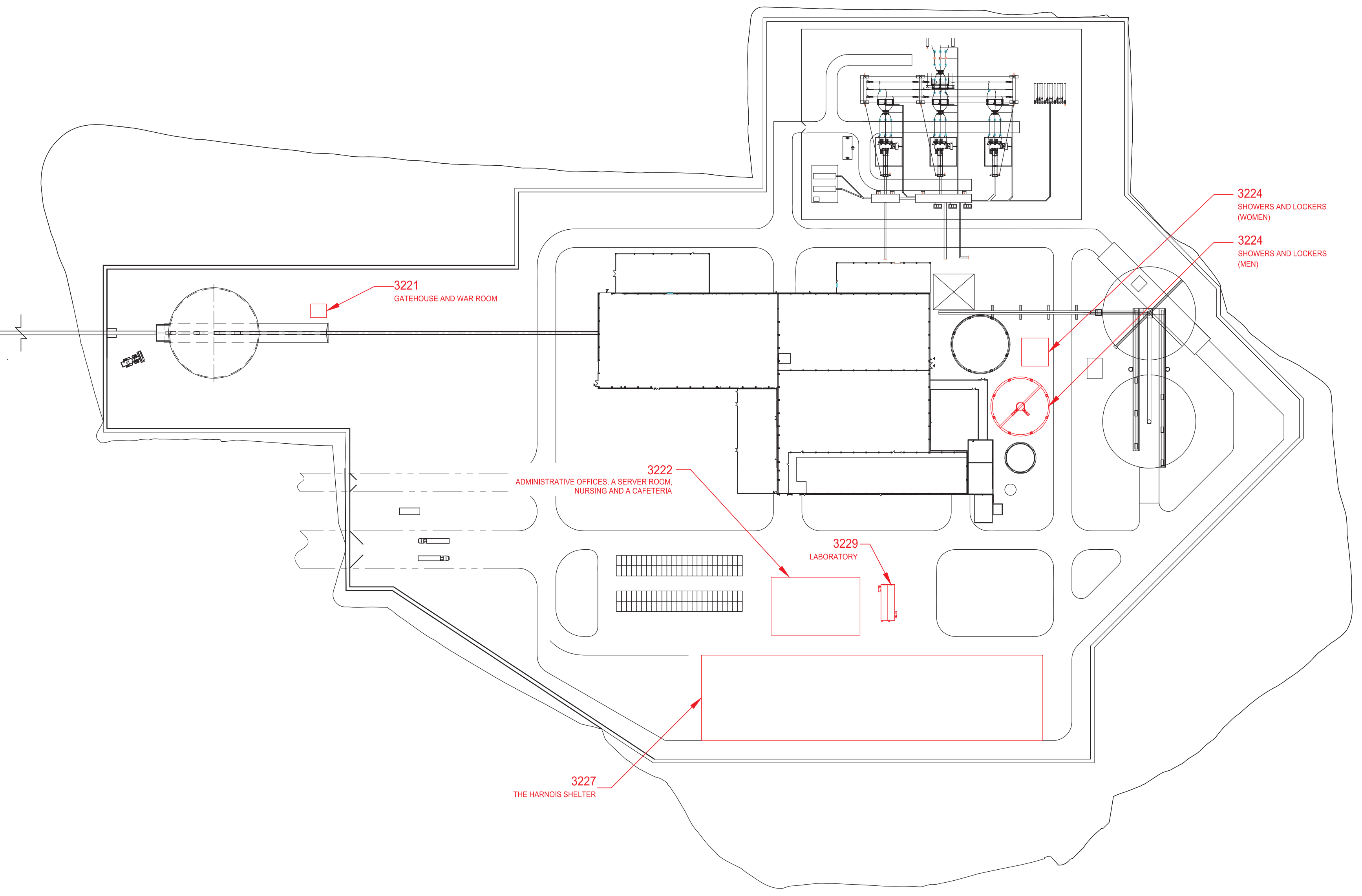
SCEAU	CONCEPTEUR MARTIN BOUCHARD	DESSINATEUR YANNE PELLETIER	
	ECHELLE INDIQUEE	DATE 11/12/2012	
APPROUVE DATE	NO. DESSIN 207090-19468-3200-CI-DGA-0001		REV. G

Référence circulaire pour le bloc RESSOURCES D'ARIANNE

Appendix 8 Site Buildings Location



PLAN VIEW - CRUSHER AREA



PLAN VIEW - MILL AREA

Appendix 9 Lac a Paul FS Concentrate Sales and Pricing

Lac a Paul BFS Concentrate Sales and Pricing
(in constant 2013 $US FOB vessel unless noted otherwise)
updated 8-aug-13

Client defined start date.

Client defined mass of concentrate available based on the 3 Oct 2013 mine plan con make data.

Client defined market split based on credible third party marketing study reports by CRU and Integer.

Tonnage calculated based on client defined split of sales for the high purity market sectors.

Tonnage calculated based on client defined split of sales for the fertiliser manufacturing market sectors.

Integer report, Section 7.3, figure 37, page 103/121.

Integer report, Section 7.3, figure 36, page 102/121.

Integer report, Section 7.3, figure 38, page 104/121.

CRU report, Section 8.3, Table 8.1, page 90/96

CRU report, Section 8.3, Table 8.2, page 91/96

	Mining	Concentrate	% of Sales to	Sales to High-Purity Customers			Sales to Fertilizer Customers		from Integer Premium on High-Purity Sales			from CRU Premium on Fertilizer Sales		Weighted Average	CRU Benchmark	Lac a Paul	CRU Projections Nominal $US		
Year	Year	Sales	High Purity	Brazil	SE US+ Gulf	NW Europe	Vancouver	US Gulf	Brazil	US Gulf	NW Europe	Vancouver	US Gulf	Premium	FOB Morocco	Average Price	Benchmark FOB Morocco	Projection Vancouver	Projection US Gulf
2016	1	1,500	0%	-	-	-	750	750	80	91	80	65	61	63	147	210	159	229	225
2017	2	3,000	20%	75	300	225	1,000	1,400	80	91	80	63	60	66	142	208	157	227	223
2018	3	3,000	40%	150	600	450	1,000	800	80	91	80	62	58	70	138	208	157	227	223
2019	4	3,000	67%	250	1,000	750	1,000	0	80	91	80	62	59	78	136	214	158	230	226
2020	5	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	135	212	161	234	229
2021	6	3,000	67%	250	1,000	750	1,000	0	80	91	80	60	57	77	134	211	164	238	234
2022	7	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	134	211	168	244	240
2023	8	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	134	211	172	250	245
2024	9	3,000	67%	250	1,000	750	1,000	0	80	91	80	60	57	77	134	211	177	256	252
2025	10	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	135	212	181	263	258
2026	11	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	135	212	186	270	265
2027	12	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	58	77	135	212	191	277	273
2028	13	3,000	67%	250	1,000	750	1,000	0	80	91	80	62	58	78	136	214	196	285	280
2029	14	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	58	77	136	213	202	293	288
2030	15	3,000	67%	250	1,000	750	1,000	0	80	91	80	62	59	78	137	215	207	301	296
2031	16	3,000	67%	250	1,000	750	1,000	0	80	91	80	62	59	78	137	215	213	309	304
2032	17	3,000	67%	250	1,000	750	1,000	0	80	91	80	62	58	78	137	215	219	318	312
2033	18	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	58	77	137	214	225	326	321
2034	19	3,000	67%	250	1,000	750	1,000	0	80	91	80	62	59	78	138	216	231	334	329
2035	20	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	138	215	238	343	337
2036	21	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	138	215			
2037	22	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	138	215			
2038	23	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	138	215			
2039	24	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	138	215			
2040	25	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	138	215			
2041	26	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	138	215			
2042	27	3,000	67%	250	1,000	750	1,000	0	80	91	80	61	57	77	138	215			
Life of Mine							Average								137	213			
									80	91	80	61	58	76					
							Stdev										26	38	37
	25th Pct						P25		215	226	215	61	57	77	135	212	163	237	233
	50th Pct						P50		217	228	217	61	57	77	137	214	184	267	262
	75th Pct						P75		218	229	218	62	58	77	138	215	212	307	302
	95th Pct						P95		226	237	226	65	61	78	146	215	238	343	337

4. Production costs Shipping **Option 1**

4.2 Costs per ton produced

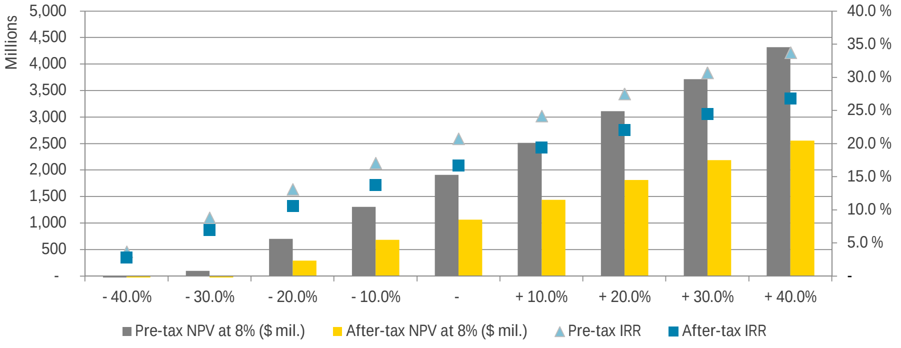
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Average
Extraction	34.51	20.19	21.06	26.02	30.91	33.21	35.82	42.67	44.34	29.73	27.61	27.33
Processing	63.91	46.07	46.47	46.07	51.00	48.36	45.22	48.66	53.92	48.86	48.85	48.11
Shipping	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96
Subtotal	**112.37**	**80.23**	**81.49**	**86.06**	**95.87**	**95.53**	**95.00**	**105.29**	**112.22**	**92.55**	**90.42**	**89.41**
SG&A	8.26	4.03	4.07	4.02	4.47	4.28	3.96	4.26	4.72	4.28	4.27	4.27
Total	**120.63**	**84.26**	**85.56**	**90.07**	**100.34**	**99.81**	**98.96**	**109.55**	**116.95**	**96.83**	**94.70**	**93.68**

5. Key sensitivities

5.1 Price of Phosphate

Base case	**213**	*USD*	0.0%
Price increments	10.0 %		602.9

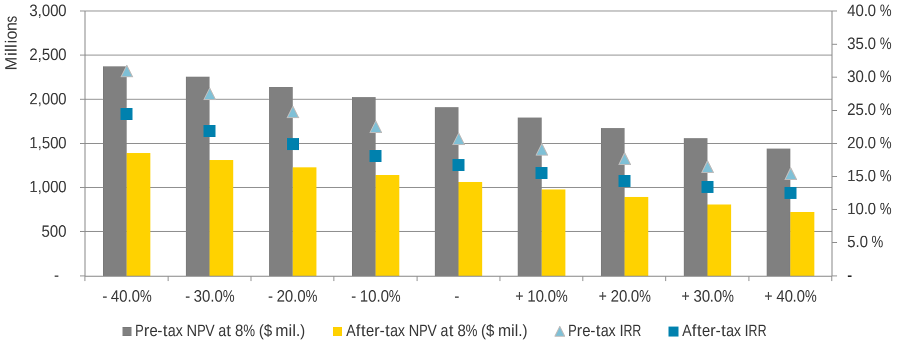
		PRICE	Pre-tax NPV at 8% ($ mil.)	After-tax NPV at 8% ($ mil.)	Pre-tax IRR	After-tax IRR
	Base case	**213**	**1,910**	**1,066**	**20.7 %**	**16.7 %**
-4	**- 40.0%**	128	(501)	(558)	3.7 %	2.7 %
-3	**- 30.0%**	149	102	(112)	8.8 %	7.0 %
-2	**- 20.0%**	170	704	296	13.1 %	10.6 %
-1	**- 10.0%**	192	1,307	685	17.0 %	13.8 %
0	**-**	213	1,910	1,066	20.7 %	16.7 %
1	**+ 10.0%**	234	2,513	1,440	24.2 %	19.4 %
2	**+ 20.0%**	256	3,116	1,817	27.5 %	22.0 %
3	**+ 30.0%**	277	3,719	2,190	30.7 %	24.5 %
4	**+ 40.0%**	298	4,322	2,561	33.7 %	26.8 %



5.2 Construction costs

Sensitivity applied	0.0 %		
Increments	10.0 %	(	116.4)

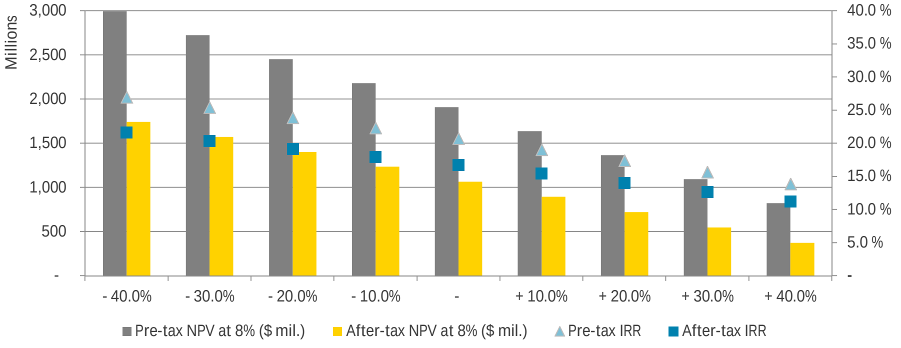
		CAPEX	Pre-tax NPV at 8% ($ mil.)	After-tax NPV at 8% ($ mil.)	Pre-tax IRR	After-tax IRR
	Base case	**1,215**	**1,910**	**1,066**	**20.7 %**	**16.7 %**
-4	**- 40.0%**	729	2,376	1,391	31.0 %	24.5 %
-3	**- 30.0%**	850	2,259	1,312	27.5 %	21.9 %
-2	**- 20.0%**	972	2,143	1,230	24.8 %	19.8 %
-1	**- 10.0%**	1,093	2,026	1,147	22.6 %	18.1 %
0	**-**	1,215	1,910	1,066	20.7 %	16.7 %
1	**+ 10.0%**	1,336	1,794	982	19.1 %	15.5 %
2	**+ 20.0%**	1,458	1,677	896	17.7 %	14.4 %
3	**+ 30.0%**	1,579	1,561	811	16.5 %	13.4 %
4	**+ 40.0%**	1,701	1,445	723	15.5 %	12.6 %



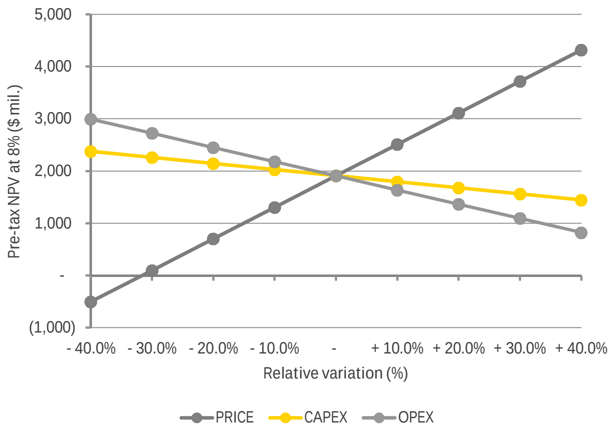
5.3 Operating costs

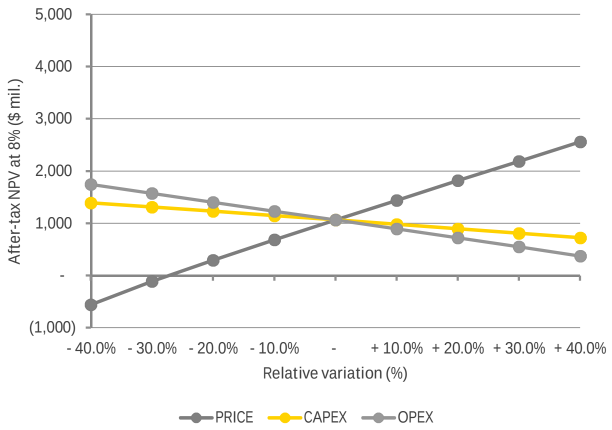
Sensitivity applied	0.0 %		
Increments	10.0 %	(	271.3)

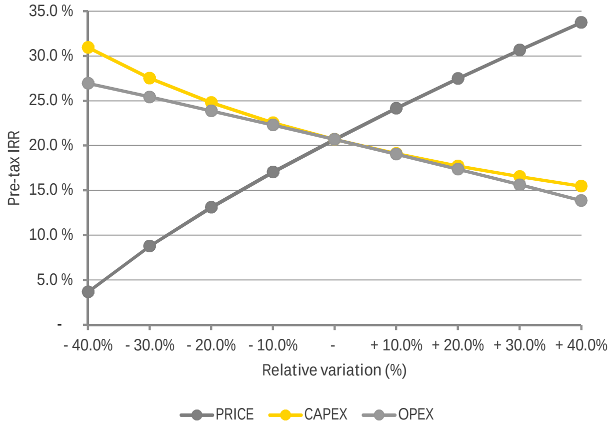
		OPEX	Pre-tax NPV at 8% ($ mil.)	After-tax NPV at 8% ($ mil.)	Pre-tax IRR	After-tax IRR
	Base case	**93.68**	**1,910**	**1,066**	**20.7 %**	**16.7 %**
-4	**- 40.0%**	56.21	2,995	1,745	26.9 %	21.6 %
-3	**- 30.0%**	65.57	2,724	1,574	25.4 %	20.4 %
-2	**- 20.0%**	74.94	2,453	1,404	23.9 %	19.2 %
-1	**- 10.0%**	84.31	2,181	1,235	22.3 %	18.0 %
0	**-**	93.68	1,910	1,066	20.7 %	16.7 %
1	**+ 10.0%**	103.04	1,639	895	19.1 %	15.4 %
2	**+ 20.0%**	112.41	1,367	721	17.4 %	14.0 %
3	**+ 30.0%**	121.78	1,096	549	15.6 %	12.7 %
4	**+ 40.0%**	131.15	825	373	13.9 %	11.2 %

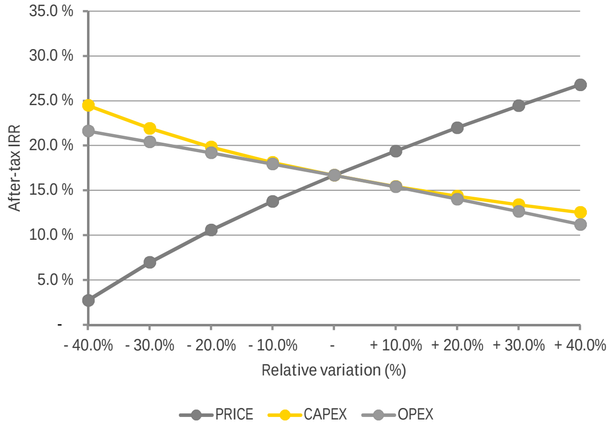


6. NI 43-101 sensitivity graphs









Appendix 10

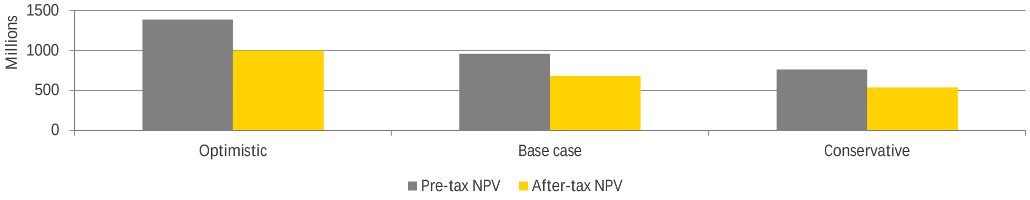
Arianne Mine Dashboard

Arianne Mine - DASHBOARD

1. NPV Analysis

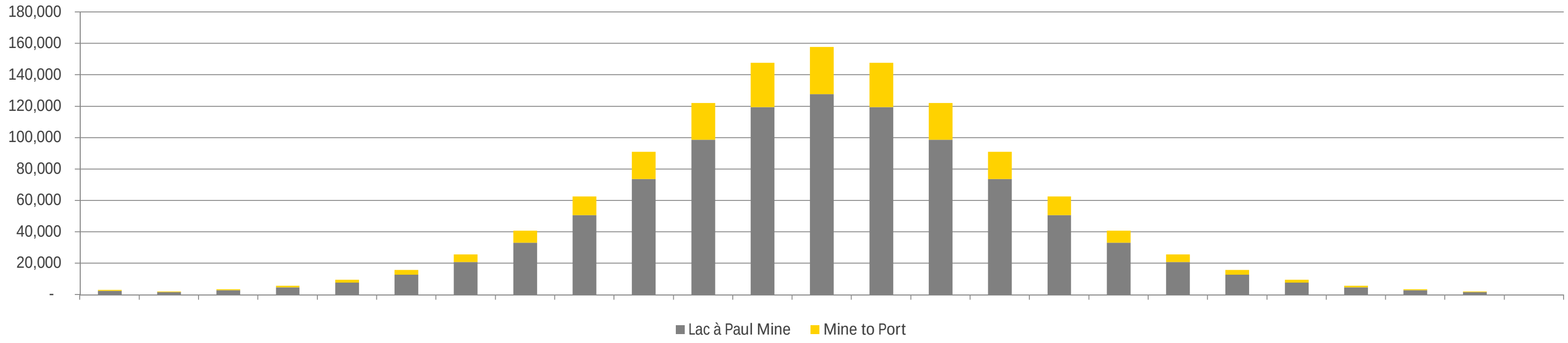
	Discount rate	Pre-tax NPV	After-tax NPV
Base case	**8.0 %**	**1,910.1**	**1,065.9**
Optimistic	6.0 %	3,139.3	1,872.2
Base case	8.0 %	1,910.1	1,065.9
Conservative	10.0 %	1,360.1	701.5

	Pre-tax	After-tax
Payback period	**4.4**	**4.8**
IRR	**20.7 %**	**16.7 %**

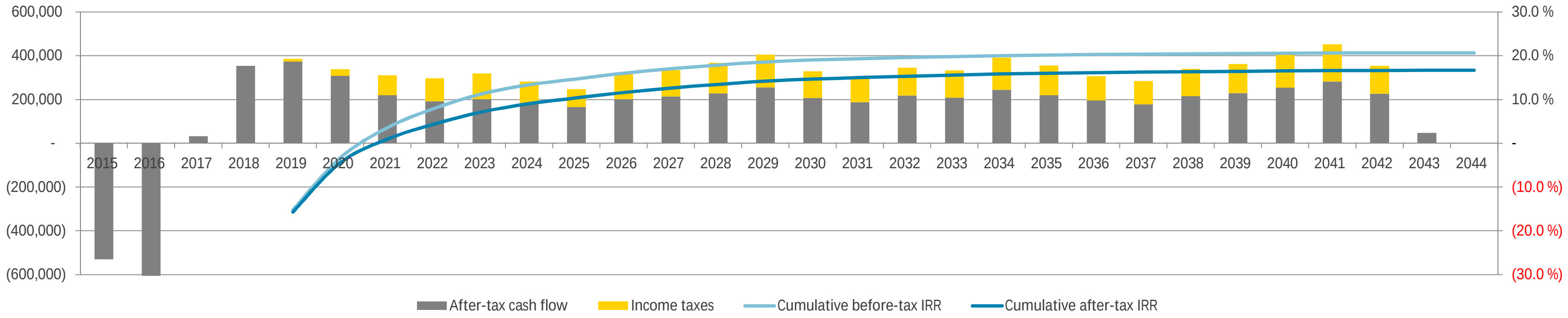


2. Capex

Ramp-up **S-Curve**

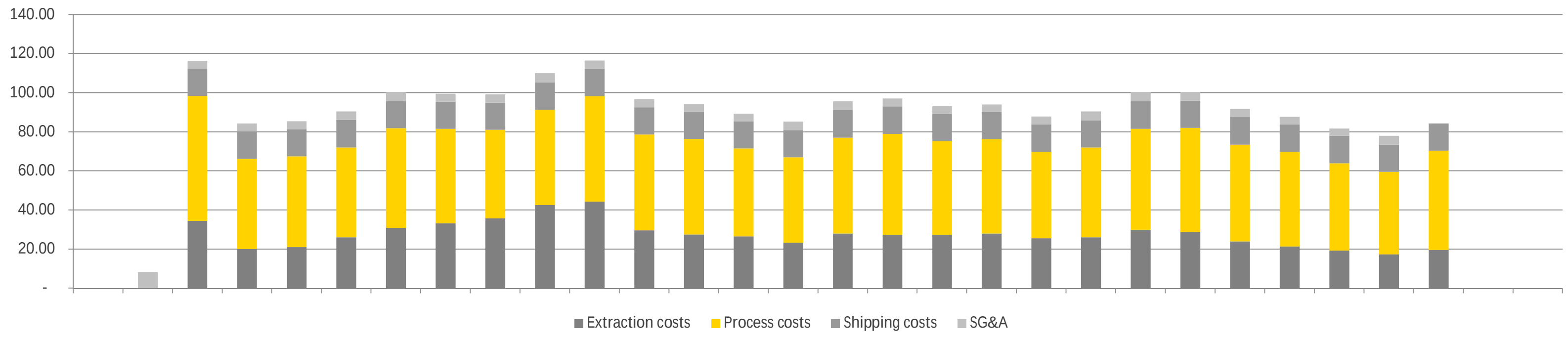


3. Cash flow analysis



4. Production costs Shipping **Option 1**

4.2 Costs per ton produced



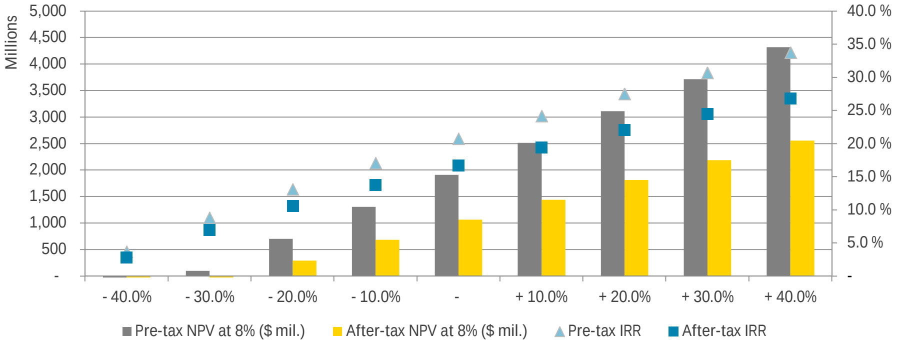
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Average
Extraction	34.51	20.19	21.06	26.02	30.91	33.21	35.82	42.67	44.34	29.73	27.61	27.33
Processing	63.91	46.07	46.47	46.07	51.00	48.36	45.22	48.66	53.92	48.86	48.85	48.11
Shipping	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96
Subtotal	**112.37**	**80.23**	**81.49**	**86.06**	**95.87**	**95.53**	**95.00**	**105.29**	**112.22**	**92.55**	**90.42**	**89.41**
SG&A	8.26	4.03	4.07	4.02	4.47	4.28	3.96	4.26	4.72	4.28	4.27	4.27
Total	**120.63**	**84.26**	**85.56**	**90.07**	**100.34**	**99.81**	**98.96**	**109.55**	**116.95**	**96.83**	**94.70**	**93.68**

5. Key sensitivities

5.1 Price of Phosphate

Base case **213** *USD* 0.0%
Price increments 10.0 % 602.9

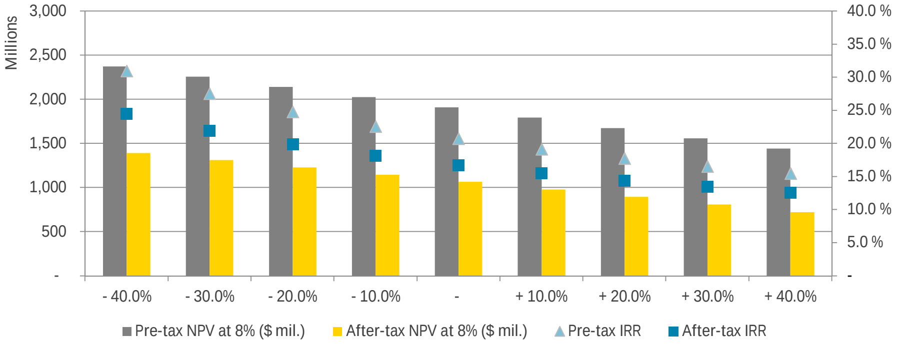
		PRICE	Pre-tax NPV at 8% ($ mil.)	After-tax NPV at 8% ($ mil.)	Pre-tax IRR	After-tax IRR
	Base case	**213**	**1,910**	**1,066**	**20.7 %**	**16.7 %**
-4	**- 40.0%**	128	(501)	(558)	3.7 %	2.7 %
-3	**- 30.0%**	149	102	(112)	8.8 %	7.0 %
-2	**- 20.0%**	170	704	296	13.1 %	10.6 %
-1	**- 10.0%**	192	1,307	685	17.0 %	13.8 %
0	**-**	213	1,910	1,066	20.7 %	16.7 %
1	**+ 10.0%**	234	2,513	1,440	24.2 %	19.4 %
2	**+ 20.0%**	256	3,116	1,817	27.5 %	22.0 %
3	**+ 30.0%**	277	3,719	2,190	30.7 %	24.5 %
4	**+ 40.0%**	298	4,322	2,561	33.7 %	26.8 %



5.2 Construction costs

Sensitivity applied 0.0 %
Increments 10.0 % (116.4)

		CAPEX	Pre-tax NPV at 8% ($ mil.)	After-tax NPV at 8% ($ mil.)	Pre-tax IRR	After-tax IRR
	Base case	**1,215**	**1,910**	**1,066**	**20.7 %**	**16.7 %**
-4	**- 40.0%**	729	2,376	1,391	31.0 %	24.5 %
-3	**- 30.0%**	850	2,259	1,312	27.5 %	21.9 %
-2	**- 20.0%**	972	2,143	1,230	24.8 %	19.8 %
-1	**- 10.0%**	1,093	2,026	1,147	22.6 %	18.1 %
0	**-**	1,215	1,910	1,066	20.7 %	16.7 %
1	**+ 10.0%**	1,336	1,794	982	19.1 %	15.5 %
2	**+ 20.0%**	1,458	1,677	896	17.7 %	14.4 %
3	**+ 30.0%**	1,579	1,561	811	16.5 %	13.4 %
4	**+ 40.0%**	1,701	1,445	723	15.5 %	12.6 %



5.3 Operating costs

Sensitivity applied 0.0 %
Increments 10.0 % (271.3)

		OPEX	Pre-tax NPV at 8% ($ mil.)	After-tax NPV at 8% ($ mil.)	Pre-tax IRR	After-tax IRR
	Base case	**93.68**	**1,910**	**1,066**	**20.7 %**	**16.7 %**
-4	**- 40.0%**	56.21	2,995	1,745	26.9 %	21.6 %
-3	**- 30.0%**	65.57	2,724	1,574	25.4 %	20.4 %
-2	**- 20.0%**	74.94	2,453	1,404	23.9 %	19.2 %
-1	**- 10.0%**	84.31	2,181	1,235	22.3 %	18.0 %
0	**-**	93.68	1,910	1,066	20.7 %	16.7 %
1	**+ 10.0%**	103.04	1,639	895	19.1 %	15.4 %
2	**+ 20.0%**	112.41	1,367	721	17.4 %	14.0 %
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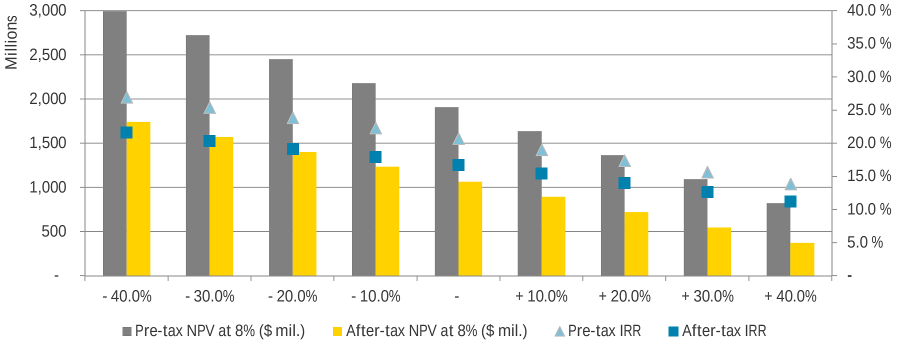
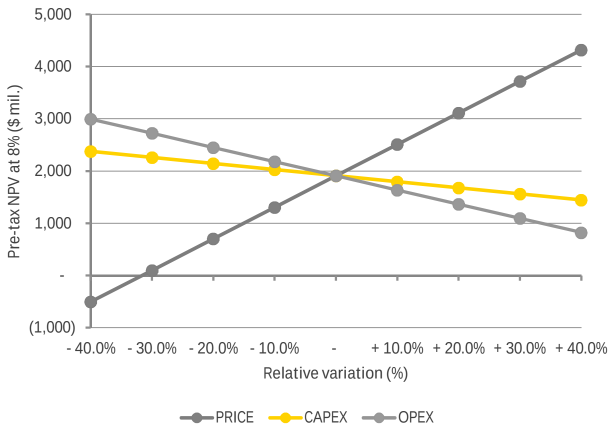
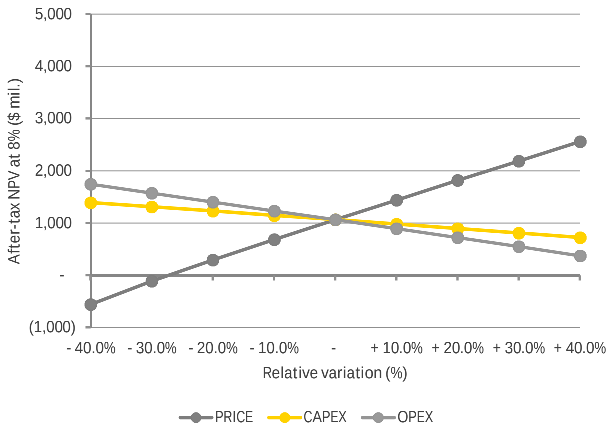
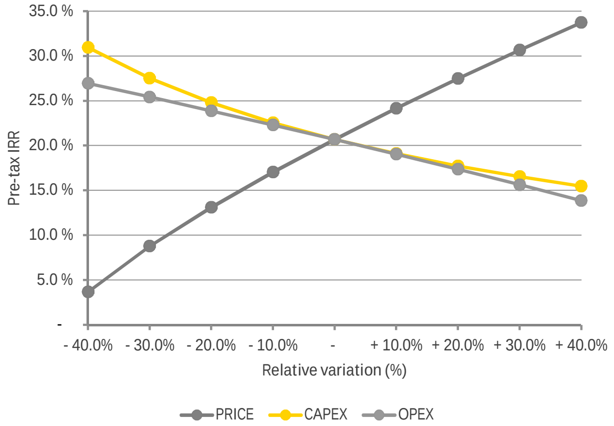
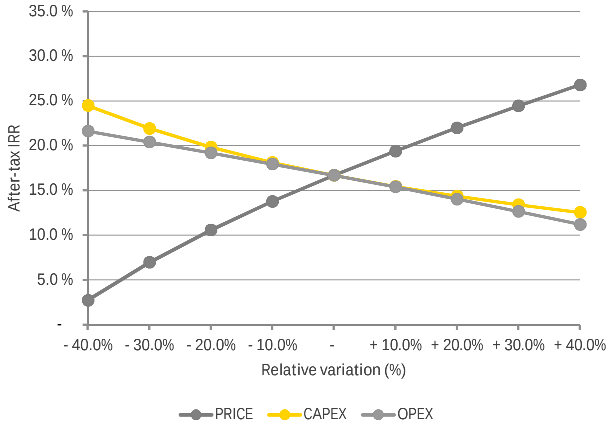


6. NI 43-101 sensitivity graphs









Appendix 11 Cash Flow Statement for the Base Case

					30-Apr-16	30-Apr-17	30-Apr-18	30-Apr-19	30-Apr-20	30-Apr-21	30-Apr-22	30-Apr-23	30-Apr-24	30-Apr-25	30-Apr-26	30-Apr-27	30-Apr-28	30-Apr-29
Production			*Total*															
Tonnes mined			472,091	kt	165	330	9,089	18,648	18,648	18,648	18,648	18,648	18,648	18,725	18,648	18,648	18,716	18,605
Waste			527,306	kt	2,602	5,205	15,159	9,504	11,703	16,734	23,965	38,748	55,306	70,804	49,375	20,362	20,311	20,432
Overburden			1,008,452	kt	3,067	6,135	26,023	29,848	30,739	35,382	43,638	60,453	74,170	89,530	68,023	39,010	39,027	39,037
Ore processed			472,091	kt	-	-	9,089	18,648	18,648	18,648	18,648	18,648	18,648	18,725	18,648	18,648	18,716	18,605
Concentrate produced			75,703	kt	-	-	1,505	3,081	3,055	3,094	2,781	2,904	3,139	2,917	2,632	2,905	2,908	3,161
			Average															
Extraction ratio			16.1 %		na	na	16.6 %	16.5 %	16.4 %	16.6 %	14.9 %	15.6 %	16.8 %	15.6 %	14.1 %	15.6 %	15.5 %	17.0 %
Phosphate price					-	-	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00
Operations		*NPV*	*Total*															
Revenue		6,065,456	16,124,825	$ '000's	-	-	320,652	656,265	650,761	659,080	592,266	618,602	668,688	621,384	560,719	618,853	619,377	673,318
Extraction costs		(810,998)	(2,069,082)	$ '000's	-	-	(51,945)	(62,210)	(64,333)	(80,513)	(85,940)	(96,454)	(112,442)	(124,485)	(116,717)	(86,381)	(80,286)	(84,061)
Process costs		(1,380,207)	(3,642,299)	$ '000's	-	-	(96,204)	(141,957)	(141,971)	(142,569)	(141,799)	(140,450)	(141,955)	(141,955)	(141,955)	(141,955)	(142,051)	(141,955)
Shipping costs		(397,592)	(1,056,985)	$ '000's	-	-	(21,019)	(43,018)	(42,658)	(43,203)	(38,823)	(40,549)	(43,833)	(40,732)	(36,755)	(40,566)	(40,600)	(44,136)
SG&A		(124,358)	(323,182)	$ '000's	-	-	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)
Cash flow from operations		3,352,303	9,033,278	$ '000's	-	-	139,055	396,650	389,371	380,366	313,274	328,719	358,028	301,782	252,862	337,522	344,010	390,736
Capital costs		*NPV*	*Total*															
Construction		(1,163,956)	(1,214,682)	$ '000's	(529,879)	(684,803)	-	-	-	-	-	-	-	-	-	-	-	-
Land royalties		(463)	(500)	$ '000's	-	(500)	-	-	-	-	-	-	-	-	-	-	-	-
Financing royalty buy-outs		(8,333)	(9,000)	$ '000's	-	(9,000)	-	-	-	-	-	-	-	-	-	-	-	-
Investment in working capital		(36,930)	-	$ '000's	-	-	(26,355)	(27,585)	599	(830)	5,492	(2,165)	(3,966)	3,738	4,986	(4,778)	96	(4,573)
Sustaining capital expenditure		(193,325)	(384,773)	$ '000's	-	-	(68,202)	(2,714)	(3,583)	(40,731)	(6,466)	(29,228)	(33,832)	(22,523)	(9,809)	(13,115)	(8,506)	(17,751)
Site restoration costs		(39,201)	(44,763)	$ '000's	-	(22,381)	(11,191)	(11,191)	-	-	-	-	-	-	-	-	-	-
	IRR	*NPV*	*Total*															
Before-tax cash flow	20.7 %	1,910,094	7,379,559	$ '000's	(529,879)	(716,685)	33,307	355,161	386,387	338,805	312,300	297,326	320,230	282,998	248,039	319,629	335,600	368,413
Mining tax		(324,878)	(1,056,609)	$ '000's	-	-	-	-	(11,721)	(29,768)	(26,419)	(32,967)	(40,290)	(33,677)	(28,130)	(43,113)	(45,379)	(53,271)
Federal tax		(289,603)	(950,381)	$ '000's	-	-	-	-	-	-	(36,493)	(40,049)	(43,187)	(36,037)	(30,223)	(41,065)	(42,160)	(47,984)
Provincial tax (Quebec)		(229,752)	(753,969)	$ '000's	-	-	-	-	-	-	(28,951)	(31,772)	(34,262)	(28,589)	(23,977)	(32,578)	(33,447)	(38,067)
	IRR	*NPV*	*Total*															
Net cash flow	16.7 %	1,065,861	4,618,601	$ '000's	(529,879)	(716,685)	33,307	355,161	374,665	309,038	220,437	192,538	202,491	184,694	165,710	202,873	214,613	229,091
Costs per ton mined			*Average*															
Extraction costs			2.26	$ / t	na	na	2.00	2.08	2.09	2.28	1.97	1.60	1.52	1.39	1.72	2.21	2.06	2.15
Process costs			4.29	$ / t	na	na	3.70	4.76	4.62	4.03	3.25	2.32	1.91	1.59	2.09	3.64	3.64	3.64
SG&A			0.38	$ / t	na	na	0.48	0.42	0.40	0.35	0.28	0.21	0.17	0.14	0.18	0.32	0.32	0.32
Shipping costs			1.25	$ / t	na	na	0.81	1.44	1.39	1.22	0.89	0.67	0.59	0.45	0.54	1.04	1.04	1.13
Total			8.17	$ / t	-	-	6.98	8.70	8.50	7.88	6.39	4.80	4.19	3.57	4.53	7.21	7.06	7.24
Costs per ton of ore milled			*Average*															
Extraction costs			4.38	$ / t	na	na	5.71	3.34	3.45	4.32	4.61	5.17	6.03	6.65	6.26	4.63	4.29	4.52
Process costs			7.72	$ / t	na	na	10.58	7.61	7.61	7.65	7.60	7.53	7.61	7.58	7.61	7.61	7.59	7.63
SG&A			0.68	$ / t	na	na	1.37	0.67	0.67	0.67	0.67	0.67	0.67	0.66	0.67	0.67	0.66	0.67
Shipping costs			2.24	$ / t	na	na	2.31	2.31	2.29	2.32	2.08	2.17	2.35	2.18	1.97	2.18	2.17	2.37
Total			15.02	$ / t	-	-	19.98	13.92	14.02	14.95	14.96	15.54	16.66	17.07	16.51	15.09	14.71	15.19
Costs per ton of concentrate			*Average*															
Extraction costs			27.33	$ / t	na	na	34.51	20.19	21.06	26.02	30.91	33.21	35.82	42.67	44.34	29.73	27.61	26.59
Process costs			48.11	$ / t	na	na	63.91	46.07	46.47	46.07	51.00	48.36	45.22	48.66	53.92	48.86	48.85	44.91
SG&A			4.27	$ / t	na	na	8.26	4.03	4.07	4.02	4.47	4.28	3.96	4.26	4.72	4.28	4.27	3.93
Shipping costs			13.96	$ / t	na	na	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96
Total operating cost			93.68	$ / t	-	-	120.63	84.26	85.56	90.07	100.34	99.81	98.96	109.55	116.95	96.83	94.70	89.39

	30-Apr-30	30-Apr-31	30-Apr-32	30-Apr-33	30-Apr-34	30-Apr-35	30-Apr-36	30-Apr-37	30-Apr-38	30-Apr-39	30-Apr-40	30-Apr-41	30-Apr-42	30-Apr-43	30-Apr-44
Production															
Tonnes mined	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	14,848	-
Waste	19,200	18,200	18,200	18,200	17,700	17,700	18,028	19,906	11,339	4,883	2,306	985	292	159	-
Overburden	37,848	36,848	36,848	36,848	36,348	36,348	36,676	38,554	29,987	23,531	20,954	19,633	18,940	15,008	-
Ore processed	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	18,648	15,343	-
Concentrate produced	3,245	2,895	2,747	2,968	2,950	3,214	3,085	2,748	2,664	2,860	2,934	3,171	3,370	2,768	-
Extraction ratio	17.4 %	15.5 %	14.7 %	15.9 %	15.8 %	17.2 %	16.5 %	14.7 %	14.3 %	15.3 %	15.7 %	17.0 %	18.1 %	18.0 %	na
Phosphate price	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00	213.00	-
Operations															
Revenue	691,211	616,716	585,139	632,260	628,394	684,571	657,024	585,220	567,357	609,199	624,966	675,472	717,745	589,584	-
Extraction costs	(75,569)	(81,349)	(75,333)	(81,249)	(82,742)	(82,443)	(80,262)	(82,343)	(76,475)	(68,408)	(62,983)	(61,063)	(58,552)	(54,544)	-
Process costs	(141,955)	(141,955)	(141,776)	(141,951)	(141,972)	(141,953)	(141,954)	(141,956)	(141,952)	(141,957)	(141,948)	(141,962)	(141,955)	(140,281)	-
Shipping costs	(45,309)	(40,426)	(38,356)	(41,445)	(41,191)	(44,874)	(43,068)	(38,361)	(37,190)	(39,933)	(40,967)	(44,277)	(47,048)	(38,647)	-
SG&A	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	(12,430)	-
Cash flow from operations	415,948	340,557	317,244	355,185	350,058	402,872	379,309	310,130	299,310	346,471	366,639	415,739	457,761	343,681	-
Capital costs															
Construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land royalties	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Financing royalty buy-outs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Investment in working capital	(1,471)	6,123	2,727	(4,004)	318	(4,617)	2,412	5,754	1,468	(3,439)	(1,156)	(4,292)	(3,475)	10,534	48,459
Sustaining capital expenditure	(8,067)	(17,489)	(19,110)	(5,259)	(15,828)	(5,498)	(25,236)	(8,851)	(15,579)	(1,764)	(1,762)	(2,333)	(1,540)	-	-
Site restoration costs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Before-tax cash flow	406,410	329,191	300,861	345,922	334,548	392,756	356,485	307,033	285,199	341,268	363,721	409,115	452,746	354,215	48,459
Mining tax	(58,060)	(46,075)	(42,321)	(49,039)	(48,165)	(57,073)	(52,677)	(41,956)	(40,145)	(48,299)	(51,951)	(60,077)	(67,028)	(49,008)	-
Federal tax	(51,407)	(41,812)	(38,753)	(43,862)	(43,146)	(50,061)	(46,692)	(38,168)	(36,747)	(43,064)	(45,891)	(52,278)	(57,748)	(43,555)	-
Provincial tax (Quebec)	(40,783)	(33,171)	(30,744)	(34,797)	(34,229)	(39,715)	(37,043)	(30,280)	(29,152)	(34,164)	(36,407)	(41,474)	(45,814)	(34,554)	-
Net cash flow	256,160	208,134	189,043	218,224	209,007	245,907	220,073	196,630	179,154	215,741	229,473	255,286	282,156	227,098	48,459
Costs per ton mined															
Extraction costs	2.00	2.21	2.04	2.20	2.28	2.27	2.19	2.14	2.55	2.91	3.01	3.11	3.09	3.63	na
Process costs	3.75	3.85	3.85	3.85	3.91	3.91	3.87	3.68	4.73	6.03	6.77	7.23	7.49	9.35	na
SG&A	0.33	0.34	0.34	0.34	0.34	0.34	0.34	0.32	0.41	0.53	0.59	0.63	0.66	0.83	na
Shipping costs	1.20	1.10	1.04	1.12	1.13	1.23	1.17	1.00	1.24	1.70	1.96	2.26	2.48	2.58	na
Total	7.27	7.49	7.27	7.52	7.66	7.75	7.57	7.14	8.94	11.17	12.33	13.23	13.73	16.39	-
Costs per ton of ore milled															
Extraction costs	4.05	4.36	4.04	4.36	4.44	4.42	4.30	4.42	4.10	3.67	3.38	3.27	3.14	3.55	na
Process costs	7.61	7.61	7.60	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	9.14	na
SG&A	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.81	na
Shipping costs	2.43	2.17	2.06	2.22	2.21	2.41	2.31	2.06	1.99	2.14	2.20	2.37	2.52	2.52	na
Total	14.76	14.81	14.37	14.86	14.93	15.11	14.89	14.75	14.37	14.09	13.85	13.93	13.94	16.03	-
Costs per ton of concentrate															
Extraction costs	23.29	28.10	27.42	27.37	28.05	25.65	26.02	29.97	28.71	23.92	21.47	19.26	17.38	19.71	na
Process costs	43.74	49.03	51.61	47.82	48.12	44.17	46.02	51.67	53.29	49.63	48.38	44.77	42.13	50.68	na
SG&A	3.83	4.29	4.52	4.19	4.21	3.87	4.03	4.52	4.67	4.35	4.24	3.92	3.69	4.49	na
Shipping costs	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	13.96	na
Total operating cost	84.82	95.38	97.52	93.34	94.34	87.65	90.03	100.12	100.63	91.86	88.04	81.90	77.15	88.84	-

Note: Due to the temporal format imposed by the financial model, there is about 4 months of time schedule discrepancy between this table and the EPCM schedule (section 24.1); results shown above should be reflected ≈4 months ahead of the above time line.

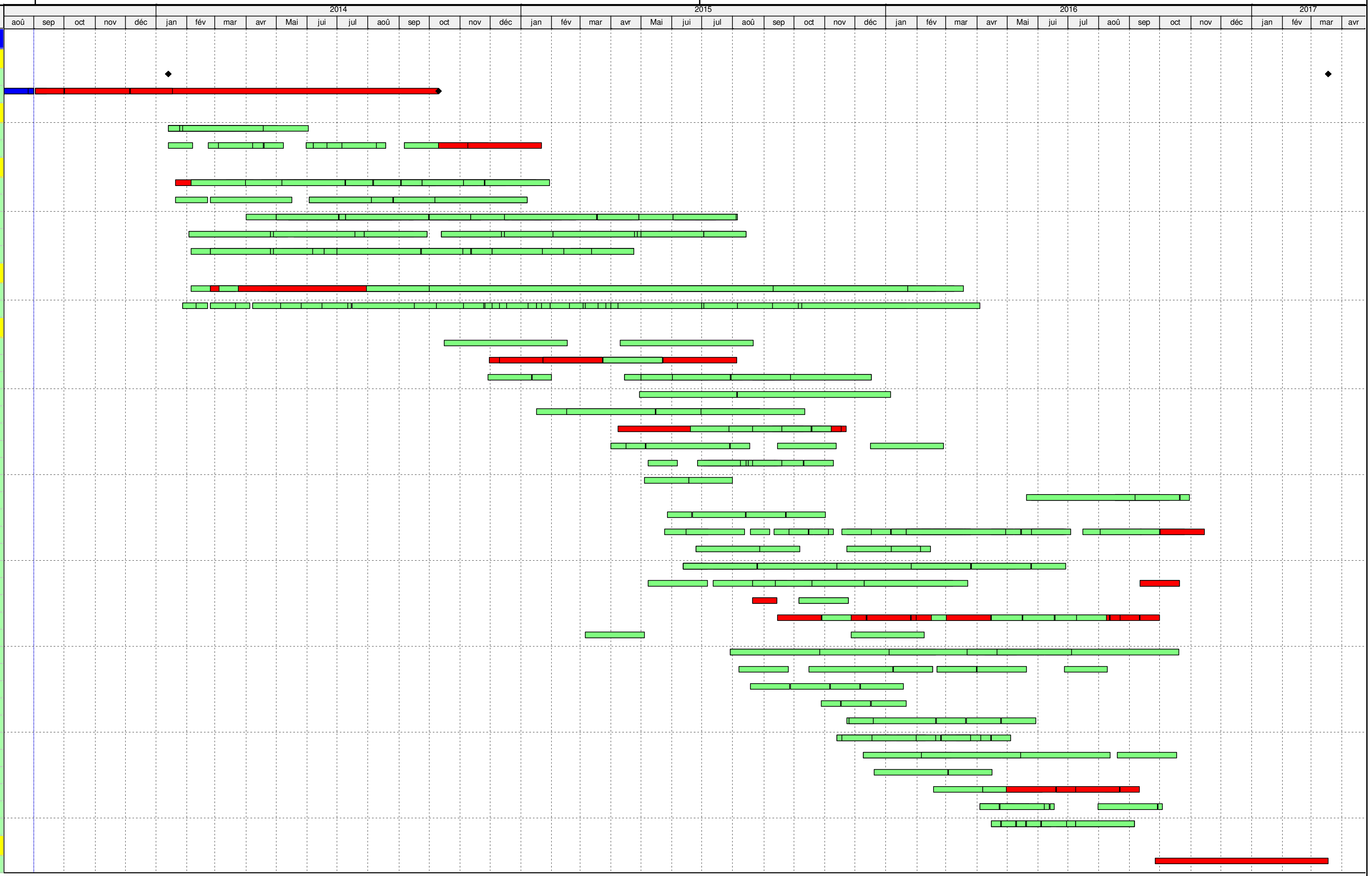
Appendix 12 EPCM Level 1 Summary Schedule

Lac a Paul EPCM Schedule

BFS Report

03-oct-13 14:41

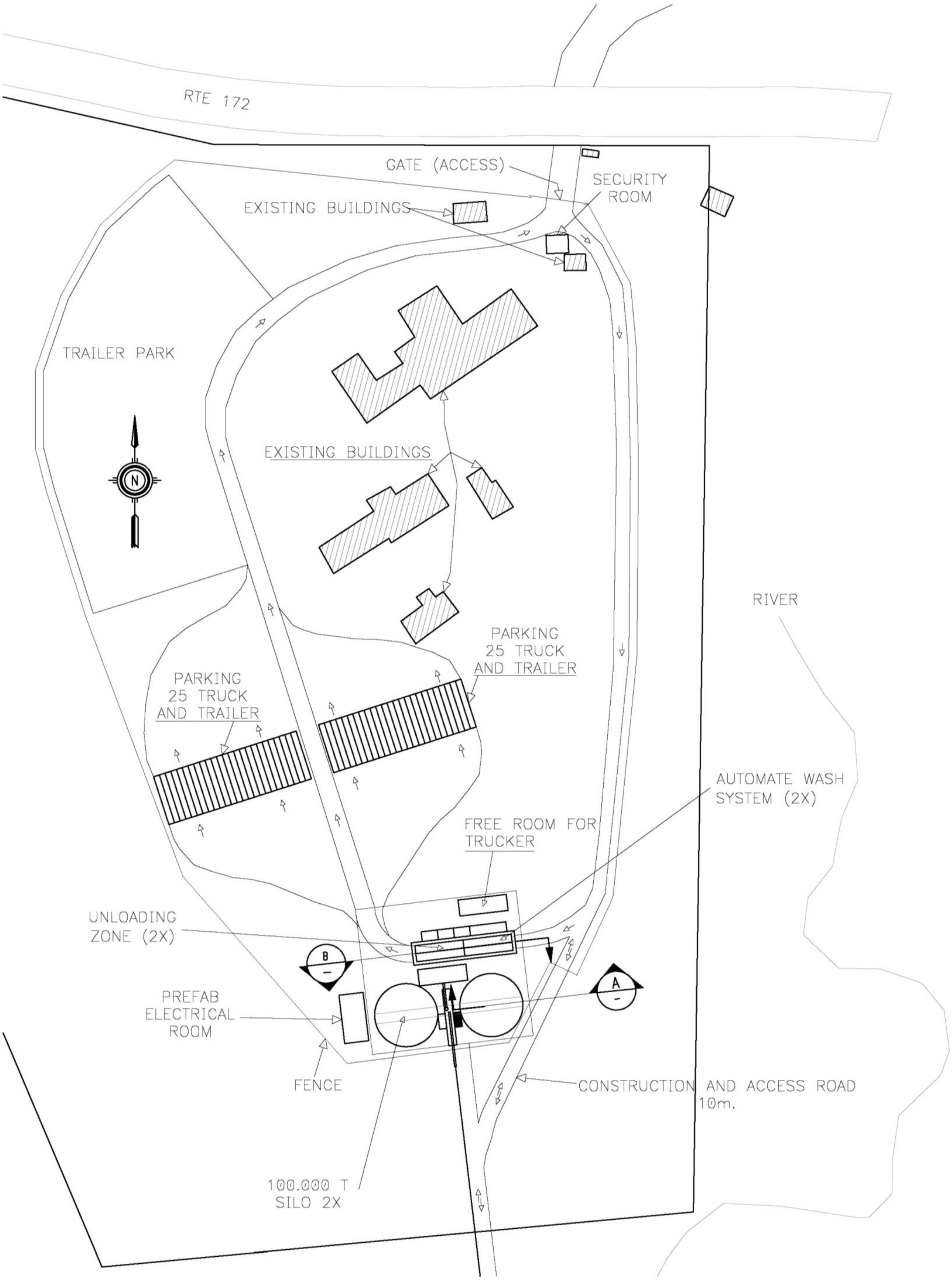
ID de tâche	Nom de la tâche	Budget Durée	Début	Fin
	Lac a Paul EPCM Schedule - BFS Report	893	21-jui-13 A	18-mar-17
	General	893	21-jui-13 A	18-mar-17
	Milestones	807	13-jan-14	18-mar-17
	EIA and Testwork	421	21-jui-13 A	10-oct-14
	Early Works	261	13-jan-14	21-jan-15
	Engineering	101	13-jan-14	02-jui-14
	Early Construction Works	261	13-jan-14	21-jan-15
	Engineering	402	20-jan-14	14-aoû-15
	0100 - Mill	262	20-jan-14	29-jan-15
	1100 - Open Pit Mine	246	20-jan-14	07-jan-15
	3100 - General Services	344	01-avr-14	05-aoû-15
	3200 - Infrastructures	392	03-fév-14	14-aoû-15
	3300 - Power and Communication	310	05-fév-14	23-avr-15
	Procurement	557	27-jan-14	04-avr-16
	Equipment	540	05-fév-14	18-mar-16
	Procurement of Services	557	27-jan-14	04-avr-16
	Construction	705	16-oct-14	14-nov-16
	Package No 33, Temporary and Permanent Camps	282	16-oct-14	21-aoû-15
	Package No 8, Foundations East Building	220	30-nov-14	04-aoû-15
	Package No 17, Crusher and Conveyor Foundations and Structure	356	29-nov-14	17-déc-15
	Package No 29, 161 KV Power Line	224	29-avr-15	05-jan-16
	Package No 7, Foundations West Building	255	16-jan-15	11-oct-15
	Package No 9, Structure - Mill (East and West Side Buildings)	215	08-avr-15	22-nov-15
	Package No 5, Civil Works, Earthworks, Access Roads, Contractor's Pads	305	01-avr-15	27-fév-16
	Package No 37, Overhead Cranes	172	08-Mai-15	09-nov-15
	Package No 25, Fuel Supply	75	04-Mai-15	31-jul-15
	Package No 36, Fire Protection	150	20-Mai-16	30-oct-16
	Package No 26, Heavy Vehicle Garage	145	27-Mai-15	01-nov-15
	Package No 15, Plant Electrical Distribution	499	24-Mai-15	14-nov-16
	Package No 30, HV and MV Distribution Overall Site	207	25-jui-15	14-fév-16
	Package No 21, Tailings	355	12-jui-15	28-jui-16
	Package No 28, Piping Works Inside plant	490	08-Mai-15	20-oct-16
	Package No 10, Architecture - Mill (East and West Side Buildings)	97	20-aoû-15	24-nov-15
	Package No 12, Mechanical Equipment Installation - Floatation, Drying an	355	14-sep-15	30-sep-16
	Package No 22, Stockpile Dry Concentrate - Foundations and Structure	312	06-mar-15	08-fév-16
	Package No 32, Mine	421	29-jul-15	19-oct-16
	Package No 14, Main Electrical Sub-Station	341	07-aoû-15	09-aoû-16
	Package No 27, Water Intake and Pump House	140	18-aoû-15	18-jan-16
	Package No 24, Gate House and Fence	71	28-oct-15	21-jan-16
	Package No 34, HVAC Mill	175	23-nov-15	29-Mai-16
	Package No 18, Crusher and Conveyor Mechanical Equipment Installation	160	13-nov-15	04-Mai-16
	Package No 16, Instrumentation and Control	286	09-déc-15	17-oct-16
	Package No 35, Compressed Air	105	20-déc-15	16-avr-16
	Package No 11, Mechanical Equipment Installation - Grinding Area (0130)	193	17-fév-16	10-sep-16
	Package No 38, Service Areas	169	04-avr-16	03-oct-16
	Package No 20, Administration and Service Buildings	130	15-avr-16	05-sep-16
	Commissioning and Start-up	160	26-sep-16	18-mar-17
	Plant Commissioning	160	26-sep-16	18-mar-17



🟦 Actual Work
🟥 Critical Remaining Work
🟩 Remaining Work ◆
◆ Milestone

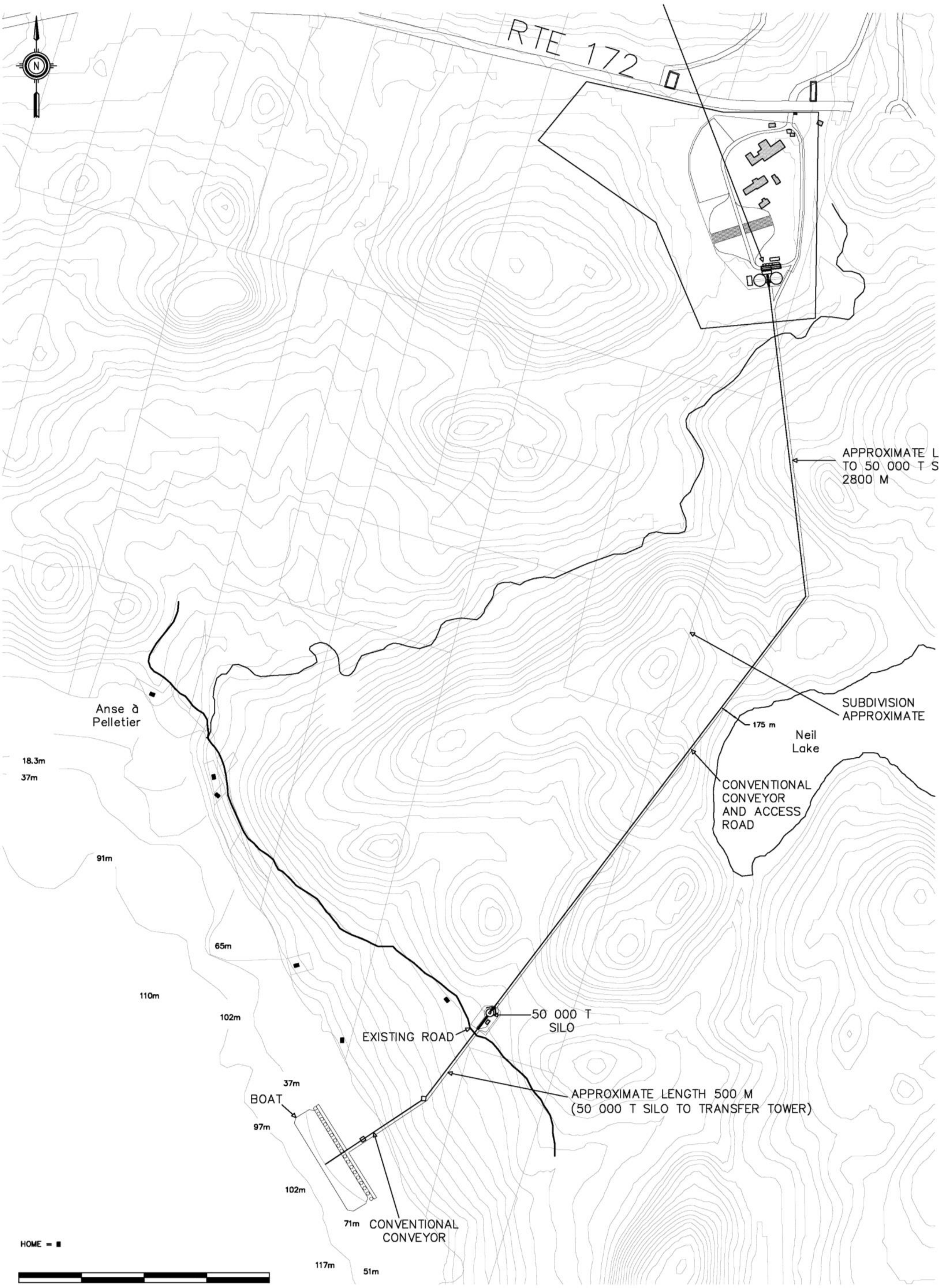
Appendix 13

Schematic View of the Saint-Fulgence Unloading Area and Storage

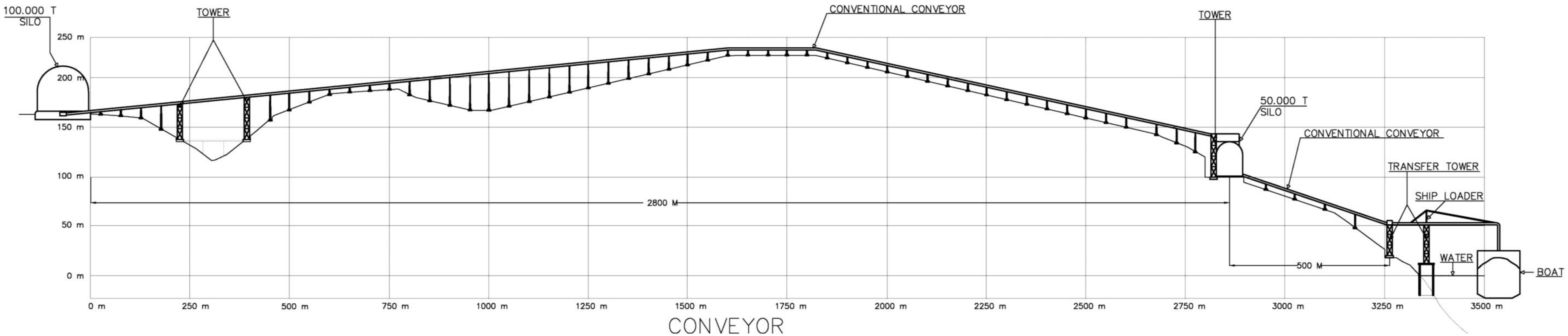

RTE 172
GATE (ACCESS)
SECURITY ROOM
EXISTING BUILDINGS
TRAILER PARK
N
EXISTING BUILDINGS
RIVER
PARKING 25 TRUCK AND TRAILER
PARKING 25 TRUCK AND TRAILER
AUTOMATE WASH SYSTEM (2X)
FREE ROOM FOR TRUCKER
UNLOADING ZONE (2X)
B
A
PREFAB ELECTRICAL ROOM
FENCE
CONSTRUCTION AND ACCESS ROAD 10m.
100.000 T SILO 2X

Appendix 14

Proposed Layout of Arianne's Equipment in St-Fulgence


N
RTE 172
APPROXIMATE LENGTH
TO 50 000 T SILO
2800 M
SUBDIVISION
APPROXIMATE
175 m
Neil
Lake
CONVENTIONAL
CONVEYOR
AND ACCESS
ROAD
Anse à
Pelletier
18.3m
37m
91m
65m
110m
102m
50 000 T
SILO
EXISTING ROAD
APPROXIMATE LENGTH 500 M
(50 000 T SILO TO TRANSFER TOWER)
37m
BOAT
97m
102m
71m
CONVENTIONAL
CONVEYOR
HOME = ■
117m
51m

Appendix 15 Elevation View of the Saint-Fulgence Site


100.000 T
SILO
TOWER
CONVENTIONAL CONVEYOR
TOWER
50.000 T
SILO
CONVENTIONAL CONVEYOR
TRANSFER TOWER
SHIP LOADER
WATER
BOAT
250 m
200 m
150 m
100 m
50 m
0 m
2800 M
500 M
0 m
250 m
500 m
750 m
1000 m
1250 m
1500 m
1750 m
2000 m
2250 m
2500 m
2750 m
3000 m
3250 m
3500 m

CONVEYOR