

REHABILITATION OF AN ABANDONED MINING SITE WITH GOLDEX TAILINGS – 2017 UPDATE

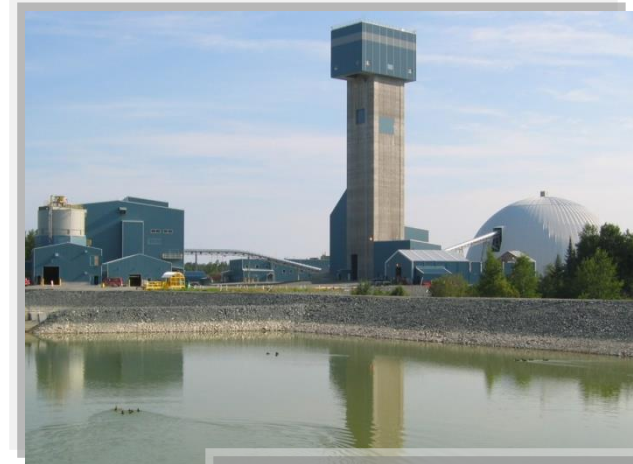


MANITOU – GOLDEX PROJECT

AGENDA



- Introduction
 - Sites presentation
 - Location
- Approach
 - Principle
 - Columns tests
 - Hydrogeology
- 2006-2007 Projects
 - Phase 1
 - Phase 2
- Update
 - Rehabilitation
 - Deposition plan
 - Signs of improvements
- Questions





INTRODUCTION

SITES PRESENTATION
LOCATION

PROJET MANITOU – GOLDEX

GOLDEX MINE



- Gold underground mine
- 2 km from city of Val d'Or
- Production start-up in April 2008
- Operation shut down temporary between October 2011 and October 2013
- Restart in October 2013
- Estimated reserves at 13 Mtm @ ≈ 1.6 g/tm
- Average daily tonnage of 6 800tm
- Waste rock and tailings non acid generation and non leachable



PROJET MANITOU GOLDEX

SITE MANITOU



- Site abandoned to MRNF
- Production between 1942 and 1979
- Widespread tailings on 6.5 km up to the Bourlamaque River
- Fish habitat affected by the Bourlamaque river
- 11 Mtm of acid generator tailings
- Contaminated on 200 ha
- Thickness of tailings of 1 to 17 m
- Water pH of 3.0



MANITOU-GOLDEX PROJECT LOCALISATION



Goldex mine

City of Val d'Or

Manitou site

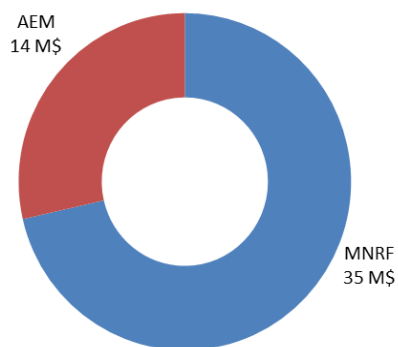


23 km

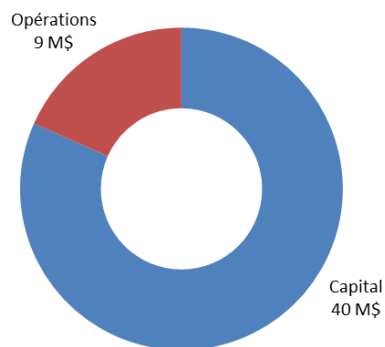
*Agreement signed in 2006- MERN and AE
In order to complete Manitou rehabilitation*



Répartition des coûts



Coût projetés : 2008



MRNF responsibilities

- Manitou site
- Pipeline, roads, bridge
- Equipments at Goldex
- To receive Goldex's tailings

AEM responsibilities

- Construction management
- Operation management
- Provide adequate quantities of tailings

Who are involved in Manitou-Goldex project?

Management committee (AE – MERN – independent expert)

Project collaborators

- Unité de recherche et de service en technologie minérale (URSTM)
- AMEC- geotechnical consultant
- Hydrogéologie Richelieu inc.
- Services Miniers Nord-Ouest
- Goldex operation team

Large work team!!





AGNICO EAGLE



APPROACH

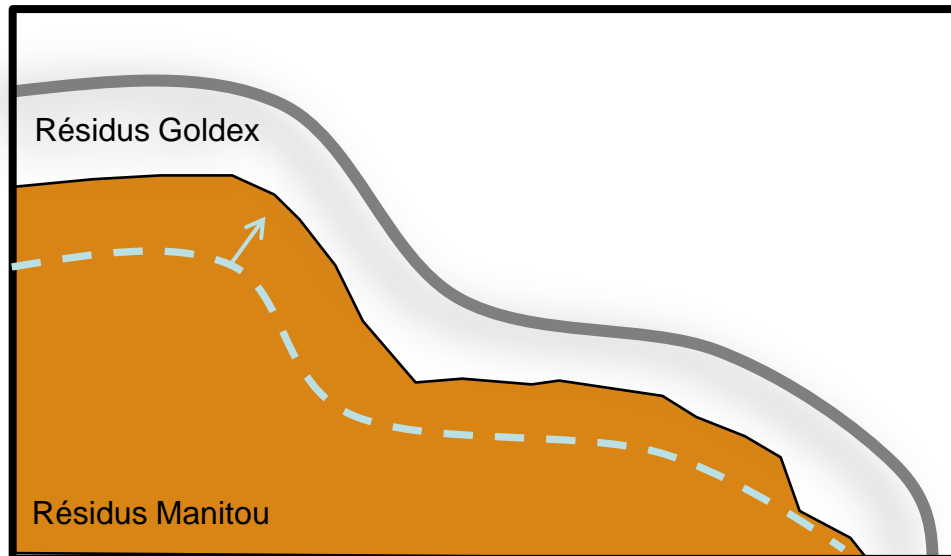
PRINCIPLE
COLUMNS TESTS
HYDROGEOLOGY

- First → Goldex tailings characteristics
- Non acid generation
 - Non-leachable
 - Neutralisation Potentiel Net $\approx 60 \text{ kg CaCO}_3/\text{tonne}$
 - No cyanide

Good materiel just like sand!!

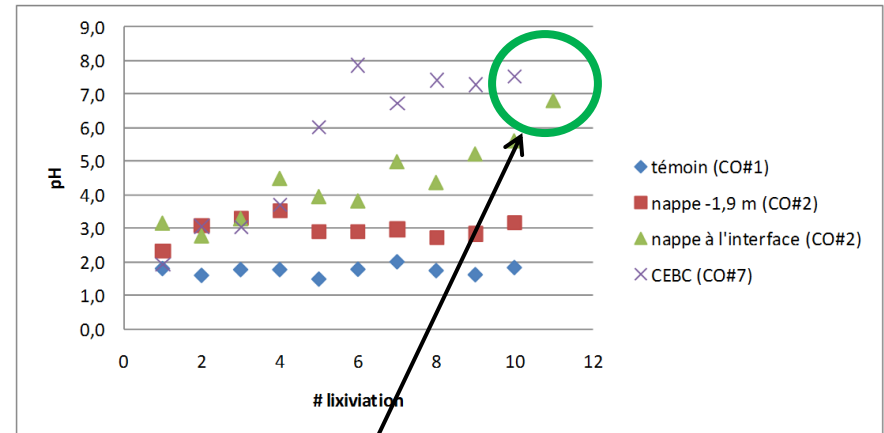
Goal → Stop oxygen from accessing Manitou Tailings (sulfur)

Principle → monolayer cover and watertable increasing



PROJET MANITOU-GOLDEX

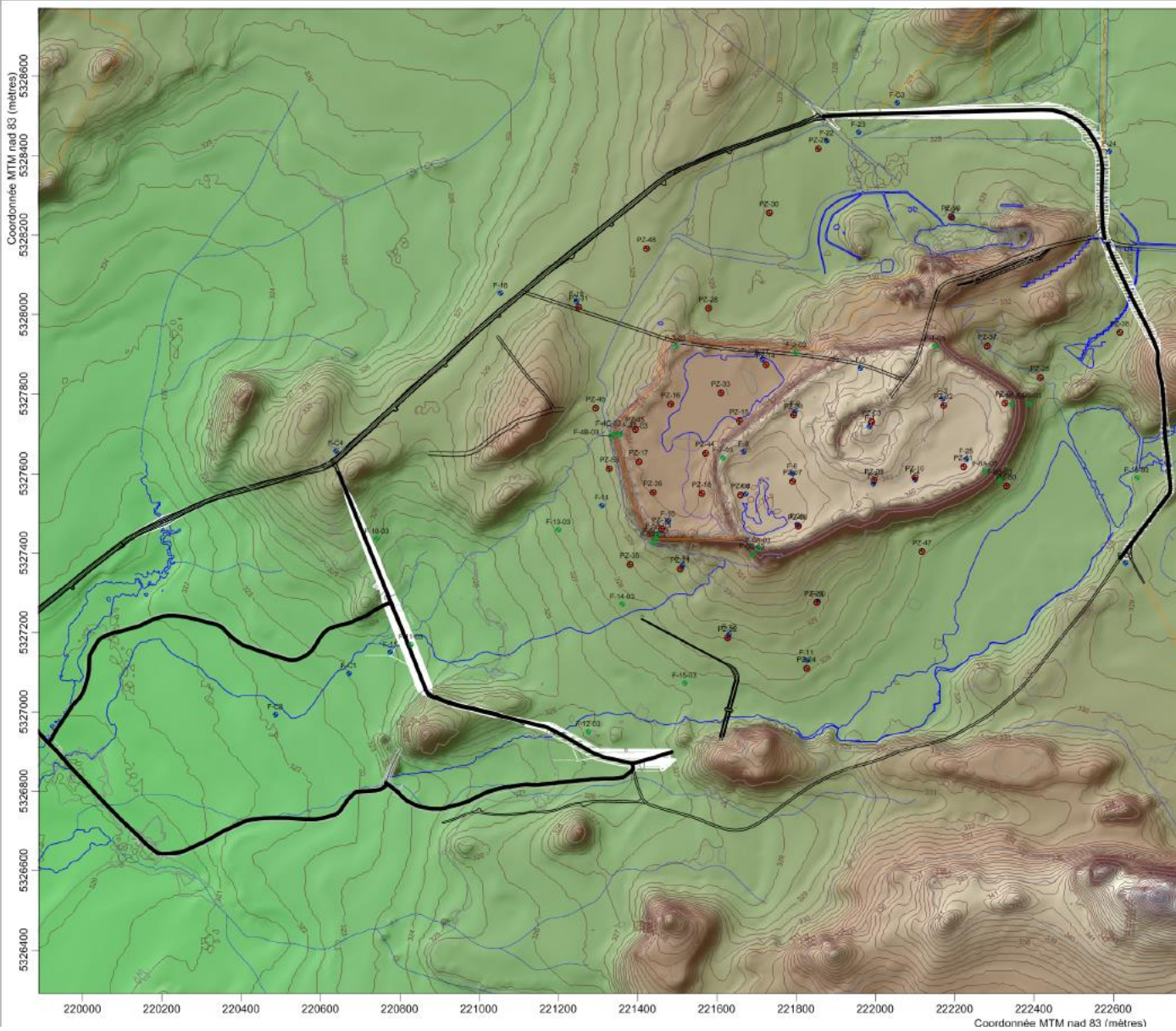
REHABILITATION APPROACH – COLUMNS TESTS



Conclusion – Equivalent results as a multilayers covering type

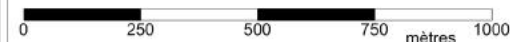
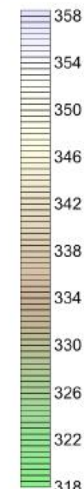
PROJET MANITOU-GOLDEX

REHABILITATION APPROACH

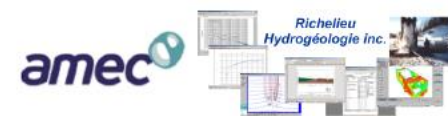


Légende

- Forage réalisé par Géocon, 2004
- Forage réalisé par l'URSTM, 2008
- Emplacement proposé pour les pointes filtrantes



Fond cartographique et données d'élevation fournies par AMEC
plan autocad: Manitou_carte 2007 épurée.dxf



Titre

FIGURE 1: LOCALISATION
DES POINTES FILTRANTES INSTALLÉES

Projet

ÉTUDE HYDROGÉOLOGIQUE
SITE MANITOU, VAL D'OR
AGNICO-EAGLE LTÉE

Interprétation et dessin

Yves Leblanc, ing. géo.
M.Sc. Hydrogéologie

Date

Le 30 AOÛT 2013

Échelle

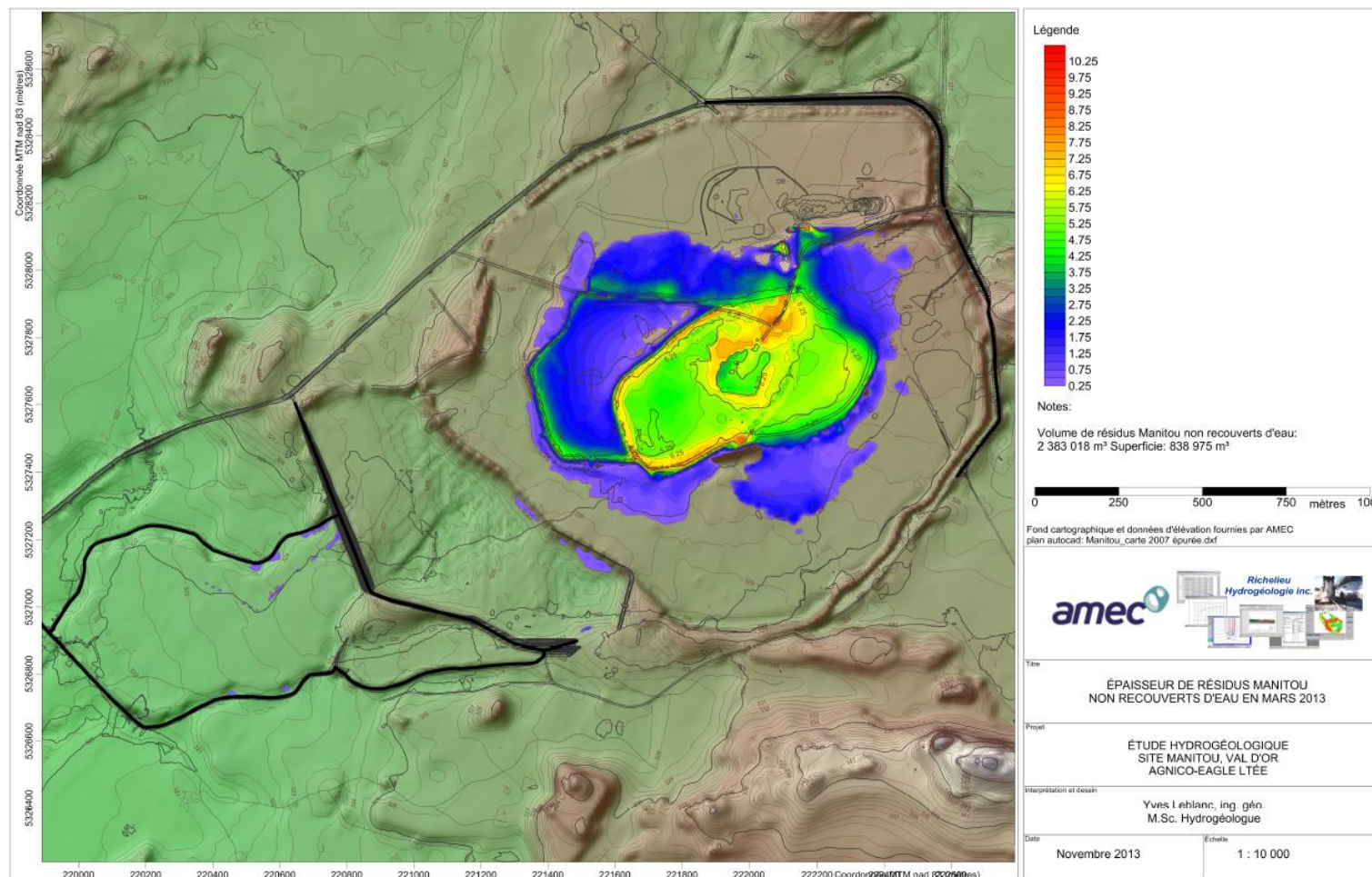
1 : 10 000

PROJET MANITOU-GOLDEX

REHABILITATION APPROACH



Key aspect → Hydrogeological model updated annually!





AGNICO EAGLE

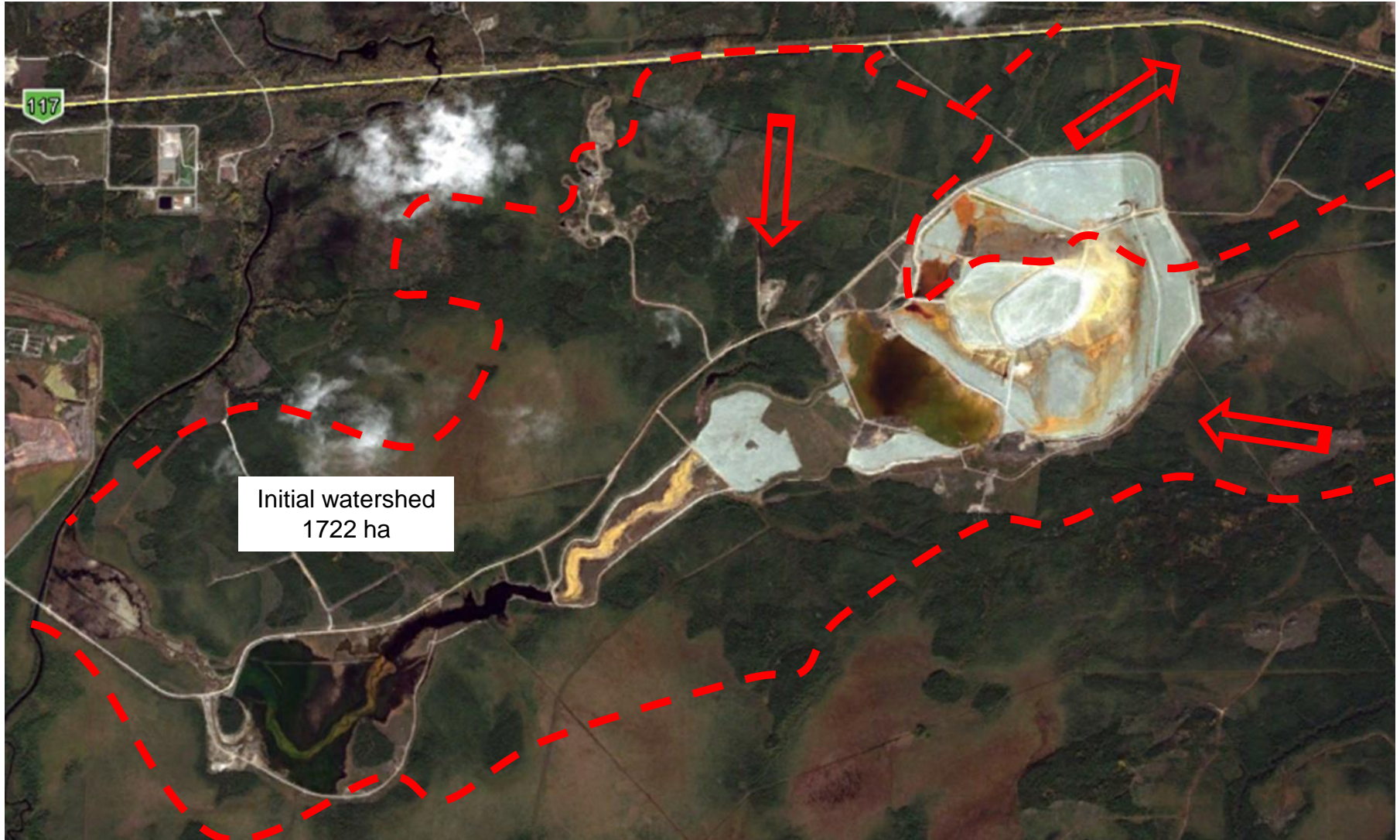


2006-2007 PROJECTS

PHASE 1
PHASE 2

PROJET MANITOU-GOLDEX

PHASE 1 – WATER MANAGEMENT



PROJET MANITOU-GOLDEX

PHASE 1 – WATER MANAGEMENT



PROJET MANITOU-GOLDEX

PHASE 1 – WATER MANAGEMENT



PROJET MANITOU-GOLDEX

PHASE 1 – EXCAVATION WORKS

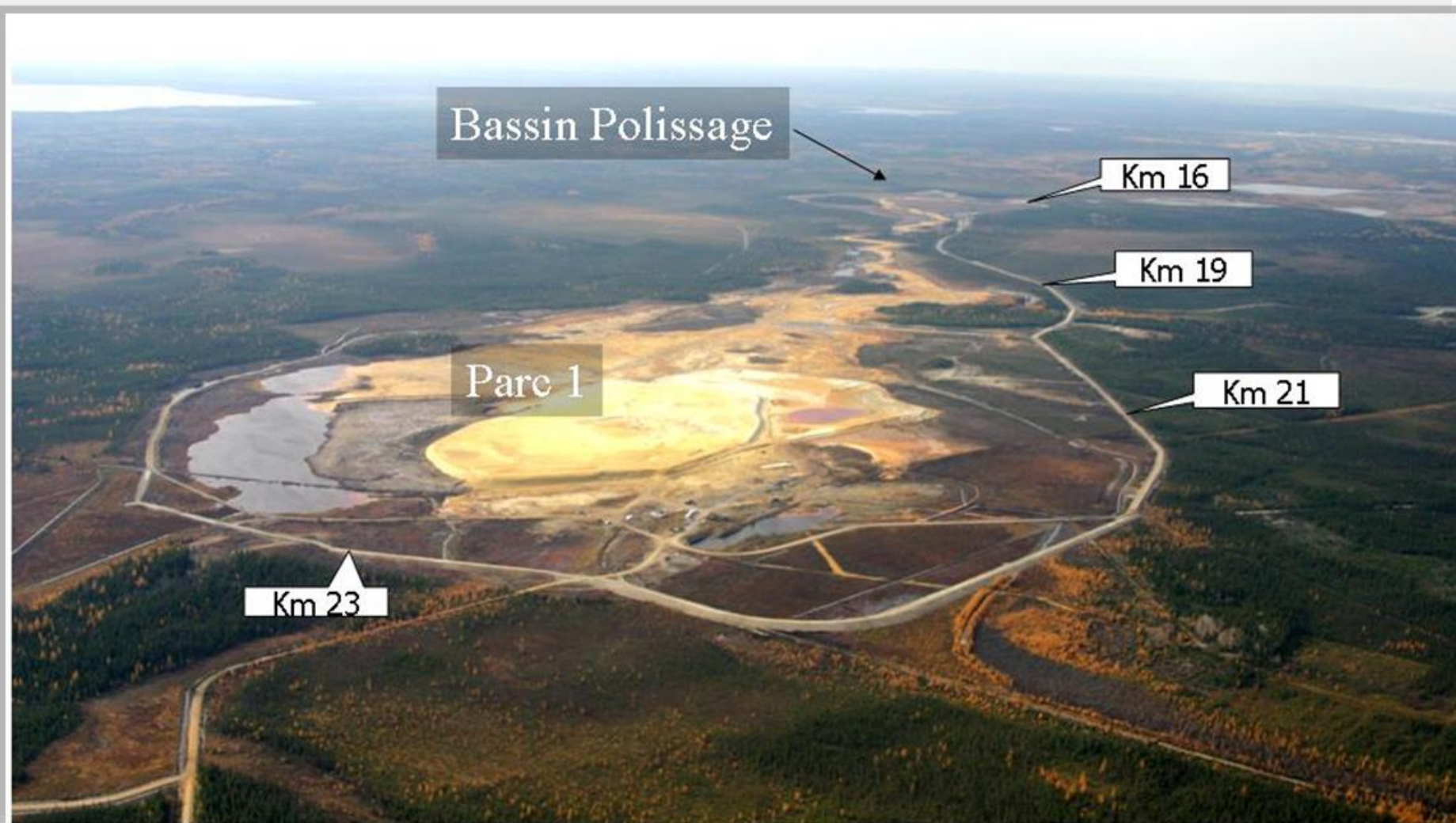
- Excavation of 350 000 m³ of Manitou tailings located near the Bourlamaque River during 2007 winter



2011

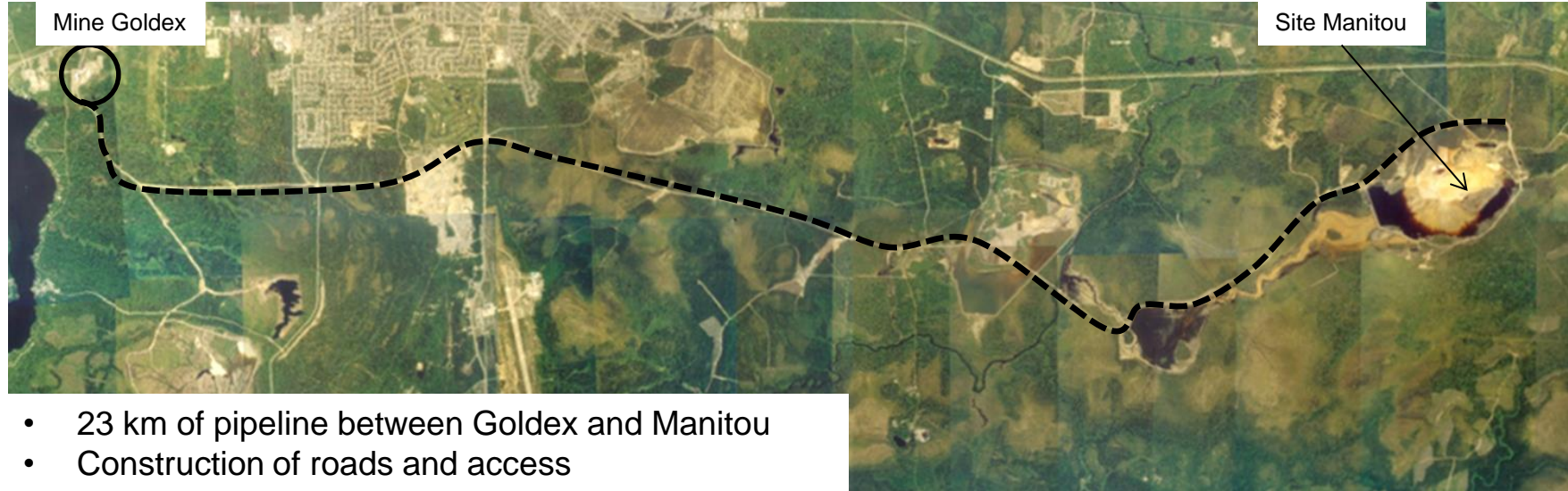
PROJET MANITOU-GOLDEX

PHASE 2 – DYKES CONSTRUCTION



MANITOU-GOLDEX PROJECT

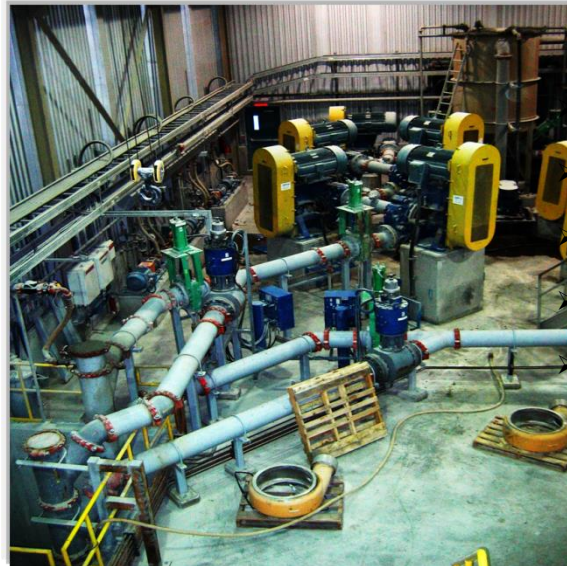
PHASE 2 – ROAD/PIPELINE/PUMPING STATION



- 23 km of pipeline between Goldex and Manitou
- Construction of roads and access



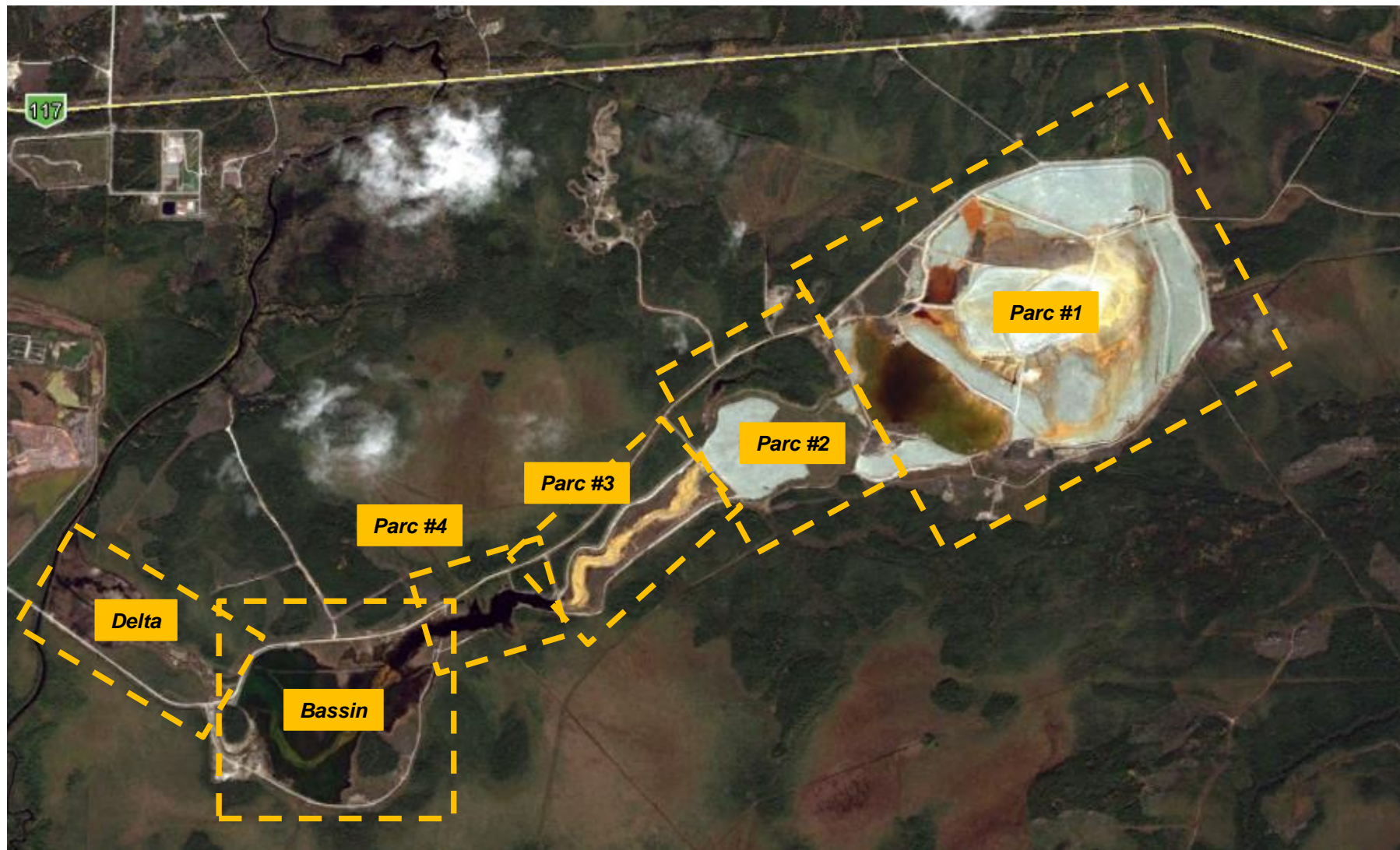
Pipeline installation



Pumping station
2 sets of 5 pumps (200 hp)
Pressure at 450 PSI
50% solid slurry
325 tm/hr

MANITOU-GOLDEX PROJECT

SECTORS ORGANIZATION





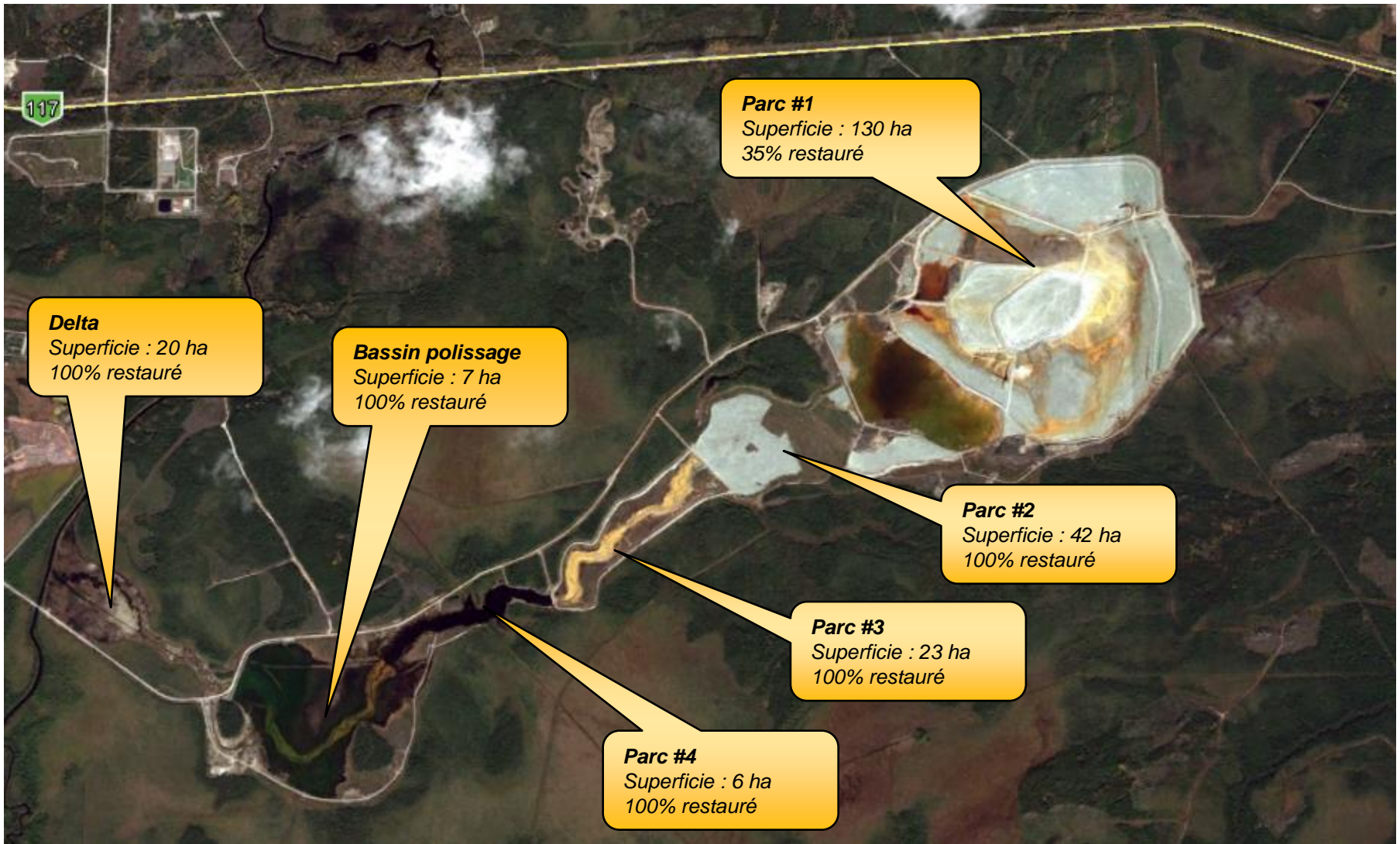
AGNICO EAGLE



UPDATE
REHABILITATION
DEPOSITION PLAN
SIGNS OF IMPROVEMENTS

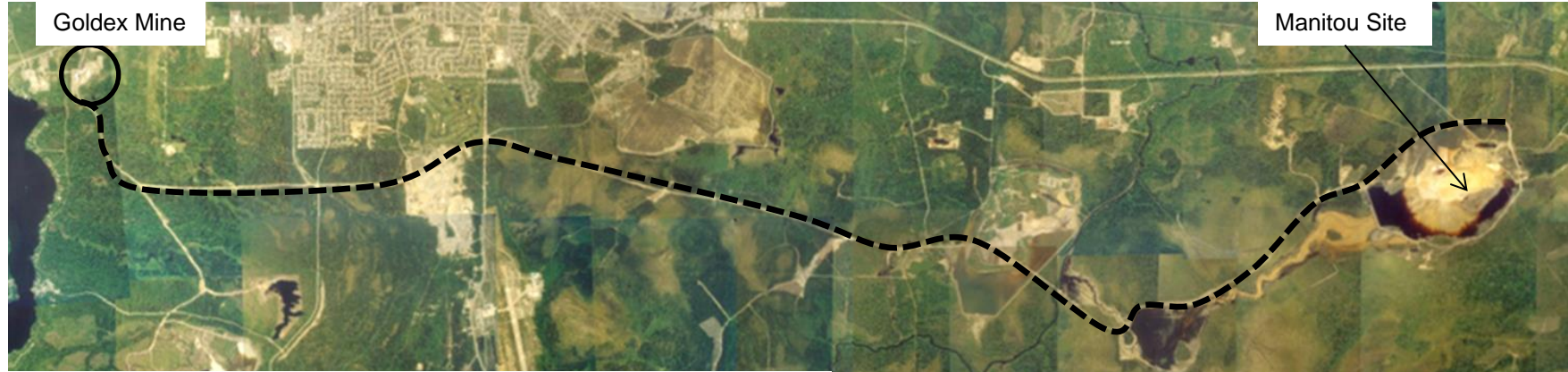
MANITOU-GOLDEX PROJECT

ACTUAL STATEMENT



MANITOU-GOLDEX PROJECT

ROAD/PIPELINE/PUMP STATION – 10 YEARS AFTER



- Replacement of 1,5km steel pipe. 2 km will be replaced in 2017
- Conversion of 2 km of steel pipe in HDPE in 2016-2017



Km 0 à 3,5

- Abrasion in the bottom of the pipeline
- Presence of bacteriological corrosion

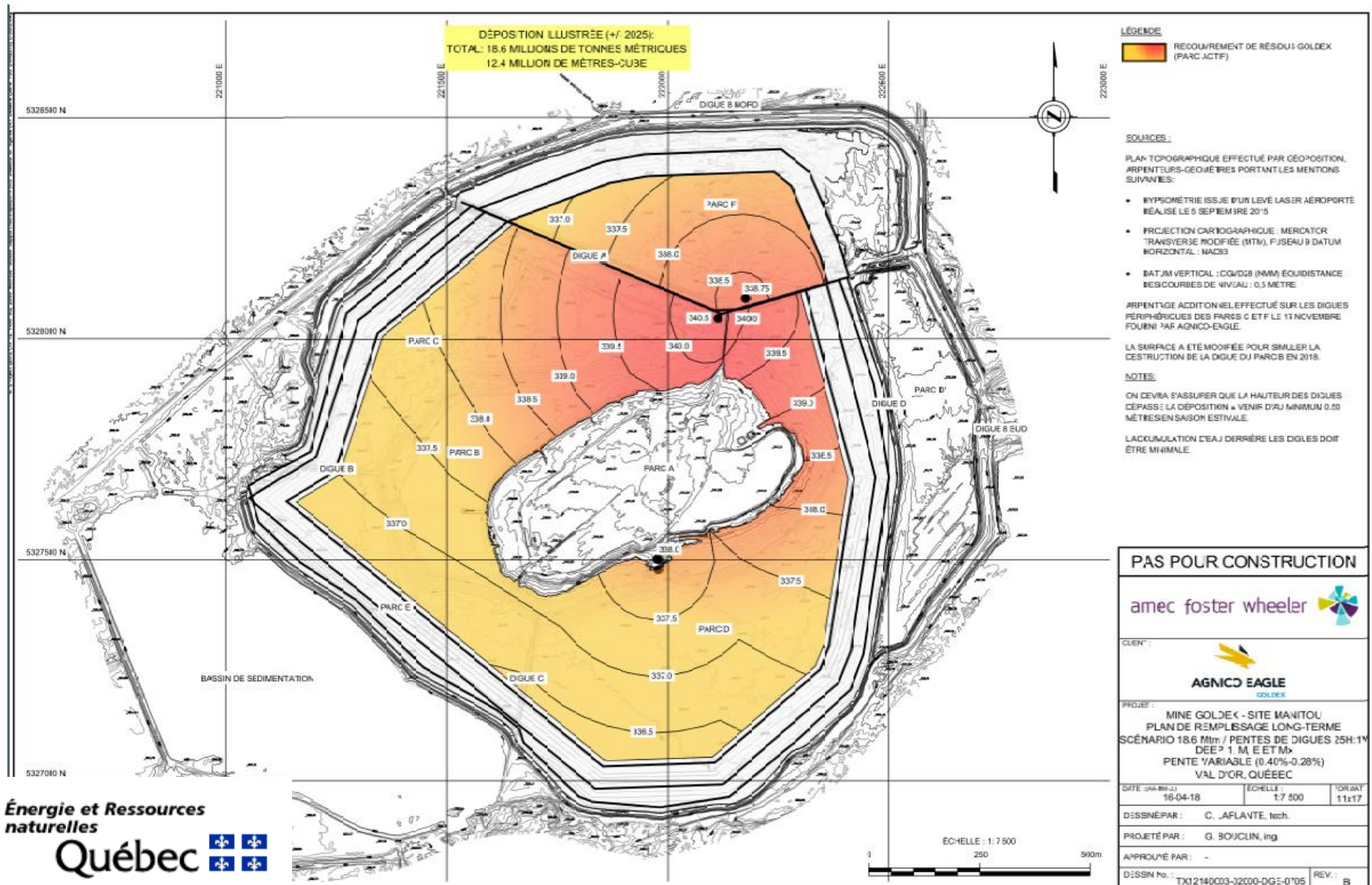


Km 16 à 21

- External corrosion of the pipeline due to acidic water of the wet land
- HDPE performance improvement over the last years allow to use it at higher pressure (210psi)

MANITOU-GOLDEX PROJECT

18.6 MTM SCENARIO



DÉPOSITION ILLUSTRÉE (+/- 2025):
TOTAL: 18.6 MILLIONS DE TONNES MÉTRICIQUES
12.4 MILLION DE MÈTRES-CUBE

LEGENDE

 RECOUVREMENT DE RÉSIDUS GOLDEX (PARC ACTIF)

SOURCES :
 PLAN TOPOGRAPHIQUE EFFECTUÉ PAR GÉOPOSITION, ARPENTEURS-GÉOMÈTRES PORTANT LES MENTIONS SUIVANTES:

- HYPSOMÉTRIE ISSUE D'UN LEVÉ LASER AÉROPORTE RÉALISÉ LE 5 SEPTEMBRE 2015
- PROJECTION CARTOGRAPHIQUE : MERCATOR TRANSVERSE MODIFIÉE (MTM), FUSEAU 9 DATUM HORIZONTAL : NAD83
- DATUM VERTICAL : CGVD83 (MMM) ÉQUIDISTANCE REG COURBES DE NIVEAU : 0,5 MÈTRE

ARPENTAGE ADDITIONNEL EFFECTUÉ SUR LES DIGUES PÉRIPHÉRIQUES DES PARCS C ET F LE 17 NOVEMBRE FOURNI PAR AGNICO-ÉAGLE.

LA SURFACE A ÉTÉ MODIFIÉE POUR SIMULER LA DESTRUCTION DE LA DIGUE DU PARCS EN 2018.

NOTES:
 ON DEVRA S'ASSURER QUE LA HAUTEUR DES DIGUES DÉPASSÉ LA DÉPOSITION À VENIR D'AU MINIMUM 0,50 MÈTRE EN SAISON ESTIVALE.

L'ACCUMULATION D'EAU DERRIÈRE LES DIGUES DOIT ÊTRE MINIMALE.

PAS POUR CONSTRUCTION

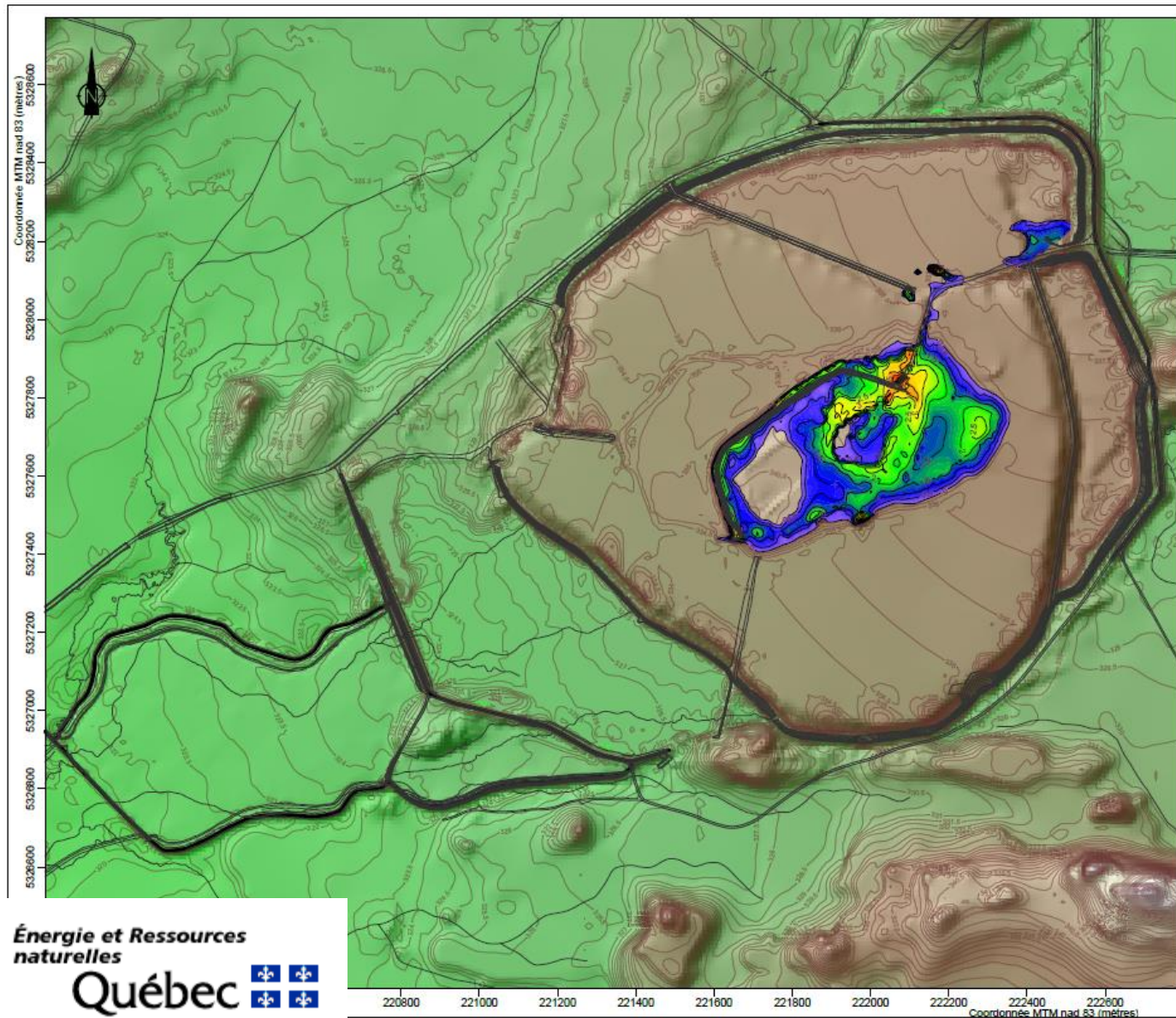


PROJET :
 MINE GOLDEX - SITE MANITOU
 PLAN DE REMPLISSAGE LONG-TERME
 SCÉNARIO 18.6 Mtm / PENTES DE DIGUES 25H:1M
 DEE² 1, M E ET M^x
 PENTE VARIABLE (0,40%-0,28%)
 VAL D'OR, QUÉBEC

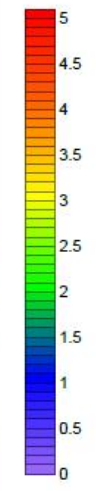
DATE (PARA-MI-J)	ÉCHELLE	ORIGAT
16-04-18	1:7 500	11x17
D'ESSINÉ PAR : C. AFLANTE, tech.		
PROJETÉ PAR : G. BOUCLIN, Ing		
APPROUVÉ PAR : -		
D'ISSIN No. :	TR12140003-32000-DG2-0705	REV. :
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MANITOU-GOLDEX PROJECT

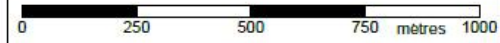
SURFACE OF MANITOU TAILINGS – NON-SUBMERGED



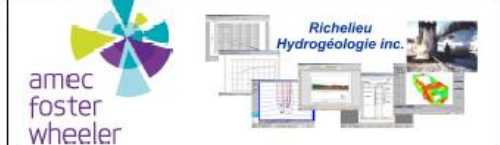
Legende



Surface de résidus au-dessus de la nappe: 240 000 m²
 Volume de résidus au-dessus de la nappe: 360 000 m³



Fond cartographique et données d'élévation fournies par AMEC
 plan autocad: fond.dxf



Titre
 ÉPAISSEUR DE RÉSIDUS MANITOU NON SATURÉS
 POUR UN TOTAL DE DÉPOSITION DE 18,6 Mt

Projet
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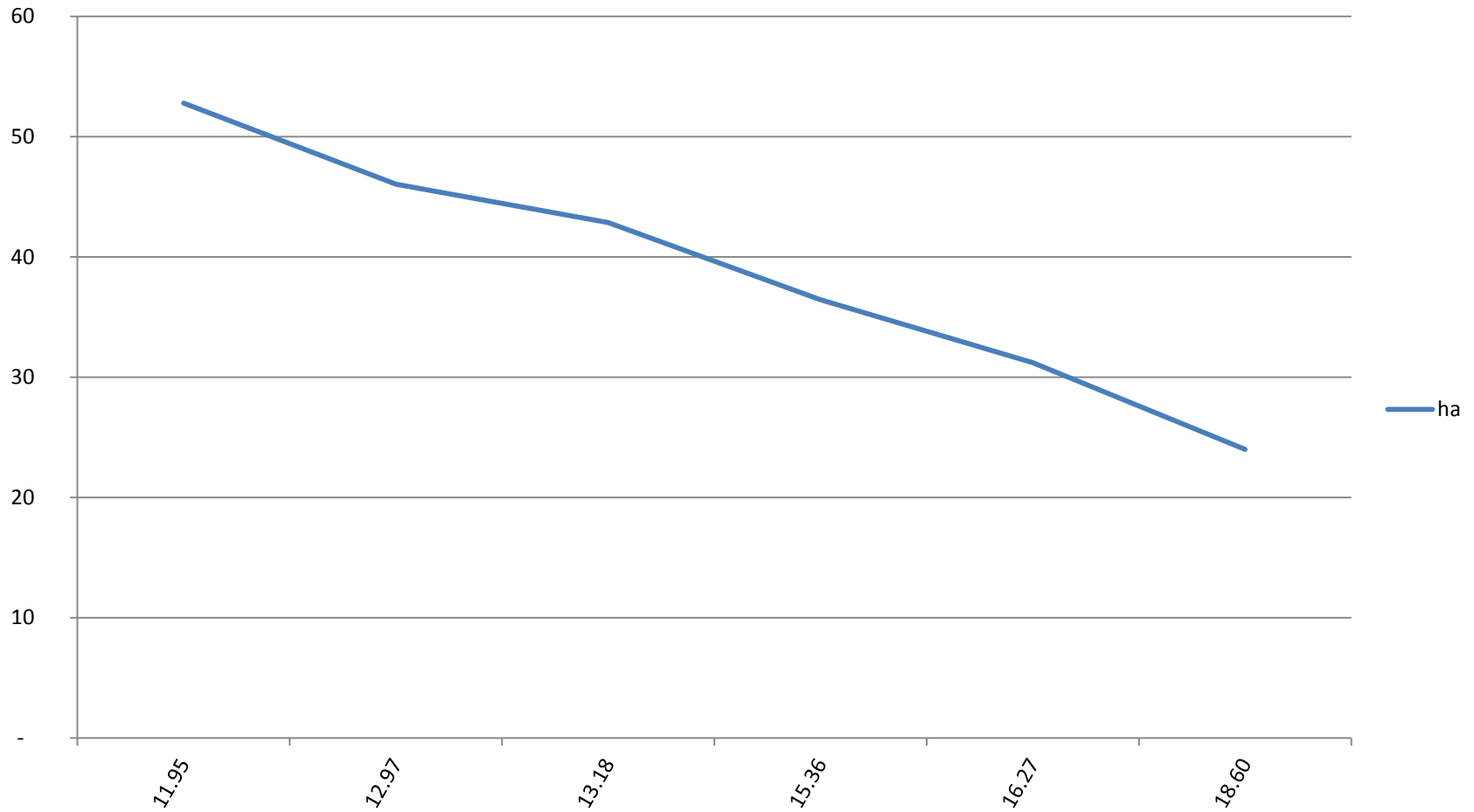
Date Décembre 2015 **Échelle** 1 : 10 000

MANITOU-GOLDEX PROJECT

SURFACE NON-SUBMERGED VS TOTAL DEPOSITION OF TAILINGS



Hectares non-saturés vs M tm de résidus Goldex déposés



MANITOU-GOLDEX PROJECT

EVOLUTION OF TAILINGS DEPOSITION



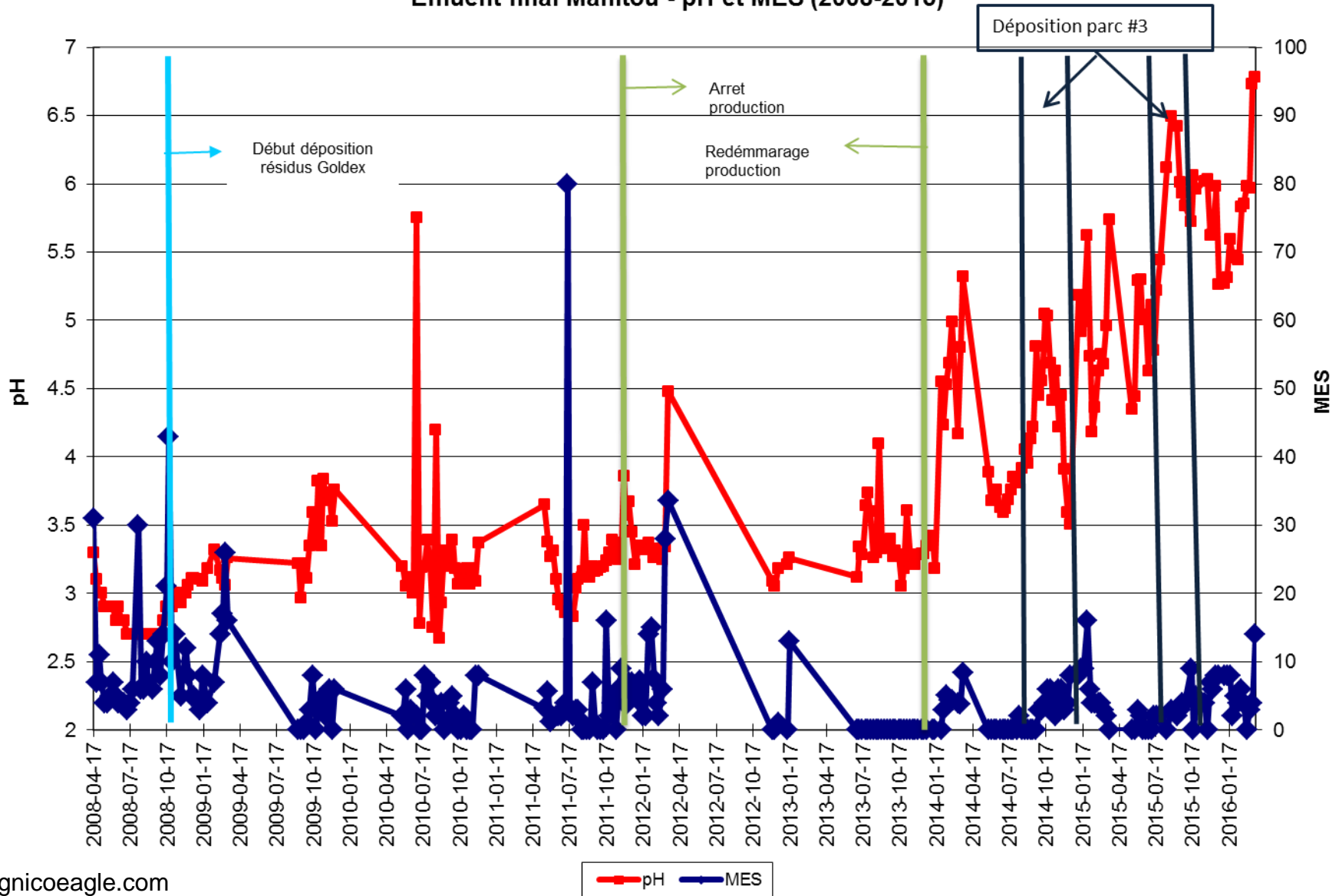
2013

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SIGNS OF IMPROVEMENTS AT THE MANITOU SITE



Effluent final Manitou - pH et MES (2008-2015)

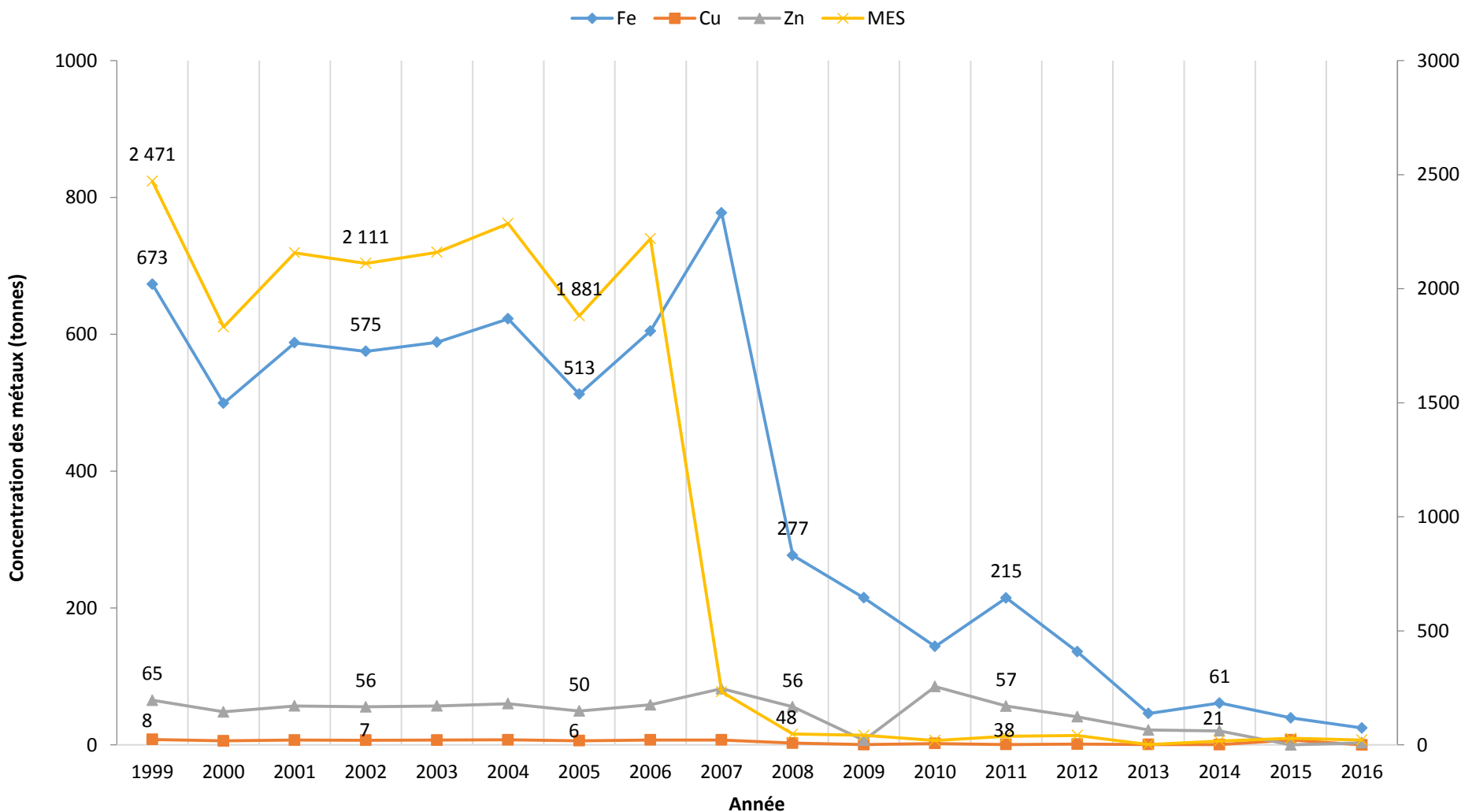


MANITOU-GOLDEX PROJECT

SIGNS OF IMPROVEMENTS AT THE MANITOU SITE



Charge des métaux - Site Manitou -1999-2016

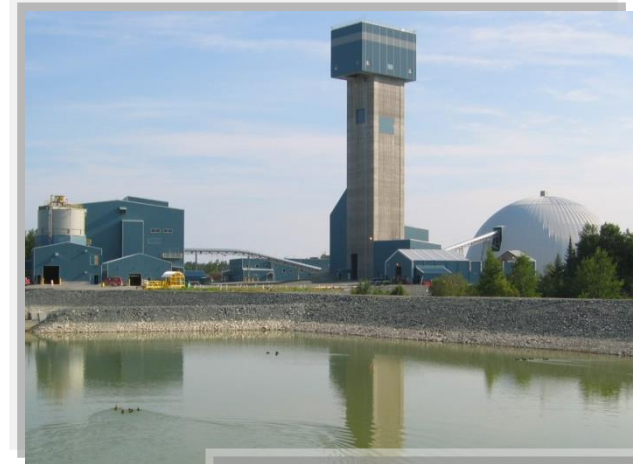


MANITOU-GOLDEX PROJECT

SIGNS OF IMPROVEMENTS AT THE MANITOU SITE



- Decreased flow of low pH effluent
- Upward trend of pH in effluent
- The return of living organisms in the Bourlamaque River
- Nesting in the new wetland of the effluent
- Good results from URSTM investigation follow-up program in park #2
- Modeling and measurements of the water table
- Revegetation testing on-going
- Actual statement – 50% of Manitou surface rehabilitated



Questions???

