CUMBERLAND
RESOURCES LTD.

MEADOWBANK GOLD PROJECT

MINE WASTE & WATER MANAGEMENT

JANUARY 2005

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DESCRIPTION OF SUPPORTING DOCUMENTATION

Cumberland Resources Ltd. (Cumberland) is proposing to develop a mine on the Meadowbank property. The property is located in the Kivalliq region approximately 70 km north of the Hamlet of Baker Lake on Inuit-owned surface lands. Cumberland has been actively exploring the Meadowbank area since 1995. Engineering, environmental baseline studies, and community consultations have paralleled these exploration programs and have been integrated to form the basis of current project design.

The Meadowbank project is subject to the environmental review and related licensing and permitting processes established by Part 5 of the Nunavut Land Claims Agreement. To complete an environmental impact assessment (EIA) for the Meadowbank Gold project, Cumberland followed the steps listed below:

1. Determined the VECs (air quality, noise, water quality, surface water quantity and distribution, permafrost, fish populations, fish habitat, ungulates, predatory mammals, small mammals, raptors, waterbirds, and other breeding birds) and VSECs (employment, training and business opportunities; traditional ways of life; individual and community wellness; infrastructure and social services; and sites of heritage significance) based on discussions with stakeholders, public meetings, traditional knowledge, and the experience of other mines in the north.

2. Conducted baseline studies for each VEC and compared / contrasted the results with the information gained through traditional knowledge studies (see Column 1 on the following page for a list of baseline reports).

3. Used the baseline and traditional knowledge studies to determine the key potential project interactions and impacts for each VEC (see Column 2 for a list of EIA reports).

4. Developed preliminary mitigation strategies for key potential interactions and proposed contingency plans to mitigate unforeseen impacts by applying the precautionary principle (see Column 3 for a list of management plans).

5. Developed long-term monitoring programs to identify residual effects and areas in which mitigation measures are non-compliant and require further refinement. These mitigation and monitoring procedures will be integrated into all stages of project development and will assist in identifying how natural changes in the environment can be distinguished from project-related impacts (monitoring plans are also included in Column 3).

6. Produce and submit an EIS report to NIRB.

As shown on the following page, this report is part of the documentation series that has been produced during this six-stage EIA process**.**

EIA DOCUMENTATION ORGANIZATION CHART

ENVIRONMENTAL IMPACT STATEMENT

Project Description Report
Main Contributor: Cumberland Resources
Reviewer: All Consultants

Project Alternatives
Main Contributor: Lynton Gormley, AMEC Americas
Reviewer: Brad Thiele, Cumberland Resources; Golder Associates Ltd.

Baseline Reports

- **Aquatic Ecosystem**
  Main Contributor: Randy Baker, Azimuth Consulting
  Reviewer: Mike Lawrence, North-South Consulting
- **Fish Habitat**
  Main Contributor: Randy Baker, Azimuth Consulting
  Reviewer: Mike Lawrence, North-South Consulting
- **Terrestrial Ecosystem**
  Main Contributor: Martin Gebauer, Gebauer & Associates
  Reviewer: Ben Hubert , Hubert & Associates
- **Physical Ecosystem**
  Main Contributor: BGC Engineering
  Reviewer: Golder Associates Ltd.
- **Socioeconomic**
  Main Contributor: Robert Hornal
  Reviewer: Susan Ross, Golder Associates Ltd.
- **Archaeology**
  Main Contributor: Deborah Webster
  Reviewer: Gloria Fedirchuk, FMA Heritage Resource Consultants
- **Traditional Knowledge (TK)**
  Main Contributor: Darlene Hughes, IBIS Group, Inc.
  Reviewer: Tom & Hattie Mannik

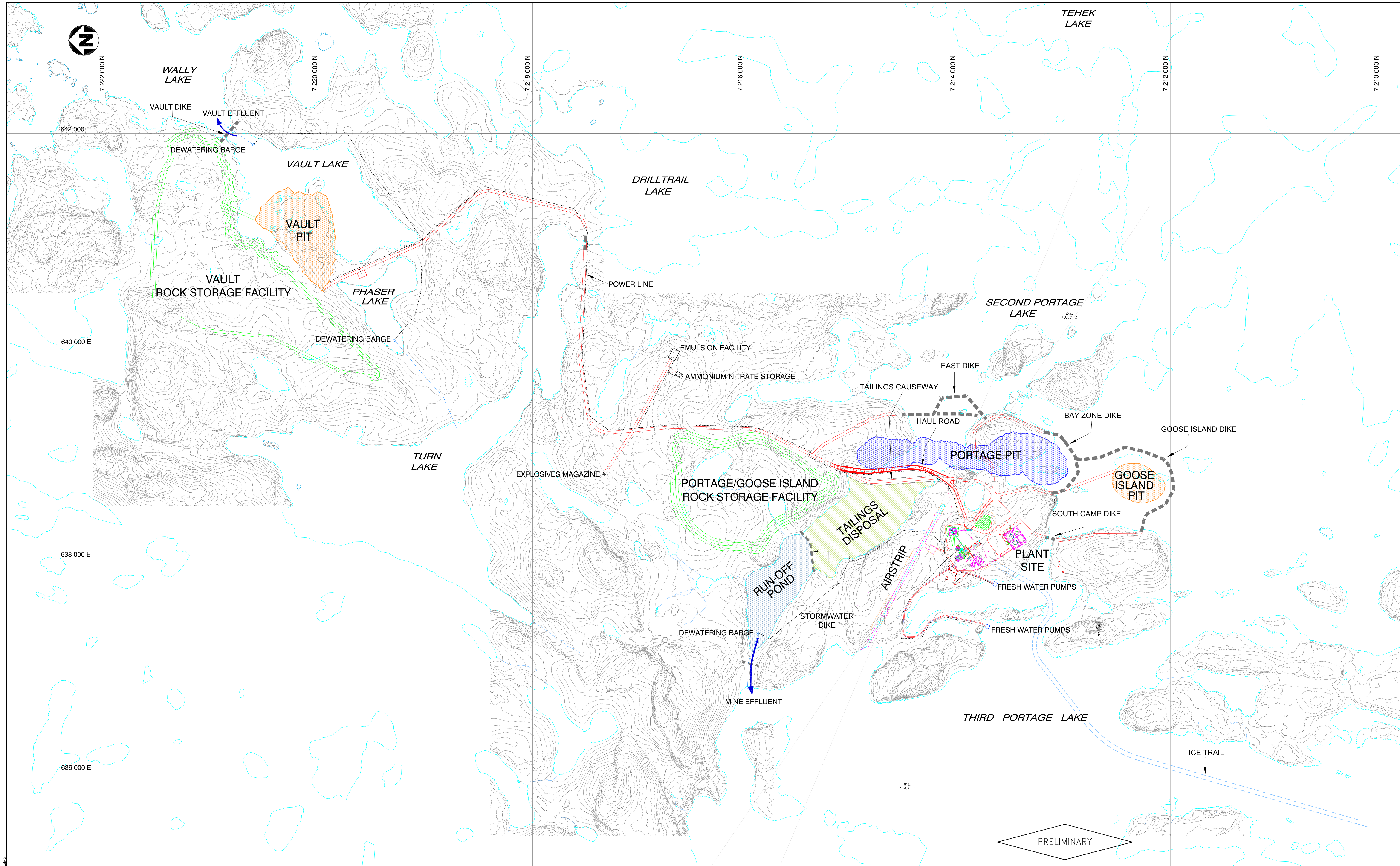
Impact Assessments

- **Aquatic Ecosystem/Fish Habitat**
  Main Contributor: Randy Baker, Azimuth Consulting
  Reviewer: Mike Lawrence, North-South Consulting
- **Cumulative Effects (CEA)**
  Main Contributor: Ly-Shu Ramos, AMEC Americas
  Reviewer: Robert Hornal, Hornal & Associates
- **Terrestrial Ecosystem**
  Main Contributor: Martin Gebauer, Gebauer & Associates
  Reviewer: Ben Hubert, Hubert & Associates
- **Physical Ecosystem**
  Main Contributor: BGC Engineering Ltd.
  Reviewer: Golder, Azimuth, AMEC
- **Socioeconomic & Archaeology**
  Main Contributor: Susan Ross, Golder Associates Ltd.
  Reviewer: George Hegmann, AXYS Environmental Consulting
- **Noise**
  Main Contributor: Richard Palczynski, AMEC Americas
  Reviewer: Bob Humphries, Levelton Engineering
- **Air Quality**
  Main Contributor: Richard Palczynski, AMEC Americas
  Reviewer: Levelton Engineering

Management & Monitoring Plans

- **Aquatic Effects Management Program (AEMP)**
  Main Contributor: Randy Baker, Azimuth Consulting
  Reviewer: Mike Lawrence, North-South Consulting
- **Metal Mining Effluent Regulations (MMER)**
  Main Contributor: Randy Baker, Azimuth Consulting
  Reviewer: Mike Lawrence, North-South Consulting
- **Terrestrial Ecosystem**
  Main Contributor: Martin Gebauer, Gebauer & Associates
  Reviewer: Ben Hubert , Hubert & Associates
- **No-Net-Loss of Habitat (NNL)**
  Main Contributor: Randy Baker, Azimuth
  Reviewer: Mike Lawrence, North-South Consulting
- **Socioeconomic & Archaeology**
  Main Contributor: Susan Ross, Golder Associates Ltd.
  Reviewer: Robert Hornal, Hornal & Associates
- **Mine Waste & Water**
  Main Contributor: Golder Associates Ltd..
  Reviewer: BGC Engineering Ltd.
- **Air Quality & Noise**
  Main Contributor: Richard Palczynski, AMEC Americas
  Reviewer: Bob Humphries, Levelton
- **Access & Air Traffic**
  Main Contributor: Raj Anand, Cumberland Resources
  Reviewer: Alistair Kent, Gartner Lee
- **Reclamation & Closure**
  Main Contributor: Golder Associates Ltd..
  Reviewer: BGC Engineering Ltd.
- **Emergency Response**
  Main Contributor: Darlene Hughes, IBIS Group, Inc.
  Reviewer: Cumberland Resources
- **Hazardous Materials**
  Main Contributor: Darlene Hughes, IBIS Group, Inc.
  Reviewer: Cumberland Resources
- **Spill Contingency**
  Main Contributor: Darlene Hughes, IBIS Group, Inc.
  Reviewer: Cumberland Resources
- **Occupational Health & Safety**
  Main Contributor: Darlene Hughes, IBIS Group, Inc.
  Reviewer: Ted Rutherglen, Cumberland Resources
- **Human Resources**
  Main Contributor: Ted Rutherglen, Cumberland Resources
  Reviewer: Cumberland Resources

PROJECT LOCATION MAP



Proposed Mine Site Layout

CUMBERLAND RESOURCES LTD.

Meadowbank Gold Project

SOURCE: AMEC drawing 100-c000c.dwg

SECTION 1 • INTRODUCTION

Cumberland Resources Ltd. (CRL) is currently evaluating the feasibility of developing the Meadowbank project located approximately 70 km north of Baker Lake in Nunavut.

This report presents the proposed Mine Waste and Water Management Plan for the Meadowbank project in Nunavut. The site is located in an arctic environment and is underlain by continuous permafrost. The proposed mine will generate approximately 160 Mt of mine waste rock and 20 Mt of tailings from the following deposits:

- Vault (intermediate volcanic rocks)
- North Portage (iron formation, intermediate volcanic, and ultramafic rocks)
- Third Portage (iron formation, intermediate volcanic, and ultramafic rocks)
- Goose Island (iron formation, intermediate volcanic, and ultramafic rocks).

The ultramafic rocks are not expected to be acid-generating (non-PAG). Some of the intermediate volcanic rocks from the Vault deposit are potentially acid-generating (PAG). All other waste rock types and the tailings are potentially acid-generating.

Several options for the storage of mine waste rock and tailings were evaluated using decision matrices, and preferred sites were selected. Waste rock from the North Portage, Third Portage, and Goose Island open pits will be stored in an area to the north of Second Portage Arm and to the west of the Vault haul road. The rock storage facility will be capped with a layer of non-PAG rock at closure to constrain the active layer within relatively inert materials. The PAG waste rock below the capping layer will freeze, resulting in low rates of acid rock drainage (ARD) generation in the long term.

Waste rock from the Vault open pit will be stored in an area to the north and west of the Vault open pit. The rock storage facility will be regraded at closure to encourage runoff and to provide a final shape consistent with the surrounding topography. The water seepage from the Vault waste rock storage area is expected to be of suitable quality to allow discharge to the environment without treatment, and capping of this facility is therefore not proposed.

Tailings will be stored in Second Portage Arm, which is currently underlain by a talik that extends through the permafrost to the underlying groundwater. Tailings will be placed as thickened slurry, initially by subaqueous deposition and later subaerially. A reclaim pond will be operated within the tailings impoundment.

A dry cover of non-PAG ultramafic rockfill will be placed over the tailings at closure to confine the active layer within relatively inert materials. Thermal modelling indicates that the tailings will freeze in the long term, and that the talik that currently exists below Second Portage Arm will freeze before seepage from the tailings impoundment reaches the groundwater below the permafrost. Therefore, the potential for groundwater contamination to occur as a result of seepage from the tailings impoundment is considered to be low.

A site water balance model was prepared to identify the water sources and their relative contribution and to evaluate proposed water management infrastructure.

A water management plan is also presented. The plan proposes diversions to avoid the contact of clean runoff water with areas affected by the mine or mining activities. Contact water originating from mine-affected areas will be intercepted, collected, conveyed to central storage facilities, and decanted to treatment, if needed, or to receiving lakes. Portions of the dewatered Vault Lake and Second Portage Arm will serve as the central water attenuation storage facilities.

The design of water management facilities must recognize the potential challenges presented by ice-rich ground, including icing, localized thawing, local ground instabilities, subsidence, and transport of fine-grained soils. The detailed design and maintenance procedures for the diversion infrastructure will take into consideration these challenges. Design features that can be adopted to avoid problems include alignment of channels to take advantage of favourable foundation conditions, oversizing of the drainage structures, the provision of training berms instead of, or in combination with, channels, and lining and insulating of channels to prevent sedimentation and permafrost degradation.

SECTION 2 • BACKGROUND INFORMATION

2.1 PROJECT DESCRIPTION

The Meadowbank project consists of several gold-bearing deposits within reasonably close proximity to one another. The four main deposits are: Vault, North Portage, Third Portage (including Bay Zone and Connector Zone), and Goose Island.

The Vault deposit is located adjacent to Vault Lake, approximately 6 km north from the North Portage deposit. The Third Portage deposit is located on a peninsula, and extends northward under Second Portage Lake, and southward under Third Portage Lake. The North Portage deposit is located on the northern shore of Second Portage Lake. The Third Portage deposit, Bay Zone, Connector Zone, and North Portage deposit will be mined from a single pit, termed the Portage pit, which will extend approximately 2 km in a north-south direction. The Goose Island deposit lies approximately 1 km to the south of the Third Portage deposit, and beneath Third Portage Lake.

Mining will be primarily as a truck-and-shovel open pit operation. A series of dikes will be required to isolate the mining activities from the lakes. It is proposed to construct the dikes using materials produced during mining or by stripping from the footprint of the proposed waste rock storage areas.

2.2 MINING PLAN

The current mining plan indicates that approximately 20 Mt of ore will be mined over a nominal mine life of 10 years. It is possible that some mining may occur into the eleventh year. The operation will generate approximately 160 Mt of mine waste rock and 20 Mt of tailings.

The mining plan has been used to prepare a materials balance, as shown in Table 2.1. This balance indicates the distribution of the following categories of materials by rock type:

- mine rock for general construction
- mine rock for dike construction
- mine rock for capping
- mine rock to waste rock storage areas
- tailings.

Table 2-1
Meadowbank Mined Tonnages and Volumes

ANNUAL ORE PRODUCTION		Assumptions		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
				-2	-1	1	2	3	4	5	6	7	8	9	10	11	
Mined Ore Open Pit	t			-	-	2,007,500	2,007,500	2,007,500	2,007,500	2,007,500	2,007,500	2,007,500	2,007,500	2,007,500	1,589,510	110,869	19,767,882
Grade	g/t			-	-	5.13	4.22	3.93	4.07	4.43	3.84	4.02	3.49	4.04	6.36	6.36	
				-	-	10,296,021	8,470,421	7,888,536	8,168,271	8,896,943	7,701,537	8,065,482	7,014,261	8,109,695	10,107,561	705,006	85,423,735
Recovery	%			-	-	95%	95%	95%	94%	94%	94%	94%	93%	92%	92%	92%	
Tailings Production, tonnes	t			-	-	2,007,490	2,007,492	2,007,493	2,007,493	2,007,492	2,007,493	2,007,493	2,007,494	2,007,493	1,589,501	110,868	19,767,802
Tailings Production, m3	m3	1.45	t/m3	-	-	1,384,476	1,384,477	1,384,478	1,384,478	1,384,477	1,384,478	1,384,478	1,384,478	1,384,478	1,096,207	76,461	13,632,967
ANNUAL WASTE PRODUCTION																	
Portage Pit																	
Overburden	t			-	915,145	1,181,899	344,052	1,415,052	858,362	-	1,028,930	151,364	-	-	-	-	5,894,804
UM (Ultramafic)	t			-	161,424	870,165	2,047,706	2,606,760	4,030,192	2,756,831	2,869,373	4,230,059	2,320,748	2,422,948	680,212	53,835	25,050,256
IF (Iron Formation)	t			-	1,350,376	3,505,432	3,766,198	4,674,081	3,716,710	3,329,997	2,872,252	2,808,018	1,860,802	1,610,966	905,506	312,928	30,713,265
IV (Intermediate Volcanic)	t			-	1,749,376	3,096,487	3,468,825	3,693,520	3,131,945	2,601,659	2,692,840	1,744,856	608,850	426,829	127,400	45,150	23,387,736
QZ (Quartzite)	t			-	1,013	138,407	161,194	541,603	125,157	186,388	16,364	-	-	-	-	-	1,170,126
Total	t			-	4,177,333	8,792,390	9,787,975	12,931,016	11,862,366	8,874,875	9,479,759	8,934,298	4,790,400	4,460,743	1,713,119	411,913	86,216,187
Goose Island Pit																	
Overburden	t			-	-	-	-	-	-	-	1,028,930	151,364	-	-	-	-	1,180,294
UM (Ultramafic)	t			-	-	-	-	-	-	-	494,268	2,632,476	3,196,324	2,391,415	812,413	-	9,526,897
IF (Iron Formation)	t			-	-	-	-	-	-	-	354,271	466,229	453,435	626,081	663,942	-	2,563,958
IV (Intermediate Volcanic)	t			-	-	-	-	-	-	-	572,477	943,310	1,068,105	815,196	232,219	-	3,631,307
QZ (Quartzite)	t			-	-	-	-	-	-	-	133,913	484,366	143,185	-	-	-	761,463
Total	t			-	-	-	-	-	-	-	2,583,859	4,677,745	4,861,049	3,832,692	1,708,575	-	17,663,920
Vault Pit																	
Overburden	t			-	-	205,000	95,300	95,300	95,300	-	-	-	-	-	-	-	490,900
UM (Ultramafic)	t			-	-	-	-	-	-	-	-	-	-	-	-	-	-
IF (Iron Formation)	t			-	-	-	-	-	-	-	-	-	-	-	-	-	-
IV (Intermediate Volcanic)	t			-	-	5,870,425	6,719,315	3,547,203	4,815,741	7,336,539	6,864,792	4,495,692	6,765,350	4,826,036	2,298,941		53,540,034
QZ (Quartzite)	t			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	t			-	-	6,075,425	6,814,615	3,642,503	4,911,041	7,336,539	6,864,792	4,495,692	6,765,350	4,826,036	2,298,941	-	54,030,934
All Pits																	
Overburden	t			-	915,145	1,386,899	439,352	1,510,352	953,662	-	2,057,860	302,728	-	-	-	-	7,565,999
UM (Ultramafic)	t			-	161,424	870,165	2,047,706	2,606,760	4,030,192	2,756,831	3,363,641	6,862,535	5,517,072	4,814,364	1,492,626	53,835	34,577,153
IF (Iron Formation)	t			-	1,350,376	3,505,432	3,766,198	4,674,081	3,716,710	3,329,997	3,226,523	3,274,247	2,314,237	2,237,047	1,569,448	312,928	33,277,223
IV (Intermediate Volcanic)	t			-	1,749,376	8,966,911	10,188,140	7,240,723	7,947,686	9,938,197	10,130,110	7,183,858	8,442,305	6,068,060	2,658,560	45,150	80,559,077
QZ (Quartzite)	t			-	1,013	138,407	161,194	541,603	125,157	186,388	150,277	484,366	143,185	-	-	-	1,931,590
Total	t			-	4,177,333	14,867,815	16,602,591	16,573,519	16,773,407	16,211,414	18,928,411	18,107,735	16,416,799	13,119,471	5,720,635	411,913	157,911,041
ANNUAL MATERIAL REQUIREMENTS FROM PORTAGE PIT																	
Portage and Goose Pits																	
Site Construction																	
Overburden	m3	1.70	t/m3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ultramafic and Quartzite	m3	1.90	t/m3	-	89,380	41,152	-	-	-	29,483	-	-	-	-	-	-	160,015
IF (Iron Formation)	m3	1.90	t/m3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IV (Intermediate Volcanic)	m3	1.90	t/m3	-	178,177	123,456	-	-	-	-	-	-	-	-	-	-	301,632
Total	m3			-	267,557	164,607	-	-	-	29,483	-	-	-	-	-	-	461,648
Dike Construction																	
Overburden	m3	1.70	t/m3	-	311,000	-	-	64,600	-	272,000	-	-	-	-	-	-	647,600
Ultramafic and Quartzite	m3	1.90	t/m3	-	-	27,795	-	14,200	-	21,382	-	-	-	-	-	-	63,377
IF (Iron Formation)	m3	1.90	t/m3	-	436,000	-	-	165,000	-	426,000	-	-	-	-	-	-	1,027,000
IV (Intermediate Volcanic)	m3	1.90	t/m3	-	436,000	12,380	-	174,100	-	426,000	-	-	-	-	-	-	1,048,480
Total	m3			-	1,183,000	40,175	-	417,900	-	1,145,382	-	-	-	-	-	-	2,786,457
Capping Requirements																	
UM+QZ (Progressive Reclaim)	m3	1.90	t/m3	-	-	-	-	-	-	900,000	900,000	900,000	900,000	900,000	900,000	900,000	6,300,000
ANNUAL MATERIAL DISPOSAL TO PORTAGE ROCK STORAGE FACILITY																	
Portage Rock Disposal Facility																	
Overburden	m3	1.70	t/m3	-	227,320	695,235	202,384	767,783	504,919	(272,000)	1,210,506	178,076	-	-	-	-	3,514,223
Overburden Cumulative Total	m3	1.70	t/m3	-	227,320	922,555	1,124,939	1,892,722	2,397,641	2,125,641	3,336,147	3,514,223	3,514,223	3,514,223	3,514,223	3,514,223	3,514,223
Ultramafic and Quartzite	m3	1.90	t/m3	-	(3,887)	461,881	1,162,579	1,642,833	2,187,026	598,198	949,431	2,966,790	2,079,083	1,633,876	(114,407)	(871,666)	12,691,736
UM+QZ Cumulative	m3	1.90	t/m3	-	(3,887)	457,993	1,620,573	3,263,406	5,450,432	6,048,630	6,998,061	9,964,851	12,043,933	13,677,809	13,563,401	12,691,736	12,691,736
IF (Iron Formation)	m3	1.90	t/m3	-	274,724	1,844,964	1,982,209	2,295,043	1,956,163	1,326,630	1,698,170	1,723,288	1,218,019	1,177,393	826,025	164,699	16,487,328
IV (Intermediate Volcanic)	m3	1.90	t/m3	-	306,547	1,493,894	1,825,697	1,769,858	1,648,392	943,294	1,718,588	1,414,824	882,608	653,697	189,273	23,763	12,870,437
Total	m3				804,704	4,495,974	5,172,869	6,475,517	6,296,500	2,596,122	5,576,695	6,282,978	4,179,710	3,464,966	900,891	(683,204)	45,563,723
ANNUAL MATERIAL REQUIREMENTS FROM VAULT PIT																	
Vault Pit																	
Roads and Dikes																	
Overburden	m3	1.70	t/m3	-	-	6,600	-	-	-	-	-	-	-	-	-	-	6,600
UM and QZ (Road Surfacing)	m3	1.90	t/m3	-	-	41,152	-	-	-	-	-	-	-	-	-	-	41,152
IF (Iron Formation)	m3	1.90	t/m3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IV (Includes Vault Haul Road)	m3	1.90	t/m3	-	-	135,836	-	-	-	-	-	-	-	-	-	-	135,836
Total	m3			-	-	183,587	-	-	-	-	-	-	-	-	-	-	183,587
ANNUAL MATERIAL DISPOSAL TO VAULT ROCK STORAGE FACILITY																	
Overburden Annual	m3	1.70	t/m3	-	-	113,988	56,059	56,059	56,059	-	-	-	-	-	-	-	282,165
IV	m3	1.90	t/m3	-	-	2,953,862	3,536,482	1,866,949	2,534,600	3,861,336	3,613,048	2,366,153	3,560,710	2,540,019	1,209,969	-	28,043,130
Total	m3			-	-	3,067,850	3,592,541	1,923,008	2,590,659	3,861,336	3,613,048	2,366,153	3,560,710	2,540,019	1,209,969	-	28,325,294

Material balance is based on current mine schedule and will likely change as project advances and mine plan is optimized.
Assumptions have been made relating to timing of overburden stripping to meet demands of project.
Mine life is nominally 10 years. Some mining is shown in Year 11 but will only be for a portion of the year.
C:\EIS\WasteManagement\[Table 2-1 Material Balance.xls]Dike and Construction Schedule

SECTION 3 • GEOCHEMISTRY

The relative potentials of the rock types to generate acid mine drainage (ARD) or metal leaching (ML) under neutral drainage conditions and the implications for potential use as construction rock are presented in Table 3.1.

Table 3.1: Summary of Geochemistry Considerations

Open Pit	Material Type	Potential for ARD	Potential for ML	Restrictions for Storage or use in Construction
All Pits	Overburden	None	Low	None
	Tailings	High	High	Requires measures to control ARD
Portage & Goose	Ultramafic & Mafic Volcanic	None	Low	May require collection and treatment of drainage
	Intermediate Volcanics	Variable (none to moderate)	Moderate	Requires measures to control ARD
	Iron Formation	High	High	Requires measures to control ARD
	Quartzite	High	Low	Co-disposal with ultramafic/mafic volcanic or cap/water cover
Vault	Intermediate Volcanics	Low	Variable (low to moderate)	May require collection and treatment of drainage

SECTION 4 • MINE WASTE ROCK STORAGE

Mine rock that is not used for construction will be trucked to mine waste rock storage areas. Waste rock from the North Portage, Third Portage, and Goose Island open pits will be stored in a storage facility located near to these pits (Portage rock storage facility). Waste rock from the Vault open pit will be stored in a separate storage facility adjacent to the Vault open pit (Vault rock storage facility). The quantities of waste rock to be excavated are summarized in Table 4.1.

Table 4.1: Quantities of Waste Rock Types

Rock Storage Facility	Rock Type	Quantity
Portage	Ultramafic and Mafic Volcanic	35 Mt
	Intermediate Volcanics	27 Mt
	Iron Formation	33 Mt
	Quartzite	2 Mt
Vault	Intermediate Volcanics	54 Mt

Source: AMEC, 2003b.

4.1 WASTE ROCK PROPERTIES

Some geotechnical properties of the major waste rock types, based on laboratory tests, are summarized in Table 4.2.

Table 4.2: Waste Rock Geotechnical Properties

Rock Type	Specific Gravity (t/m^3)	Unconfined Compressive Strength (MPa)	ISRM Grade	ISRM Description
Intermediate Volcanic (Portage)	2.89	51 to 148 (Avg. 94)	R3 to R4	Medium to Strong
Intermediate Volcanic (Vault)	2.75			
Iron Formation	3.44	137 to 248 (Avg. 175)	R4 to R5	Strong to Very Strong
Quartzite	2.70	70 to 140 (Avg. 107)	R4	Strong
Ultramafic	2.91	40 to 92 (Avg. 66)	R2 to R4	Weak to Strong
Ultramafic (serpentinized)		Avg. 32		

4.2 PORTAGE ROCK STORAGE FACILITY

4.2.1 Site Selection Criteria

The following site selection criteria were used for the Portage rock storage facility:

- minimize potential long-term environmental impacts (including ARD generation, metal leaching, and seepage to the underlying groundwater regime)
- maximize ease of water management during operation
- maximize ease of decommissioning/closure
- minimize impact on catchment area
- minimize visual impact
- minimize areas of lakes affected
- minimize footprint area (to reduce the volume of affected runoff)
- minimize the potential for geotechnical hazards (including slope instability and response to seismic activity)
- minimize haul costs.

4.2.2 Options Considered

Four potential rock storage areas on the north side of Second Portage Lake were considered, as summarized in Table 4.3 and shown on Figure 4.1 (overleaf). The options were evaluated using a decision matrix. The key categories used to evaluate the options were based on environmental, operational, and cost considerations. Within each category, the individual sub-indicators were assigned weight values based on subjective estimates of relative importance, so that the sum of the weights would contribute to the overall option weightings, according to the values shown in Table 4.4.

Table 4.3: Summary of Portage Rock Storage Facility Options

Option	Description
A	North from Second Portage Lake – small footprint
B	North-west from Second Portage Lake – large footprint
C	East from Vault Haul Road – small footprint
D	East from Vault Haul Road – large footprint

Table 4.4: Weighting Factors used in Decision Matrix

Factor	Contribution to Overall Weighting
Environmental	50%
Operational	30%
Cost	20%

Source: Golder Associates.

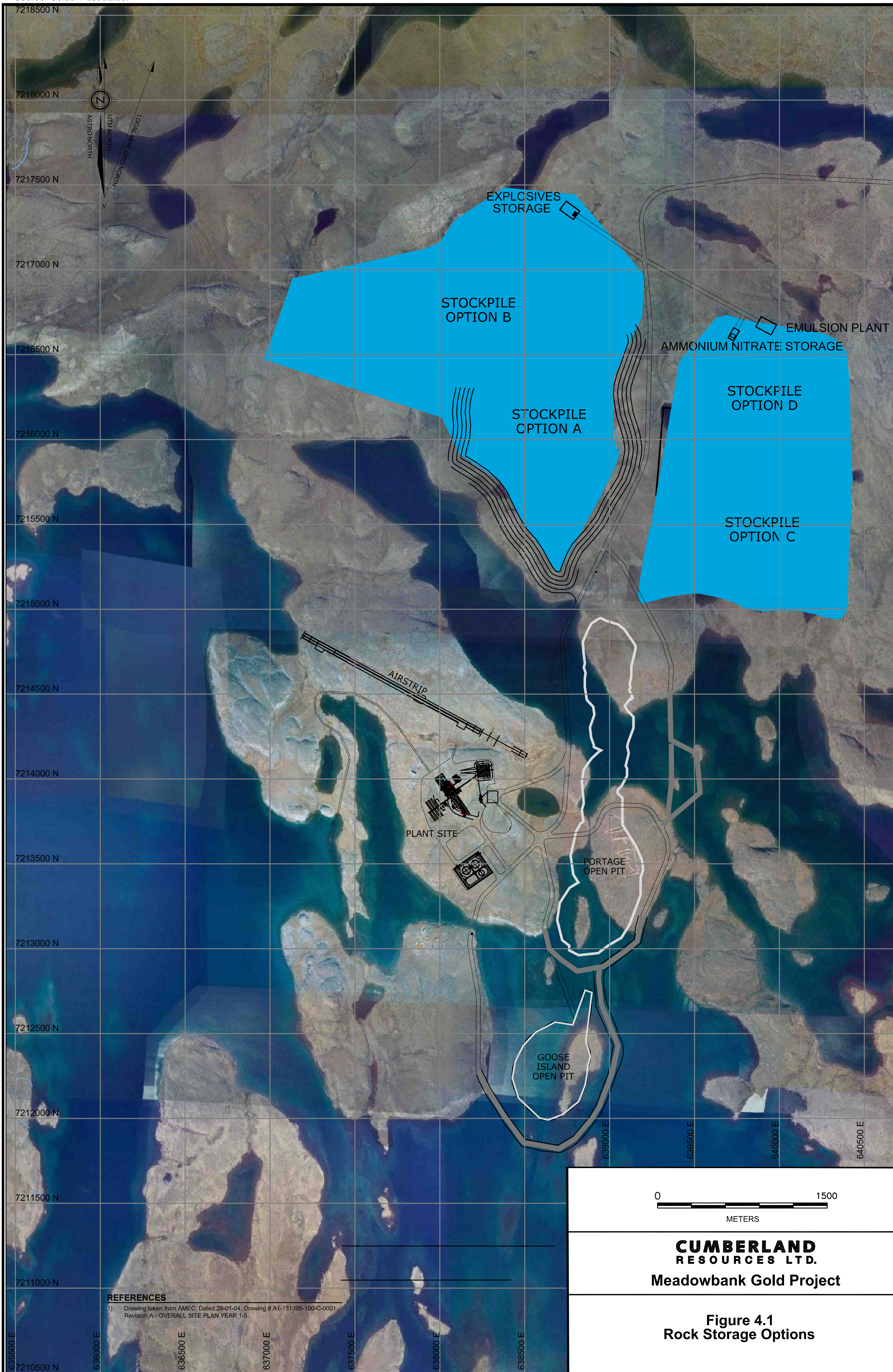


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Figure 4.1
Rock Storage Options

The options were then allocated a score for each of the criteria using a scale of 1 to 9 to show the relative difference between options, with 9 indicating the best option and 1 indicating the worst (Robertson and Shaw, 1999). An example of the scoring method is shown in Table 4.5.

Table 4.5: Example of Scoring System used in Decision Matrix

	Footprint Area	Points	Notes
Option A	30 ha	9	9 points awarded for least footprint area (BEST)
		8	-
		7	-
		6	-
Option C	60 ha	5	9 points x 30 ha (least area) / 60 ha = 5 points
		4	-
Option B	90 ha	3	9 points x 30 ha (least area) / 90 ha = 3 points
		2	-
		1	-

The individual sub-indicator weighting values were then multiplied by the score to arrive at a weighted score. The weighted scores for each category were then summed to arrive at a total weighted score for each option.

The weighted scores for the various options are summarized in Table 4.6 below. The decision matrix is presented as Table 4.7 on the following page.

Table 4.6: Summary of Weighted Scores for Rock Storage Facility Options

Option	Description	Weighted Score
A	North from Second Portage Lake – small footprint	560
B	Northwest from Portage Lake – large footprint	459
C	East from Vault Haul Road – small footprint	436
D	East from Vault Haul Road – large footprint	355

Note: The highest score indicates the most desirable option.

4.2.3 Selected Option

Option A was selected as the preferred rock storage facility, based on the decision matrix.

It is expected that dumping of waste rock would commence closest to the Portage open pit and proceed westward during development of the mine. The preparation of a detailed dump plan is outside the scope of this study; however, it is expected that the storage area may be filled to the full footprint area over the first half of the mine life, and then raised to full height in the latter part of the mine life.

Table 4.7: Decision Matrix for Potential Waste Rock Storage Areas

Insert

4.3 VAULT WASTE ROCK STORAGE FACILITY

The presence of numerous lakes adjacent to Vault Lake limits the number of potential rock storage areas. In addition, the lack of topographical relief in the immediate area limits the height to which a rock storage facility should be constructed without becoming visible from large distances. Further, it was recognized that placing waste rock in the areas to the south of Vault Lake would affect a sub-watershed that did not drain towards the Vault open pit.

The area to the north and west of the Vault open pits was therefore selected for the waste rock storage area.

4.4 SUMMARY OF WASTE ROCK STORAGE FACILITIES

Some details of the proposed rock storage facilities are summarized in Table 4.8.

Table 4.8: Details of Proposed Rock Storage Areas

Descriptors	Portage Rock Storage Facility	Vault Rock Storage Facility
Approximate storage volume	60 Mm^3	35 Mm^3
Approximate crest elevation	205 m	176 m
Approximate height	60 m	30 m
Maximum elevation of adjacent topography	192 m	190 m
Approximate footprint area	134 ha	191 ha
Approximate surface area	140 ha	195 ha

SECTION 5 • TAILINGS

5.1 INPUT DATA

Properties of the tailings relevant to the design of a tailings storage facility are presented in Table 5.1.

Table 5.1: Relevant Data for Tailings Storage Facility

Property	Value
Mine design life	10 years
Mill production (solids)	5,500 t/d
Ore processed	19.8 Mt
Goose pit (S.G. = 3.15)	2 Mt
Vault pit (S.G. = 3.15)	8 Mt
Portage pits (S.G. = 2.93)	10 Mt
Average specific gravity of ore	2.9 t/m^3
Assumed settled void ratio (unfrozen)	1.0
Assumed settled dry density (unfrozen)	1.45 t/ m^3
Assumed settled moisture content (by weight)	34%
Volume of settled tailings (no ice entrapment)	12 to 14 Mm^3

5.2 THERMAL MODELLING

Freezing of the tailings will have a significant impact on the long-term performance of the proposed tailings impoundment. Simplified thermal modeling of a proposed tailings deposit in the Second Portage Lake was carried out to predict the range of time required to freeze the tailings and into the underlying talik. The results of the modelling are summarized in the following sections.

5.2.1 Assumptions

Site climate data were considered with various snow packs to represent ground covers of snow, soil, and vegetation to estimate the range of surface temperature functions on the bedrock profile. Ground temperatures were estimated using each of the surface temperature functions and compared to site thermistor data for calibration.

Thermal properties for the bedrock and tailings materials were estimated from published correlations for the range of expected geotechnical conditions. In addition, the following assumptions were used in the modelling:

- Only bedrock was considered in the subsurface profile.
- A constant temperature boundary of 4°C was used at the bottom of the lake.

- All the tailings were assumed to be placed instantaneously.
- Tailings were deposited at either 6°C (unfrozen) or -0.2°C (frozen), to bind the expected deposition sequence.

5.2.2 Impact of Climate Change

To investigate the potential effect of climate change, one case with an increasing surface temperature has been considered; climate change at this site could result in a temperature rise of as much as 5.5°C in the next century. For this simplified model the effect of climate change is considered by uniformly incrementing the annual average temperature function by 5.5°C over the first 100 years in the model and then maintaining the increased mean monthly temperatures for the next 200 years.

5.2.3 Results of Modelling

After establishing the existing ground temperature conditions in the model, the tailings deposit was modelled by instantaneous replacement of the lake with either unfrozen or frozen tailings. The thermal models were run between 100 and 300 years to predict ground temperature profiles beneath the tailings impoundment.

The results indicate that complete freezing of the tailings and bedrock beneath the lake will occur with time. For tailings not frozen during deposition, the time to begin freezing the talik beneath the lake could be as long as 200 years if climate change is not considered and 270 years if climate change is considered.

If the tailings are frozen during deposition, the time to freeze 5 m into the talik is between 1 and 45 years, depending on location within the lake. When climate change is considered, this time is increased to 50 years.

5.3 SITE SELECTION CRITERIA FOR TAILINGS STORAGE FACILITY

The following site selection criteria were used for the tailings storage facility:

- The facility must have sufficient volume to store the planned volume of tailings over the mine life.
- The facility must have the potential to store some increased volume of tailings.
- The facility location must accommodate the potential for future mine expansion.
- The facility must be within a catchment draining toward the open pits.
- The facility must allow collection and control of supernatant.

5.4 OPTIONS CONSIDERED

Seven potential tailings storage options were considered, as shown on Figure 5.1. These are summarized in Table 5.2.

Source: Golder Associates

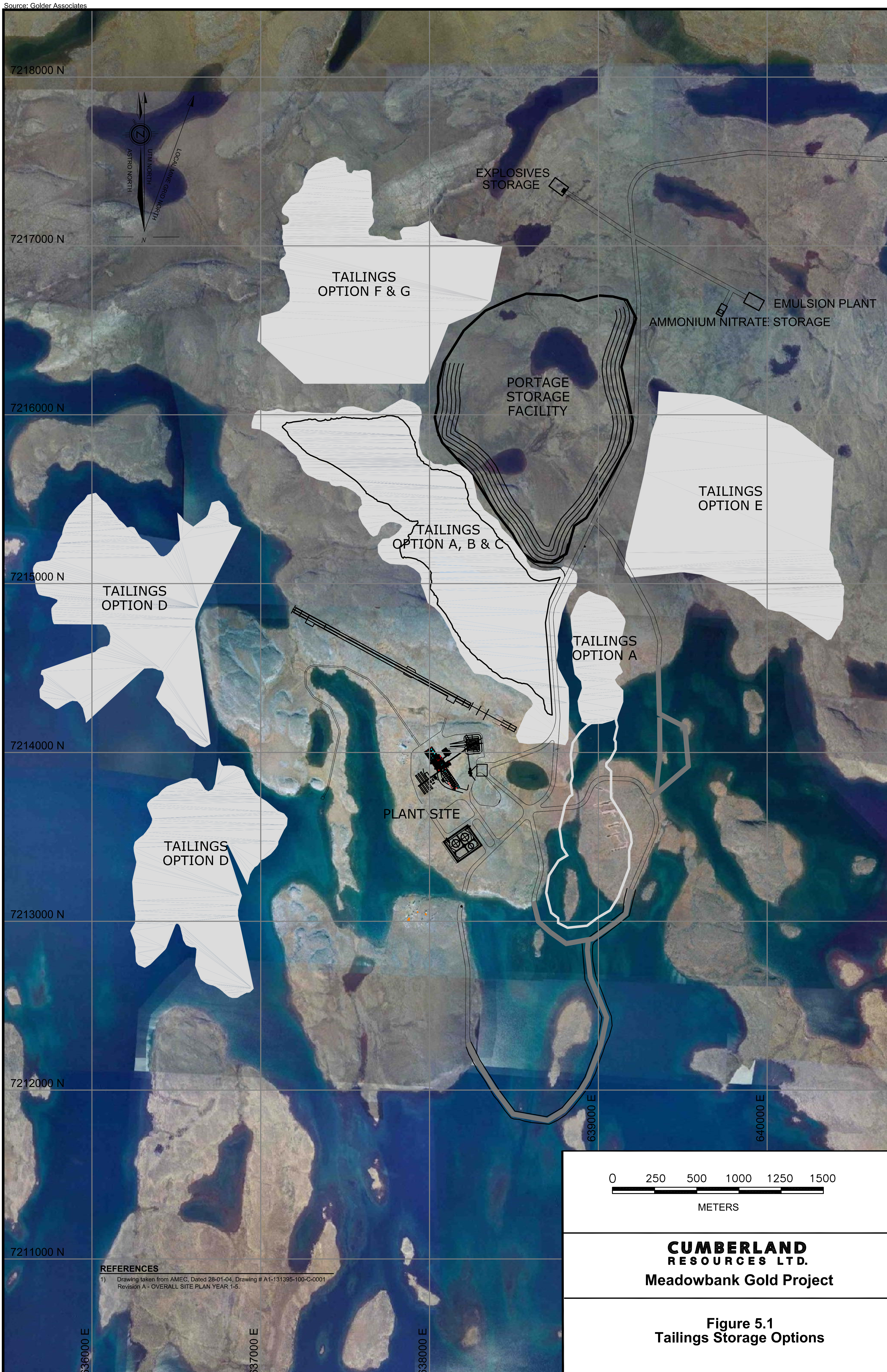

Figure 5.1
Tailings Storage Options

Table 5.2: Summary of Tailings Storage Facility Options

Option	Location	Disposal Type
A	Second Portage Arm and North Portage Pit	Subaqueous slurry
B	Second Portage Arm	Subaerial paste or drystack
C	Second Portage Arm	Subaerial slurry
D	Third Portage Lake	Subaqueous slurry
E	East from Vault Haul Road	Subaerial slurry
F	North of Second Portage Arm	Subaerial slurry
G	North of Second Portage Arm	Subaerial paste or drystack

The options were evaluated using a decision matrix. The key categories that were used to evaluate the options were based on environmental, operational, and cost considerations. Within each category, the individual sub-indicators were assigned weight values based on subjective estimates of relative importance, so that the sum of the weights would contribute to the overall option weightings according to the following Table 5.3.

Table 5.3: Weighting Factors Used in Decision Matrix

Factor	Contribution to Overall Weighting
Environmental	50%
Operational	30%
Cost	20%

The options were then allocated a score for each of the criteria using a scale of 1 to 9 to show the relative difference between options, with 9 indicating the best option and 1 indicating the worst (Robertson and Shaw, 1999). An example of the scoring method is shown in Table 5.4.

Table 5.4: Example of Scoring System used in Decision Matrix

Option	Distance to Mill	Points	Notes
A	1 km	9	9 points awarded for least distance to mill (BEST)
	-	8	-
	-	7	-
	-	6	-
C	2 km	5	9 points x 1 km (least distance) / 2 km = 5 points
	-	4	-
B	3 km	3	9 points x 1 km (least distance) / 3 km = 3 points
	-	2	-
	-	1	-

The individual sub-indicator weighting values were then multiplied by the score to arrive at a weighted score. The weighted scores for each category were then summed to arrive at a total weighted score for each option.

The weighted scores for the remaining four options are summarized in Table 5.5 below. As shown in the decision matrix on Table 5.6, Options A, D, and E were eliminated for not achieving all of the key selection criteria.

Table 5.5: Summary of Weighted Scores for Tailings Facility

Option	Summary	Environmental Factors	Operational Factors	Cost	Weighted Total
B	Subaerial paste tailings in Second Portage Arm	468	263	63	794
C	Subaqueous/subaerial slurry tailings in Second Portage Arm	477	216	234	927
F	Subaerial slurry tailings to the west of waste rock storage area	361	160	115	636
G	Subaerial paste tailings to the west of waste rock storage area	417	256	59	732

Note: The highest score indicates the most desirable option for a given factor.

5.5 SELECTED OPTION

Option C (slurry disposal in Second Portage Arm) was selected as the preferred option based on the decision matrix. Option C presents the following main advantages:

- reduced potential for ARD/ML generation
- ease of operation in the harsh arctic climate
- lowest relative capital cost.

The Second Portage Arm contains two natural basins: the main basin and the northwest basin. The main basin is situated at the deepest part of the lake, adjacent and to the west of the proposed tailings dike. The northwest basin is located at the northwest end of the Arm, and is separated from the main basin by an east-west trending ridge that rises to within about 2 to 4 m of the lake surface.

The tailings impoundment would be developed in the stages shown in Table 5.7.

TABLE 5.6: TAILINGS STORAGE OPTIONS DECISION MATRIX

Key Indicators	Sub-Indicators	Weighting, W_{IND}	Option A	Option B	Option C	Option D	Option E	Option F	Option G	B	C	F	G
			TAILINGS STORAGE OPTIONS (Portage, Goose and Vault Pits)							**SCORE, S_{IND} (1=worst 9=best)**			
			2nd Portage Arm and North Portage Pit	Second Portage Arm	Second Portage Arm	Third Portage Lake	East of Second Portage Arm	North of Second Portage Arm	North of Second Portage Arm				
			Subaqueous slurry	Subaerial Paste or Dry Stack	Subaerial Slurry	Subaerial Slurry	Subaerial Slurry	Subaerial Slurry	Subaerial Paste or Dry Stack				
			Construction – Dewater Second Portage Arm by 28 m (El. 105m ASL) to allow construction of dike.	**Construction** - Dewater Second Portage Arm by 38 m (El. 95m ASL) and allow base to freeze. Build water management pond near mill.	**Construction** - Dewater Second Portage Arm by 28 m (El. 105m ASL) to allow construction of dike.	**Construction** – Place silt curtain to control sediment dispersion or other sediment control and install pipeline.	**Construction** – build conventional tailings containment berms on frozen ground; install and maintain pipeline.	**Construction** – build conventional tailings containment berms on frozen ground; install and maintain pipeline.	**Construction** – build minor containment berms on frozen ground; install and maintain pipeline.				
			Operation - Place tailings in Second Portage Arm until Year 6, then North Portage Pit. Use water above tailings for reclaim.	**Operation** - Place thickened/paste tailings to 4 m above current lake level such that tailings freeze each year.	**Operation** - Place slurry to 4 m above current lake level. Maintain water management pond at west end of lake.	**Operation** – deposit tailings into 3rd Portage Lake. Reclaim from Second Portage Arm (water mangement pond) and 3rd Portage Lake.	**Operation** - Place tailings slurry on surface. Use Second Portage Arm for water management, plus reclaim from tailings area. Allow tailings to freeze each year.	**Operation** - Place tailings slurry on surface. Use Second Portage Arm for water management, plus reclaim from tailings area. Allow tailings to freeze each year.	**Operation** - Place tailings slurry on surface. Use Second Portage Arm for water management. Allow tailings to freeze each year.				
Key Indicators	**Sub-Indicators**	**Weighting, W_{IND}**	**Closure** – Tailings remain submerged. Long term metal leaching will occur.	**Closure** – Place ultramafic capping layer to maintain tailings frozen below active layer.	**Closure** – Place ultramafic capping layer to maintain tailings frozen below active layer.	**Closure** – Tailings remain submerged. Long term metal leaching will occur.	**Closure** – Place ultramafic capping layer to maintain tailings frozen below active layer.	**Closure** – Place ultramafic capping layer to maintain tailings frozen below active layer.	**Closure** – Place ultramafic capping layer to maintain tailings frozen below active layer.				
Site Selection Criteria	Sufficient volume to store planned volume of tailings		Yes	Yes	Yes	Yes	Yes	Yes	Yes				
	Potential for increased capacity		No	Yes	Yes	Yes	Yes	Yes	Yes				
	Location enables mine expansion		No	Yes	Yes	Yes	Yes	Yes	Yes				
	Impoundment is within catchment of open pits		Yes	Yes	Yes	No	No	Yes	Yes				
	Allows control/collection of supernatent		Yes	Yes	Yes	No	Yes	Yes	Yes				
	Potential candidate for tailings storage facility		**No**	**Yes**	**Yes**	**No**	**No**	**Yes**	**Yes**				
Key Details	Dike construction volumes required (m^3)			1,140,000	1,140,000			1,250,000	250,000				
	Capping volume, assuming 2 m thickness (m3)			2,600,000	2,600,000			2,280,000	2,280,000				
	Length of tailings pipeline (m)			2,600	2,800			4,100	4,100				
	Length of reclaim pipeline (m)			800	2,800			1,200	1,000				
	Location of water pond			Near mill	2nd Portage Arm & later near mill			2nd Portage Arm and tailings	2nd Portage Arm				
Environmental Factors (50% of Weighted Total)	Sub-catchment area (ha)	1		281	281			206	206	7	7	9	9
	Footprint area (ha)	1		130	130			114	114	8	8	9	9
	Potential for dust generation during operation	6		Moderate	Moderate			High	High	7	9	1	4
	Potential for dust generation after closure	4		Low	Low			Moderate	Moderate	9	9	6	6
	Potential for ARD generation during operation	1		Moderate	High			High	Moderate	9	6	1	5
	Potential for ARD generation after closure	5		Moderate	Low			Moderate	Moderate	5	5	5	5
	Potential for ML during operation	2		Moderate	Low			Low	Low	7	7	9	9
	Potential for ML after closure	5		Moderate	Low			Low	Low	7	7	9	9
	Potential for seepage to groundwater during operation	5		Low	Low			Low	Low	9	9	9	9
	Potential for geotechnical hazards[1]	6		Low	Low			High	Moderate	9	9	1	5
	Potential for seepage to groundwater after closure	5		Low	Low			Low	Low	7	7	9	9
	Area of lakes impacted (ha)	5		177	177			131	131	7	7	9	9
	Number of lakes impacted	2		1	1			1	1	9	9	9	9
	Visual Impact	5		Low	Low			High	Moderate	9	9	1	3
	Potential for compensatory habitat	6		Low	Low			Moderate	Moderate	9	9	9	9
	Impact on Fish	6		High	High			High	High	1	1	1	1
	Sum of Environmental Weightings, $\sum W_{ENV}$	**65**	**Weighted Subtotals for Environmental Factors, $IND_{SCORE} = \sum(W_{IND} \times S_{IND})$**							**468**	**477**	**361**	**417**
Operational Factors (30% of Weighted Total)	Ease of operation	9		High	Moderate			Low	Moderate	9	4	2	6
	Distance from mill	8		1200 m	1200 m			2800 m	2800 m	9	9	4	4
	Potential for delays due to freezing	10		Low	Moderate			High	Moderate	9	6	1	7
	Construction Risk	4		Moderate	Moderate			Low	Low	3	2	7	9
	Disposal system has precedent in arctic environment	8		No	Yes			Yes	Yes	1	5	9	8
	Sum of Operational Weightings, $\sum W_{OPS}$	**39**	**Weighted Subtotals for Operational Factors, $IND_{SCORE} = \sum(W_{IND} \times S_{IND})$**							**263**	**216**	**160**	**256**
Economic Factors[2] (assumes 8% IRR) (20% of Weighted Total)	Initial Capital Cost ($CDN) (Approximate)	15		$11,800,000	$2,860,000			$5,955,000	$14,675,000	2	9	4	1
	Net Present Value of Delayed Costs[3]			$4,023,412	$4,540,590			$6,574,951	$619,048				
	Total Present Value of costs	11		$15,823,412	$7,400,590			$12,529,951	$15,294,048	3	9	5	4
	Sum of Economic Weightings, $\sum W_{COST}$	**26**	**Weighted Subtotals for Cost Factors, $IND_{SCORE} = \sum(W_{IND} \times S_{IND})$**							**63**	**234**	**115**	**59**
TOTAL OPTION SCORE = $\sum IND_{SCORE}$			**Option not carried**	**794**	**927**	**Option not carried**	**Option not carried**	**636**	**732**	**794**	**927**	**636**	**732**

Notes
1. Includes consideration of foundation conditions, impact of seismicity, and height of structure
2. Relative capital cost for comparison only.
3. Value not used in scoring. Value is presented to allow calculation of total cost for comparison purposes.

N:\Final\2003\1413\03-1413-427\[Table 6-5 Tailings Decision Matrix.xls]Tailings (finalMarch04)

Table 5.7: Summary of Tailings Storage Facility Development

Year	Description of Activities
-1	Dewater Second Portage Arm to at least elevation 105 m Construct first stage of tailings dike up to elevation 120 m
1	Commence discharging slurry
3	Construct stormwater dike to elevation 136.6 m Construct second stage of tailings dike to elevation 139.6 m Construct perimeter dikes at west end Operate water pond within main portion of tailings facility
5	Operate water pond within main portion of tailings facility Combine reclaim and stormwater pond during or at end of Year 5 Operate water pond in western portion of 2nd Portage Arm
6 to 10	Place slurry to elevation 136.6 m (3.5 m above current lake level) Maintain water management pond at west end of lake
Closure	Place ultramafic capping layer (minimum 2 m) to maintain tailings frozen below active layer

The preliminary deposition concept is presented in Figure 5.2. The stage-storage volume curve for the tailings storage facility is shown in Figure 5.3.

This tailings deposition strategy will result in the Second Portage Arm being filled with tailings at the end of the mine life.

5.6 SUPERNATANT RECLAIM

It is expected that tailings deposition would commence from the eastern end of the impoundment, near the location of the east tailings dike. The proposed conceptual operation strategy for the tailings impoundment is presented in Figure 5.2.

A reclaim pond will be operated at the western end of the deposition area to provide water for the milling process. The reclaim of water would be achieved using a floating barge, which would be moved progressively during the operation of the tailings impoundment. It will probably be necessary to use heated reclaim pumps to ensure operation during the winter. A bubbler system may also be required to keep ice away from the barge.

A retention time of approximately 90 days is required to allow stabilization of the supernatant chemistry, thereby avoiding large variations in the chemistry of reclaimed water used for ore processing. This corresponds to a storage requirement of approximately 550,000 m^3 of supernatant. Additional volume must be allowed for ice in the winter months. Consequently, a supernatant storage volume of around 900,000 m^3 has been adopted for this plan.

It is intended that the western end of the Second Portage Arm (the northwest basin) be initially used as a stormwater management pond. Tailings will be discharged from a tailings dam at the eastern end of Second Portage Arm, and a reclaim pond will be operated in the central portion of Second

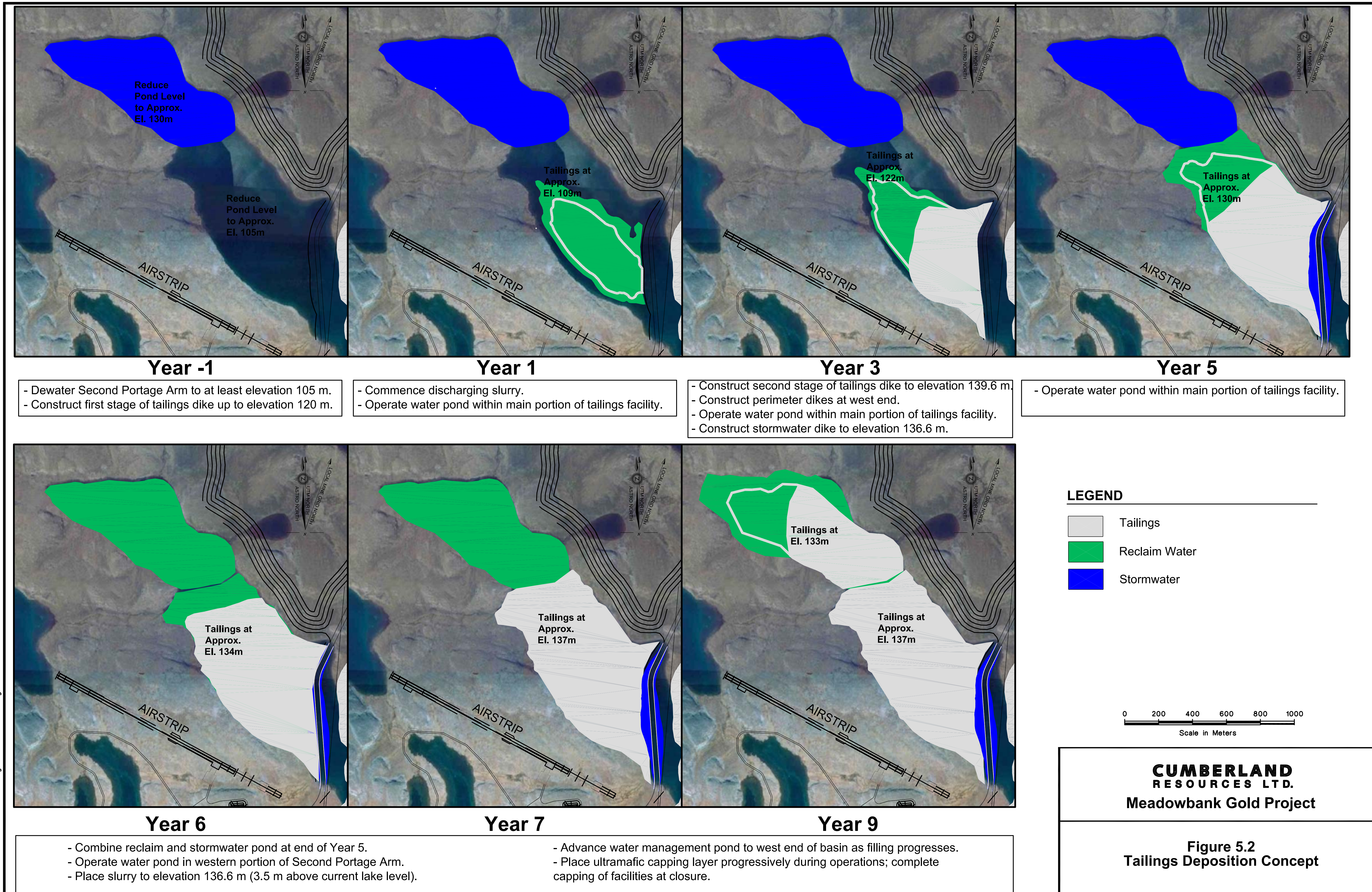

Figure 5.2
Tailings Deposition Concept

Figure 5.3: Second Portage Lake Tailings Storage Facility Stage-Storage Volume Curve

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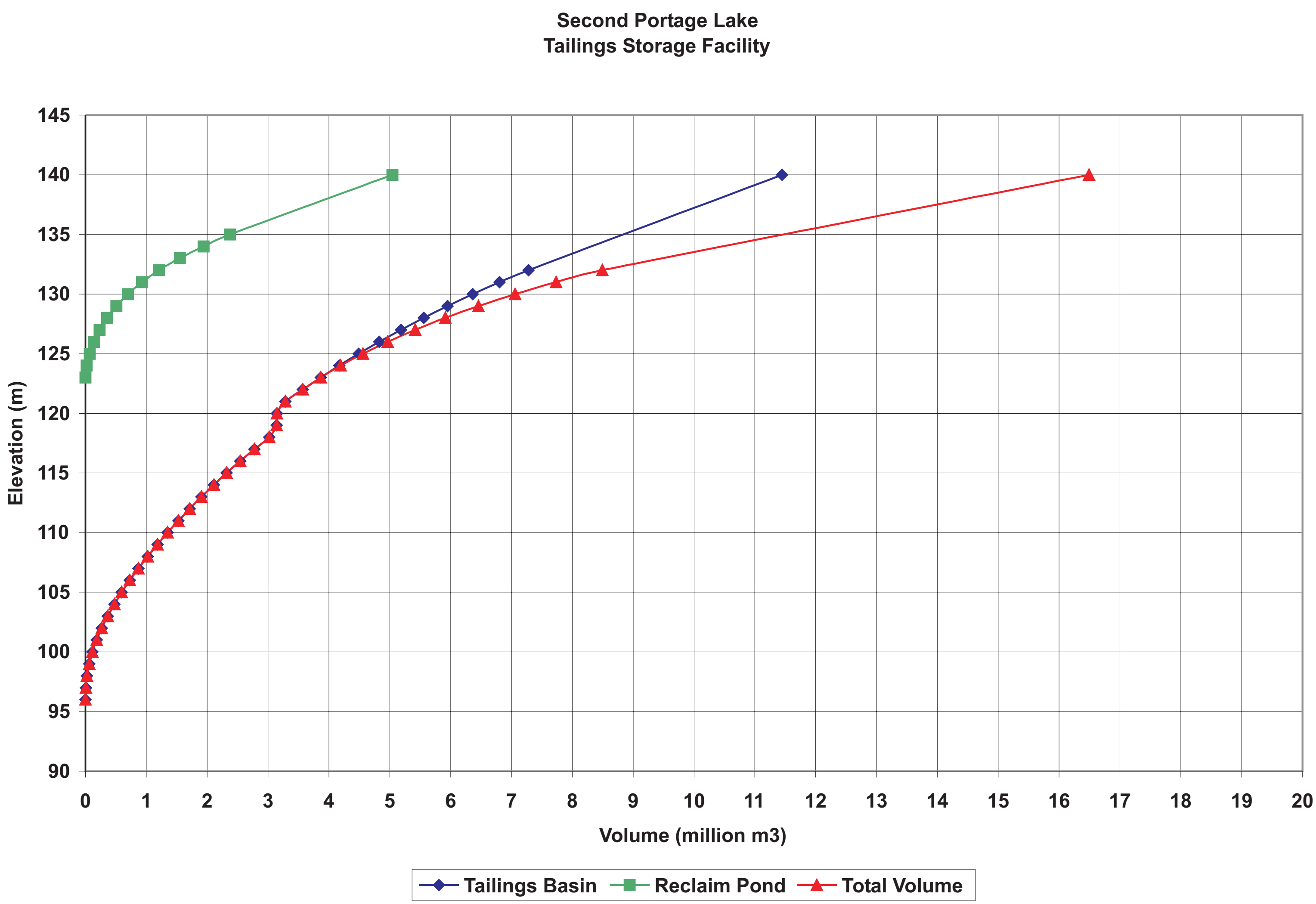


PROJECT

CUMBERLAND RESOURCES LTD.

TITLE

SECOND PORTAGE LAKE
TAILINGS STORAGE FACILITY STAGE
STORAGE VOLUME CURVE

Golder Associates

PROJECT No.	03-1413-427	
DESIGN	CJC	04MAR04
CADD	SS	04MAR04
CHECK	CJC	04MAR04
REVIEW		

FILE No. 03-1413-427
SCALE NTS REV. 0

FIGURE 5.3

Portage Arm (west end of tailings basin). As the tailings level rises, it will be necessary to construct a small dike across the bathymetric high that divides the two portions of Second Portage Arm to ensure that the reclaim pond and stormwater ponds remain separated.

Later in the mine life, the main basin of the Second Portage Arm will be filled by tailings, and the northwest basin will be used to manage both stormwater and reclaim water. This will require the construction of small saddle dikes to allow the pond level to be raised above the existing lake level.

5.7 POTENTIAL FOR ICE ENTRAPMENT

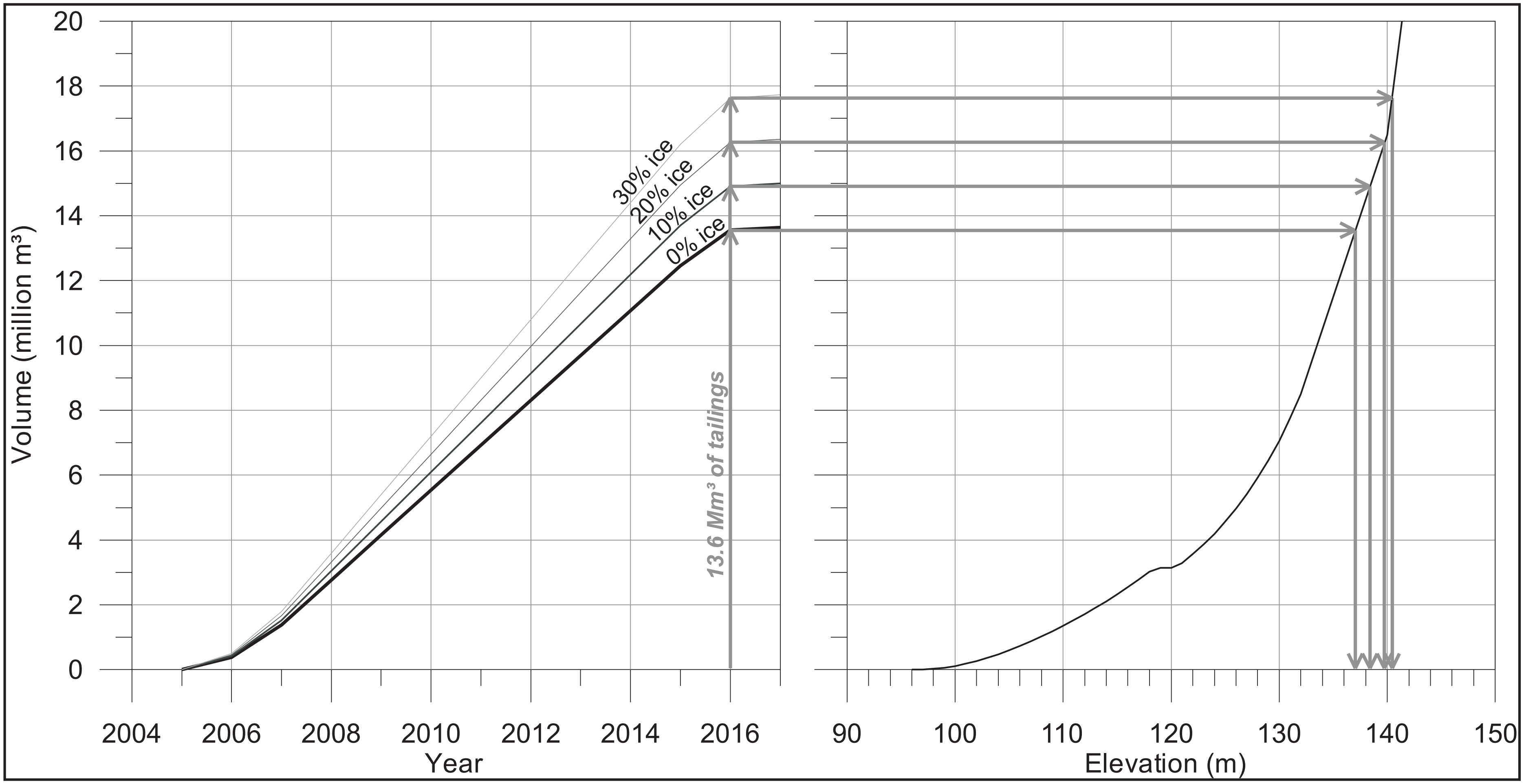
It is likely that some ice will be trapped in the tailings, as a result of tailings transport water freezing before it reaches the decant pond. The quantity of ice trapped will depend on the tailings beach management, but volumes of up to 30% have been reported by some mines in similar environments (Nixon and Holl, 1997). The impact of varying proportions of entrapped ice on the storage capacity of the proposed tailings storage facility is presented in Figure 5.4 (overleaf).

The figure indicates that the entrapment of 30% ice in the tailings would result in the final height of the tailings impoundment increasing by about 3 m relative to the height that would be required if no ice is entrapped. This increase would require minor extensions of containment berms and would have a negligible impact on the visibility of the tailings impoundment.

The impact of possible ice entrapment on the final elevation of the tailings impoundment is summarized in Table 5.8, based on the quantity of tailings shown in Table 2.1. The amount of ice entrapment can be managed to a large degree by effective beach management and through the implementation of appropriate operational strategies. A deposition plan will be developed during the detailed design phase of the project and will consider various scenarios for reducing ice entrapment. Actual amounts of ice entrapment will not be known until the commencement of operation of the tailings facility.

Table 5.8: Tailings Surface Elevation for Various Amounts of Ice Entrapment

Proportion of Entrapped Ice (%)	Final Elevation of Tailings (m)
0	137
10	138
20	139
30	140



PROJECT

CUMBERLAND RESOURCES LTD.

TITLE

SECOND PORTAGE LAKE TAILINGS STORAGE FACILITY STORAGE VOLUME AS A FUNCTION OF ICE CONTENT

Golder Associates

PROJECT No.	03-1413-427		FILE No. 03-1413-427	
DESIGN	CJC	04MAR04	SCALE NTS	REV. 0
CADD	SS	04MAR04	**FIGURE 5.4**	
CHECK	CJC	04MAR04		
REVIEW				

SECTION 6 • OVERBURDEN MATERIALS

6.1 LAKE SEDIMENTS

Soft sediments are expected to be present on the lake floors. The thickness is expected to be variable, and may range from a few centimetres up to several metres, as suggested by geophysical surveys. Other projects in the north have reported soft sediments up to about 4 m in thickness. These sediments will need to be removed to beyond the footprint of the tailings dike and the open pits after the lakes have been drawn down. Table 6.1 summarizes the volumes of soft sediments that may need to be removed. A range in potential volumes has been provided, assuming 1 and 2 m average sediment thicknesses.

Table 6.1: Estimate of Lake Bottom Sediment Volumes

	Approximate Footprint Area (m^2)	Volume (m^3) (assuming 1 m average thickness)	Volume (m^3) (assuming 2 m average thickness)
Tailings Dike	66,000	66,000	132,000
Goose Pit	209,000	209,000	418,000
Portage Pit (includes Bay Zone & Connector Zone)	529,000	529,000	1,058,000
Total	**804,000**	**804,000**	**1,608,000**

During detailed engineering design, additional geophysical surveys will be required to further quantify the thickness of these sediments.

The removal of the sediments could be achieved using a dragline-type excavator. Alternatively, the sediments could be exposed and excavation delayed until the sediments have frozen, enabling excavation with conventional equipment. Ripping or blasting may be required to loosen the materials, depending on the nature of the sediments and the time for which they are exposed to freezing conditions.

The sediments could be either dumped in the tailings impoundment, the Portage rock storage facility, or be temporarily stored in the area between the North Portage deposit and the east dike for later use in other locations on the site.

6.2 TILL

The remainder of the overburden materials are expected to be till. Some of the till will be used in the construction of retaining dikes for water and tailings. The balance may be placed in the waste rock storage areas, either mixed with the waste rock, or separately to allow the material to be used at a later date for reclamation or other works. The average till thicknesses throughout the project area are on the order of 2 to 3 m, based on reverse circulation drilling carried out by Cumberland in 2002. Locally, thicknesses may reach up to 18 m.

In general terms, the till can be described as a silty sand/gravel till, having a fines (silt + clay) content between about 30% and 40%, based on laboratory grain size analyses. The material also contains up to boulder sized particles.

The material that has been recovered from beneath the lakes during geotechnical drilling along the proposed dike alignments generally can be described as cobbles and gravel with traces of sand, silt, and clay. Locally, samples of sand have been obtained. Samples of clayey sand materials have been recovered using split spoon sampling methods.

SECTION 7 • SEQUENCING

Drawings have been prepared to illustrate conceptually the current expectation of the development sequence of the mine over the operating life, and are presented as Figures 7.1 to 7.8. The drawings reflect the periods shown in Table 7.1.

Table 7.1: Sequence Drawings

Figure	Year	Key Issues
7.1	-1	• Commence stripping for North Portage and Third Portage. • Construct Portage and Bay Zone dikes. • Lower water level in Second Portage Arm by 28 m (to ~El. 105 m). • Construct first stage of tailings dike up to elevation 120 m. • Construct airstrip and plant site.
7.2	1	• Commence discharging slurry in main basin of Second Portage Arm. • Operate water pond within north-west basin of Second Portage Arm. • Construct Vault haul road. • Commence mining on land within Vault pit. • Construct Vault dike and dewater Vault Lake.
7.3	3	• Construct stormwater dike between main basin and northwest basin of Second Portage Arm to elevation 136.6 m using till sourced from Portage waste rock storage area footprint or elsewhere. • Stockpile materials for dikes to be built in Year 9. • Construct second stage of tailings dike to elevation 139.6 m. • Construct perimeter saddle dikes at west end of tailings impoundment.
7.4	5	• Construct Goose Island dike. • Combine stormwater and reclaim pond during Year 5.
7.5	6	• Commence mining in Goose Island pit. • Operate stormwater/reclaim pond in western portion of 2nd Portage Arm. Continue advancing tailings beach and pond westward. • Complete deposition of tailings in main basin of Second Portage Lake.
7.6	7	• Commence discharging slurry in northwest basin of Second Portage Arm. • Continue to advance tailings beach and stormwater/reclaim pond westward.
7.7	9	• Continue to advance tailings beach and stormwater/reclaim pond westward to western end of Second Portage Arm. • Construct additional saddle dikes required for additional pond volume.
7.8	10	• Mining complete. • Waste disposal areas complete but not reclaimed. • Commence Goose Island/Portage pit flooding. • Commence Vault pit flooding.

Figure 7.1: Development Sequence – Year -1

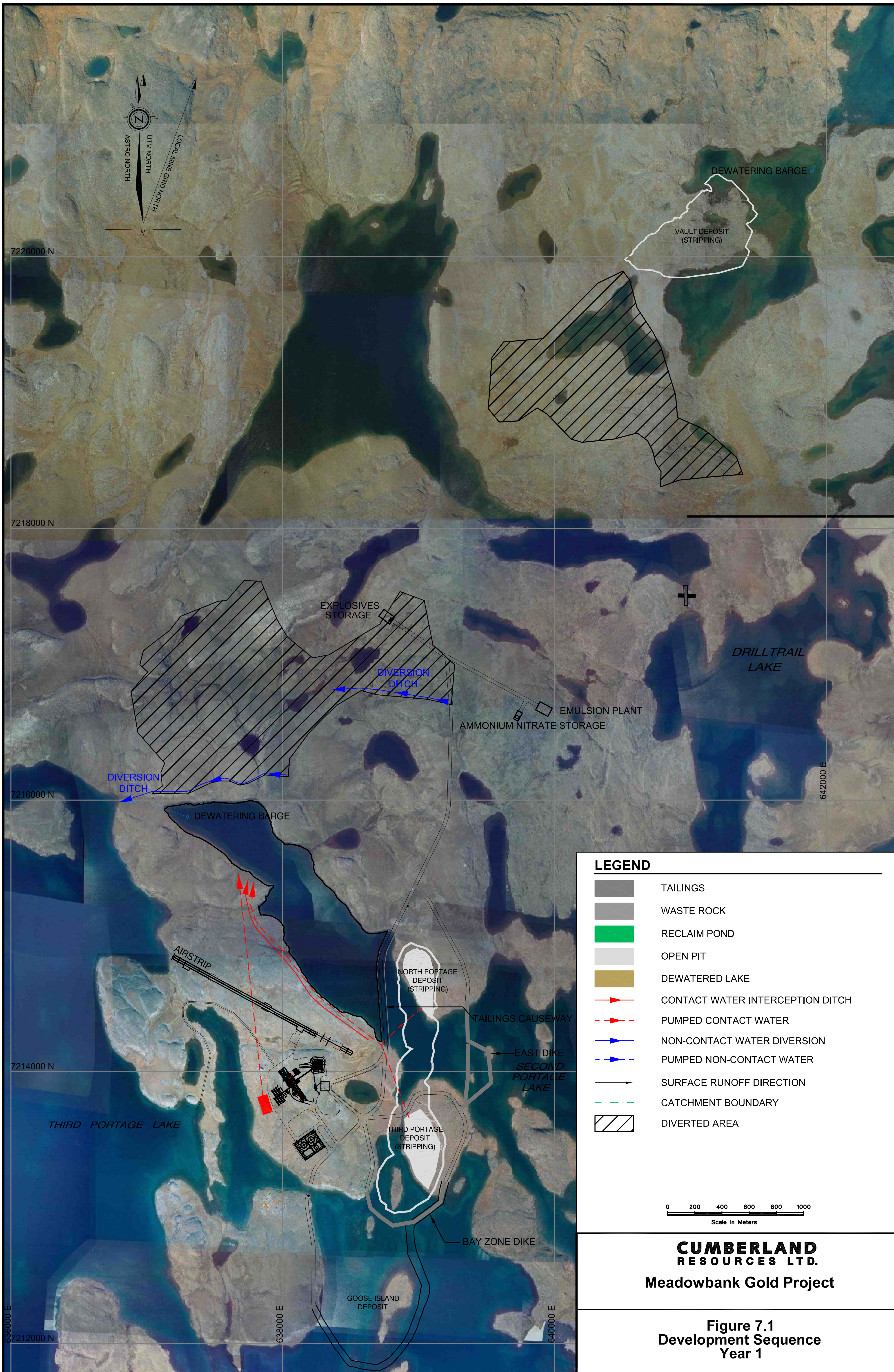


Figure 7.1
Development Sequence
Year 1

Source: AMEC Jan 2004 - OVERALL SITE PLAN, Drawing # A1-131395-100-C-0001, Rev. A.

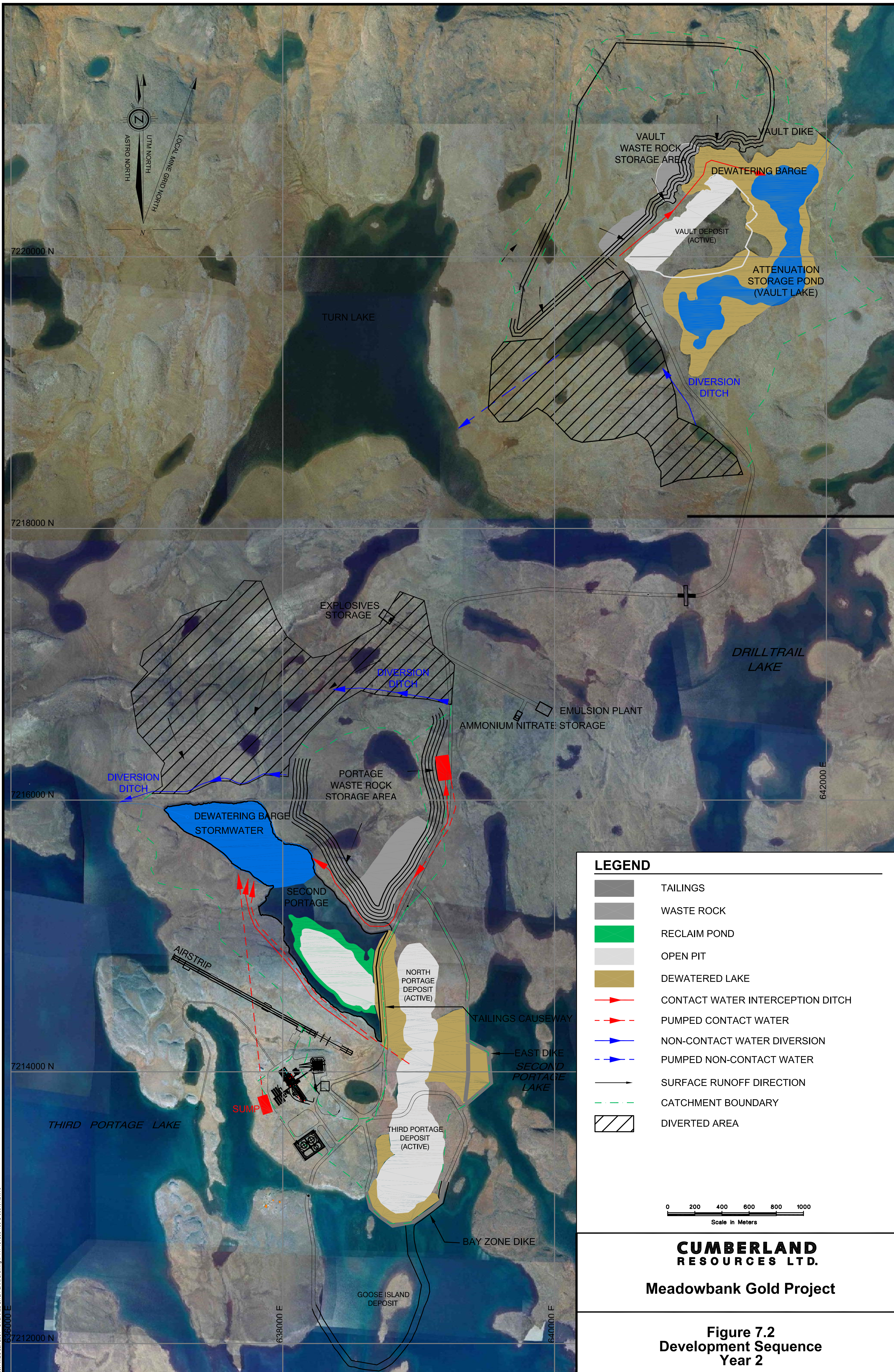


Figure 7.2
Development Sequence
Year 2

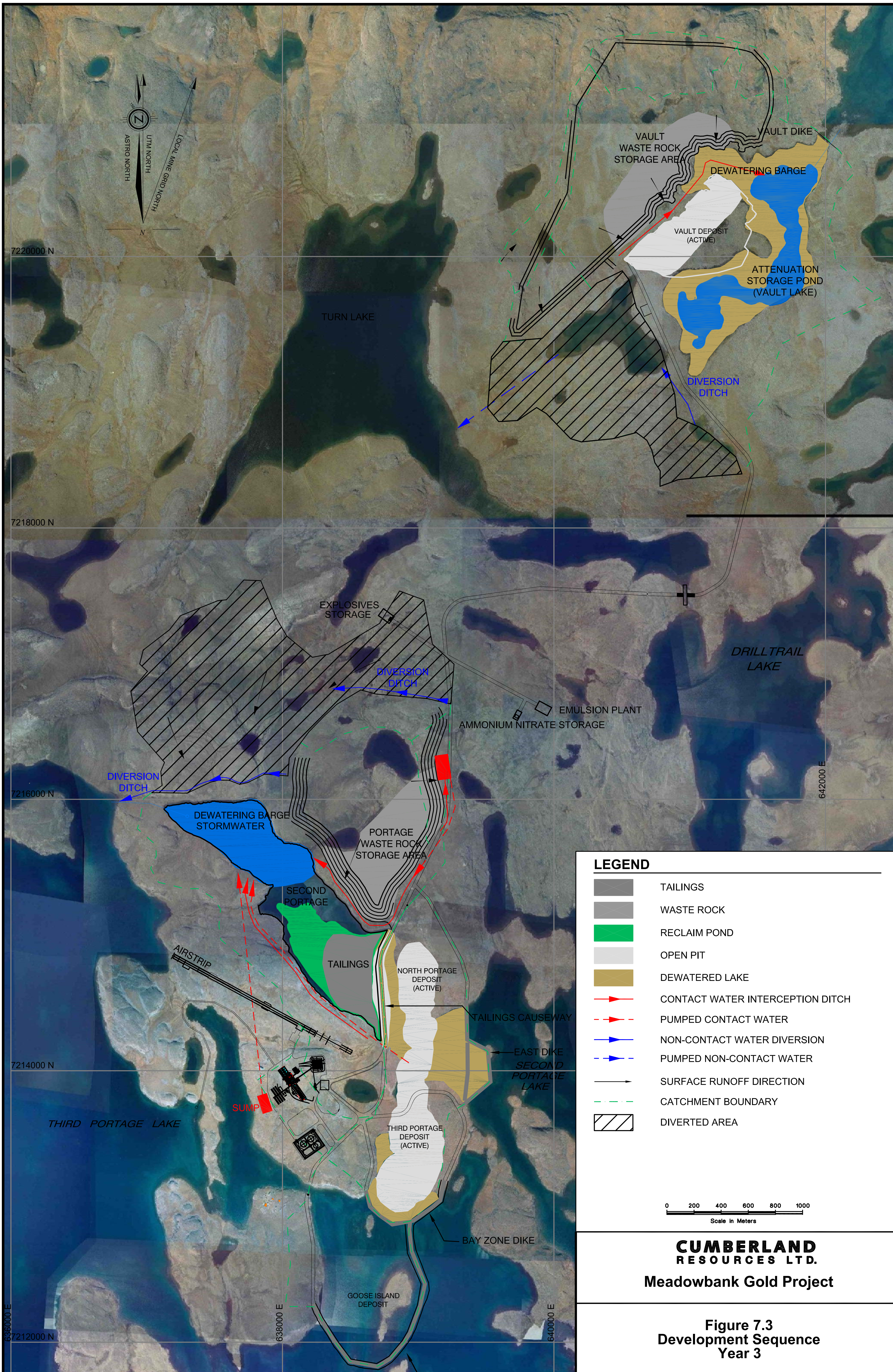


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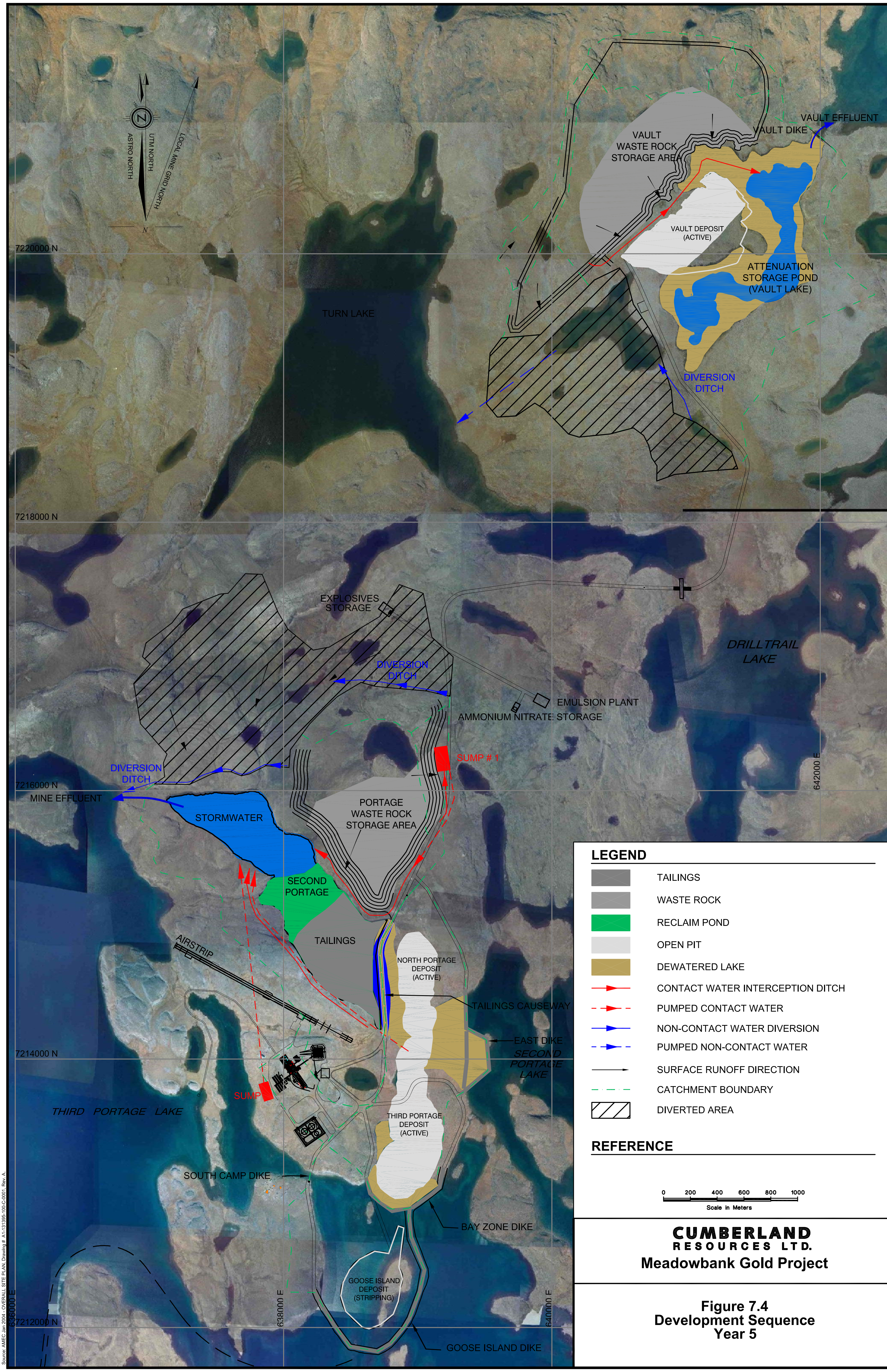
Figure 7.3
Development Sequence
Year 3



Source: AMEC Jan 2004 - OVERALL SITE PLAN Drawing # A1-131395-100-C-0001 Rev. A

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Figure 7.4
Development Sequence
Year 5

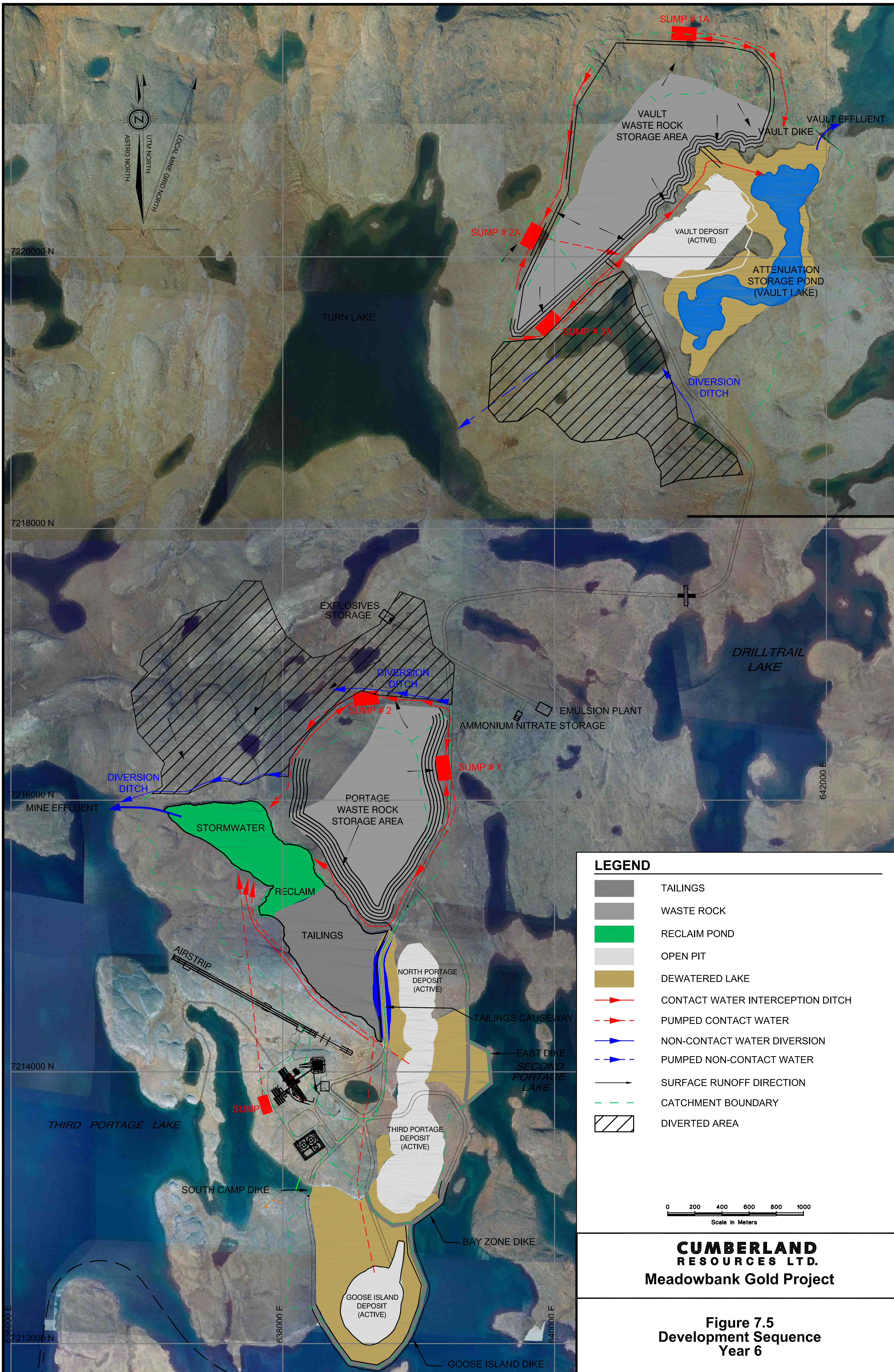


Figure 7.5
Development Sequence
Year 6

Source: AMEC Jan 2004 - OVERALL SITE PLAN, Drawing # A1-1 31395-100-C-0001, Rev. A.

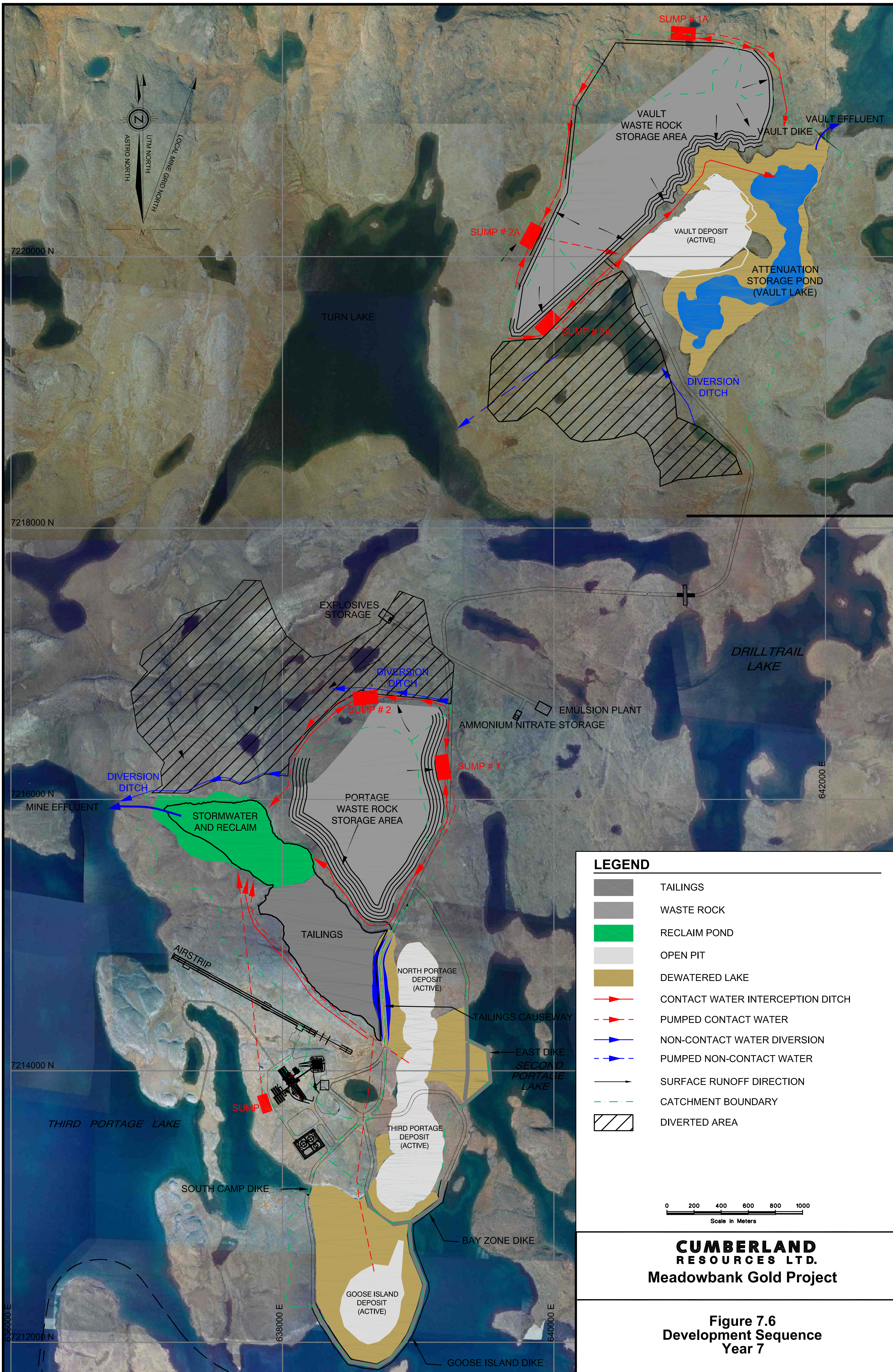


Figure 7.6
Development Sequence
Year 7

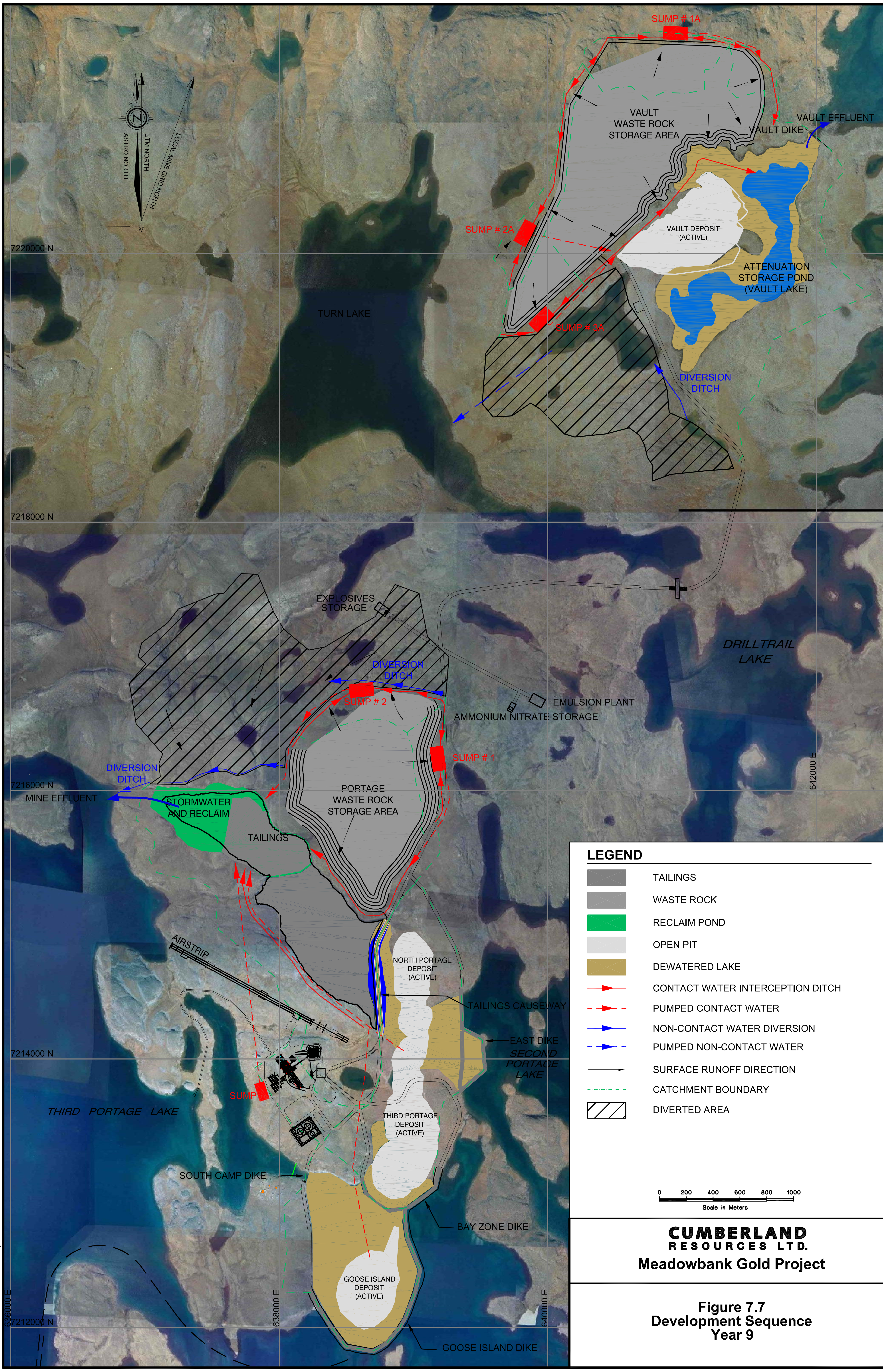


Figure 7.7
Development Sequence
Year 9

Source: AMEC Jan 2004 - OVERALL SITE PLAN, Drawing # A1-131395-100-C0001, Rev. A.

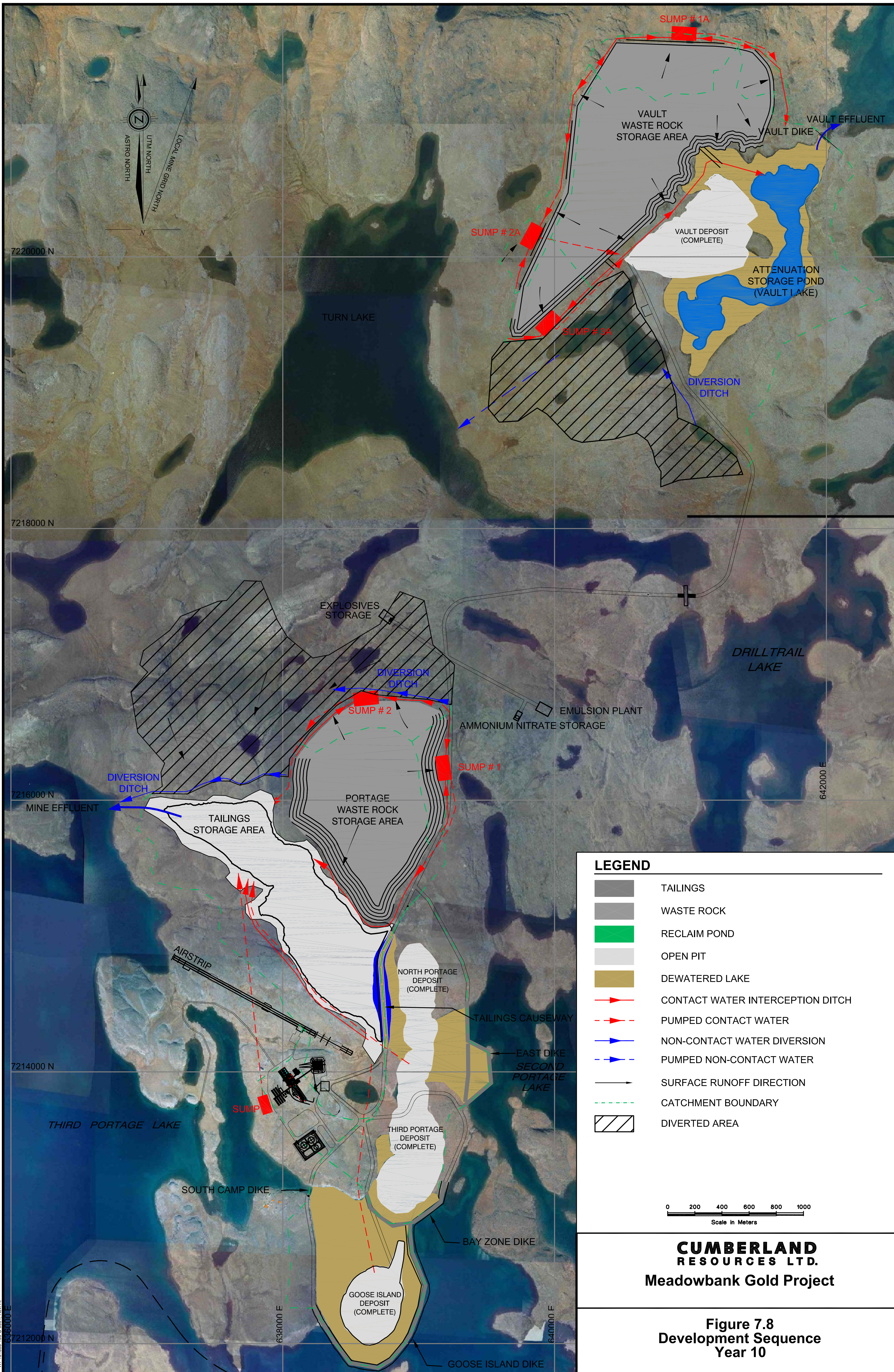


Figure 7.8
Development Sequence
Year 10

It is expected that dewatering of Second Portage Lake will be accomplished by pumping water to the west into Third Portage Lake. Dewatering of Vault Lake will be accomplished by pumping of water to the northeast into Wally Lake.

Table 7.2 summarizes the estimates of dewatering volumes for the various mining areas based on the results of bathymetry surveys carried out at the site. The dewatering volumes are based on the current dike configurations.

Table 7.2: Estimate of Dewatering Volumes

Location	**Description**	**Dewatering Volume (Mm^3)**
Second Portage Lake	Dewatering to pit side of east dike (El. 105 m)	12.2
Third Portage Lake	Dewatering to pit side of Bay Zone dike	0.4
	Dewatering between Bay Zone dike and pit side of Goose Island dike	2.2
Vault Lake	Dewatering to pit side of Vault dike	2.2

SECTION 8 • WATER MANAGEMENT

8.1 WATER MANAGEMENT OBJECTIVES & STRATEGIES

The goal of water management is to minimize the impact of the proposed Meadowbank project on the aquatic ecosystem of the neighbouring lakes, namely Third Portage, Second Portage, Turn, and Wally lakes. The primary objectives of the water management plan are to:

- minimize impacts of the proposed project on the quantity of surface water
- minimize impacts of the proposed project on the quality of surface and groundwater.

The strategies to implement the above objectives include:

- reduce the intake of fresh water from the neighbouring lakes by recycling and reusing water where practicable
- implement measures to avoid the contact of clean runoff water with areas affected by the mine or mining activities
- collect, transport, and treat as necessary mine water, camp sewage, and runoff water in contact with project activities
- manage potentially acid-generating or metal-leaching materials
- monitor quality of discharges
- adjust management practices if monitoring results indicate discharge quality does not meet discharge criteria.

8.2 WATER MANAGEMENT STANDARDS & DESIGN CRITERIA

8.2.1 Standards

The following are the minimum standards that will be incorporated into water management planning activities:

- establish compliance with all applicable federal and territorial environmental legislation including:
  - *Canadian Environmental Protection Act*
  - *Fisheries Act*
  - Freshwater Intake End-of-Pipe Fish Screen Guidelines (FOC)
  - Canadian Environment Quality Guidelines
  - Metal Mining Effluent Regulations
- cross-reference existing guidelines relevant to water management such as the Guidelines for the Discharge of Domestic Wastewater in Nunavut, Nunavut Water Board.

8.2.2 Design Criteria

For the purpose of this water management plan, surface water has been grouped into two categories, contact and non-contact water.

Contact water is defined as any water that may have been physically or chemically affected by mining activities. Contact water includes:

- surface runoff from the mining and milling areas
- groundwater seepage into open pits
- surface runoff and shallow drainage from rock storage areas
- surface runoff and shallow drainage from tailings disposal areas
- transport water from tailings
- water generated from consolidation of tailings (bleed water)
- flushing water from tailings distribution lines.

All contact water will be intercepted, contained, analyzed, treated if required, and discharged to the receiving environment when water quality meets the discharge criteria.

Non-contact water is limited to runoff originating from areas unaffected by mining activity that does not come into contact with developed areas. Non-contact water will be intercepted and directed away from developed areas by means of natural or man-made diversion channels and allowed to flow to the neighbouring lakes untreated.

The various components of the water management system for the proposed Meadowbank project will be designed to meet the following criteria:

- Water management infrastructure along the perimeter of the developed areas must be able to intercept and convey to proper handling facilities contact water from a 1:100 year, 24-hour precipitation event.

- Water management infrastructure located within mining affected areas where water has no chance of overflow outside of developed areas should be able to handle the runoff from a 1 in 10-year (1:10), 24-hour precipitation event.

- Water management infrastructure along the perimeter of the developed areas must be able to divert non-contact water from a 1:100 year, 24-hour precipitation event.

- Dewatering capacities for contact water sumps and ponds should be selected to handle the greater of:

  – the average year freshet volume in a 30-day period
  – the 1:100 year freshet volume in a 90-day period

- Attenuation ponds should be sized to accommodate the runoff from a 1:100 year, 24-hour precipitation event in excess of their maximum operating storage volume (average year climate conditions) while maintaining a 1 m freeboard before the possibility of a spill to the receiving environment.

8.3 WATER MANAGEMENT SYSTEMS

The following section describes the proposed water management systems for the Meadowbank project. The water management systems are presented independently by area of activity, namely the Vault mining area to the north and the Portage mining and milling area to the south.

The development of the proposed water management systems will require the consideration of storm drainage design in cold regions. The importance of control and prevention of icings within and adjacent to drainage structures must be acknowledged in the detailed engineering design of these structures and will include the assessment of the degree of drainage required, hydrologic data, and the effects of, and impacts on, the permafrost thermal regime. Standard techniques for addressing icings of structures and facilities in cold regions will be employed during the design phase of the project. These will include such standard techniques as avoidance and control and prevention, and are not discussed in further detail for this level of study.

8.3.1 Vault Mining Area

The Vault mining area is located approximately 6 km northeast of the Portage mining and milling area. Activities at this location will be limited to mining of an open pit, local hauling and disposal of waste rock, and hauling of ore to the mill at the Portage mining and milling area.

8.3.1.1 Water Supply & Distribution

Potable water for the local mine shop and office will be trucked in from the Portage potable water treatment plant.

Dust control water for the Vault mining area will be drawn from the Vault attenuation storage pond in an effort to keep contact water within the mining areas. Dust control water for the haul roads outside the respective Vault and Portage catchment areas will be drawn from Phaser Lake.

8.3.1.2 Water Management Systems & Activities

The proposed water management plan for the Vault mining area during operation involves (see Figure 7.1 to 7.8):

- diverting Phaser Lake non-contact water toward Turn Lake
- collecting contact water from the pit and rock storage facility and directing it toward an attenuation storage facility
- constructing a dike across the outlet of Vault Lake
- using Vault Lake, once dewatered, as an attenuation storage facility

- monitoring the water quality in the attenuation pond and treating it, if necessary, prior to pumping the water to Wally Lake.

The proposed water management plan for the Vault mining area involves the diversion of approximately 152 ha of the Vault Lake tributary area to Turn Lake. This diversion necessitates the construction, during initial site development, of an interceptor ditch to divert non-contact water from the small unnamed lake to the south of Vault Lake toward Phaser Lake. A small berm on the order of 1 m high may be necessary between Phaser and Vault Lake to ensure no flow is directed to Vault Lake. While this berm will seldom see water, its design will need to take into consideration the local frost regime and potential instabilities. It is suspected that the dewatering of Vault and Phaser lakes will promote freezing of this area. Interceptor ditches and a sump will be required along the southeast edge of the rock storage facility to direct any contact water away from Phaser Lake and toward Vault Lake. Phaser Lake water levels would be drawn down, through the use of a pump barge, during the summer months to provide storage of the spring freshet and/or extreme runoff events.

After construction of the Vault dike, the water level in Vault Lake will be lowered to form the Vault attenuation storage facility (or attenuation pond). To maximize the use of the available storage volume within the existing lake, the attenuation pond will be formed by excavating a channel to join the two deepest depressions within Vault Lake. Consequently, Vault Lake will need to be drawn down to allow excavation of this channel. The lake volume to the lake level elevation of 139 m amsl is estimated to be 2.2 Mm^3.

As a basis for the water management plan for Vault Lake, it has been assumed that the lake level will be operated at a level approximately 3 m to El. 136 m to reduce the potential for seepage into the open pit through the active layer. The Vault attenuation storage facility will be managed so as not to exceed this pond level. Based on the Vault Lake bathymetry, a storage capacity of approximately 508,000 m^3 is available below elevation 136 m. Consequently, the pond will be managed to allow the collection of runoff water during spring freshet without exceeding this pond level. Water collected within the attenuation pond will be pumped during the open water season to a water treatment plant (if needed) and then discharged directly to Wally Lake.

Lowering the water levels of Vault Lake and Phaser Lake may expose lake shoals composed of unconsolidated sediments and this may lead to local sedimentation within the impounded water. Proper timing of pumping periods will be used to prevent the discharge of sediment-laden waters to the environment.

The potential expansion of the Vault pit beyond its currently planned footprint may affect the use of Vault Lake as an attenuation storage facility. An alternative would be to use Phaser Lake as an attenuation storage pond by pumping pit water, along with rock storage runoff, to this lake.

Another alternative would be to allow Phaser Lake to drain naturally to Vault Lake and have one centralized location within Vault Lake for attenuation and pumping; however, this would result in a greater area contributing to the attenuation pond and would necessitate more aggressive dewatering to control the potential risks (seepage and/or overflow and related instabilities) to the adjacent open pit.

The rock storage facility will be surrounded along its western and northern edges by interceptor ditches, which will direct any contact water toward sumps where the water will be pumped to interceptor ditches that drain via gravity to the attenuation pond. An interceptor ditch along the eastern edge of the rock storage facility will drain by gravity to the attenuation pond. Depending on the mining schedule and the timing of the Vault Lake lowering, it may be necessary to direct runoff from the rock storage facility and ore stockpile to local sedimentation ponds, which will subsequently overflow to Vault Lake.

Water collected within the Vault pit sump will be pumped to the attenuation storage facility. The location and size of the pit sumps will vary as the pit is developed.

8.3.2 Portage Mining & Milling Areas

Under full operation, mining in the Portage area will consist of two open pits and the concurrent mining of three deposits (North Portage, Third Portage, and Goose Island), a waste rock disposal facility, a tailings disposal facility, a process water reclaim pond, an attenuation storage pond, an ore processing mill, and a service complex. The mill and service complex will be located to the west of the Portage open pit, on the land separating Third Portage and Second Portage lakes.

8.3.2.1 Water Supply & Distribution

Potable water for the service complex and mill will be supplied from the Portage potable water treatment plant.

Dust-control water for the Portage mining area will be drawn from the Portage attenuation storage pond in an effort to keep contact water within the mining areas. Dust control water for the haul roads outside the respective Vault and Portage catchment areas will be drawn from Phaser Lake.

8.3.2.2 Water Management Systems & Activities

The proposed water management plan for the Portage mining area involves (see Figures 7.1 to 7.8):

- diverting non-contact water from the northern portion of the catchment area around the northwest end of Second Portage Lake towards Third Portage Lake
- the use of the western end of Second Portage Lake, once dewatered, as an attenuation storage facility and a reclaim pond
- collecting contact water from the pits, mill site, and tailings and rock storage facilities and directing it toward the reclaim or attenuation storage facility
- monitoring the water quality in the attenuation pond and treating it, if necessary, prior to pumping it to Third Portage Lake.

The proposed water management plan for the Portage mining and milling area involves the diversion of approximately 200 ha from Second Portage Arm to Third Portage (see Figure 7.1). This will require the construction of a 1,300 m long interceptor ditch during initial site development. This ditch could be extended a further 700 m to the east, to within the rock storage footprint, in order to divert non-contact runoff from a further 75 ha in the early years of the rock pile development.

The northwest arm of Second Portage Lake (referred to as Second Portage Arm) will be isolated from the rest of Second Portage lake by the construction of a tailings dike adjacent to the west pit wall of the Portage pit. Tailings will be deposited to the west of the dike. Two basins exist within the arm of Second Portage Lake; the main basin is immediately adjacent to the tailings dike, whereas the northwest basin is located at the northwest end of the lake arm. To minimize the water treatment requirements, separate water storage ponds will be operated within this arm through approximately the first half of the mine life. A dike will be constructed in Year 3 across Second Portage Lake to separate the main basin from the northwest basin. The northwest basin will be operated as an attenuation storage pond from Year 1 to approximately Year 5. This pond will receive the site contact water including runoff from the waste rock disposal facility, seepage and runoff from the three pits, and runoff originating from the mill area. Any process (tailings-related) water will be contained in the reclaim pond located at the southeast end of Second Portage Arm. Interceptor ditches alongside the reclaim pond will direct any site runoff toward the attenuation storage pond. This will isolate the tailings disposal facility from the general site-wide water management plan.

As mining continues, the reclaim pond will advance westward as the tailings beach advances. During or at the end of Year 5, the reclaim pond and the attenuation pond will combine and will be operated as a single management pond from approximately Year 6 to the end of mine life at Year 10. This will require the construction of small saddle dikes to allow the pond level to be raised above the existing lake level.

The attenuation storage facility will provide storage capacity for spring runoff and extreme runoff events. Water from the attenuation pond will be pumped, during the open-water season, to the water treatment plant (as needed) and ultimately discharged to Third Portage Lake. Once combined, the attenuation/reclaim pond will be operated to maintain a minimum free-water volume (for process purposes) and provide storage capacity for spring runoff, extreme runoff events, and possible breakdowns or power failures at the treatment plant. Water from the management pond will be pumped, during the open-water season, to the water treatment plant (as needed) and ultimately discharged to Third Portage Lake.

Interceptor ditches along the eastern and northern edges of the waste rock storage facility will direct any contact water toward sumps where the water will be pumped to interceptor ditches that drain via gravity to the attenuation storage pond. An interceptor ditch along the southern edge of the rock storage facility will drain via gravity to the attenuation pond. It is noted that it may prove difficult to maintain gravity flow to the attenuation pond near the end of the mine life when the attenuation pond level rises above the current Second Portage Lake level (El. 133.1 m). An additional sump to the south of the rock storage area may be necessary at that time.

An interceptor ditch, located to the south of the tailing facility, will collect any water originating from part of the airstrip and the mill area and direct it to the attenuation pond. Alternatively, this area of approximately 55 ha could simply drain to the tailings facility/reclaim pond and any excess water within the reclaim pond simply be pumped to the attenuation pond. Runoff from the plant area (approx. 25 ha) will be directed to a local sump and pumped to the attenuation storage pond.

Water collected within pit sumps will be pumped to the attenuation storage facility. The location and size of the pit sumps will vary as the pits are developed.

8.3.3 Haul Roads

A network of haul roads will connect the ore bodies to the rock storage facility and the plant site. The majority of the roadways servicing the Portage mining and milling area are located so that their drainage will be directed towards the proposed contact water management infrastructure. For example, the runoff from the road leading to Goose Island pit from the plant site will be collected within either the Goose pit sump or the plant site/mill collection sump.

Due to the geographic remoteness of the Vault ore body from the Portage mining area, significant sections of haul road will fall outside of the catchment areas serviced by contact water management infrastructure. Based on the diversions proposed herein, approximately 5 km of haul road will not be serviced by the proposed water management infrastructure at the Vault or Portage mining areas. These sections will drain naturally to a number of different small and medium-sized lakes. A review of the topography in the vicinity of the proposed road indicates that, apart from Turn Lake, no significantly large tributary area or water body is intercepted and no engineered water crossings are considered necessary. The coarse road subgrade material will likely have an adequate conveyance capacity to pass the small amount of expected runoff across the roadway during summer months.

The approach to water management for these sections of haul road will involve the implementation of local best management practices during construction, operation, and closure. Where possible, the road will be constructed of non-reactive waste rock from the mining operations. Other best management practices will strive to minimize the amount of runoff originating from the roadways and to prevent the migration of surfacing material from the roadway. Any areas identified as point sources of runoff originating from the roadway can be managed locally with silt fences, interceptor ditches, rock check dams, and/or small sedimentation ponds.

8.4 INFRASTRUCTURE SIZING

8.4.1 Sumps

It is proposed that the sumps will generally be operated with a low water level to provide temporary storage capacity for runoff generated by extreme runoff event, possible breakdowns, or power failures at the pump stations. The sumps are sized to store the runoff volume from a 24-hour, 1:100 year return storm event (41 mm of runoff originating from 58.7 mm of precipitation).

Pumps must be capable of pumping either:

- the water volume resulting from the average year spring melt (126 mm) over a 30-day period, or
- the water volume resulting from the 1:100 year, wet-year spring melt (370 mm) over a 90-day period.

In this case, the resulting pump rates for the above criteria are essentially the same at 0.48 L/sec/ha.

The open pit sumps are sized to store the runoff volume from the 24-hour, 1:10 year return storm event (approximately 27 mm of runoff from 38.6 mm of precipitation). The potential seepage inflows were previously estimated. Note that the pit sump storage volumes and pumping capacities are provided as a preliminary guide. These will be established in conjunction with the mine engineer, based on estimated inflows and the potential to interrupt mining operations at each stage of pit development.

The pumping equipment and infrastructure will need to be selected and designed to accommodate the sub-zero temperatures that will prevail during the early and late portion of the open-water season. This may entail heat tracing of the pump intakes and providing self-priming pumps and increased monitoring during these periods. Pumping of the sumps will likely be possible to temperatures of up to -10°C during late winter or early spring. Other options would be to pump the sumps dry prior to freeze-up, or to break and remove ice manually or mechanically. Further standard techniques of avoidance and control, and prevention will be investigated during detailed engineering design.

8.4.1.1 Vault Mining Area

The attenuation storage pond is sized to store the runoff volume from the 24-hour, 1:100 year storm event on top of its peak annual operating volume under average climate conditions (343,200 m^3).

The preliminary requirements for sumps in the Vault area are shown in Table 8.1.

Table 8.1: Storage & Pumping Requirements – Vault Area

Description	Tributary Area (ha)	Storage Volume (m^3)	Pump Rate (L/sec)
Sump 1A	39.5	16,400	20
Sump 2A	25.5	10,500	13
Sump 3A	24.5	10,100	12
Vault Pit Sump[1]	41.8	11,300	20
Attenuation Pond	455	530,000	220
Phaser Lake	152	62,300	73

Note: 1. May be distributed among a number of sumps.

8.4.1.2 Portage Mining & Milling Area

The attenuation storage pond is sized to store the runoff volume from the 24-hour, 1:100 year storm event, in addition to its peak annual operating volume under average climate conditions. This volume varies with time because the Goose pit is operational between Year 6 and Year 10 and the attenuation pond also serves as the reclaim pond during Year 5 onward. Bathymetric information indicates that a ridge is present between the proposed stormwater and reclaim ponds, with the low point at approximately 131 m amsl. The stormwater basin, to the northwest of the ridge, has a volume of approximately 900,000 m^3 below the ridge and should accommodate the storage needs to the end of Year 4. The stormwater dike across Second Portage Arm will need to be constructed prior to the open-water season in Year 5, and will likely be constructed in Year 3.

As described in Section 5.7, ice entrapment may increase the tailings volume by up to 30%. A 20% ice entrapment of the deposited tailings has been assumed for the purposes of developing the water management plan. An increase in ice entrapment would result in a decrease in the reclaim water rate and an equivalent increase in the freshwater makeup water rate because less water would be released from the tailings and, hence, less supernatant would be available for reclaim. If less than 20% ice entrapment occurs, the reclaim rate may increase and the freshwater makeup will decrease accordingly. Furthermore, the useful life of the separated attenuation and reclaim ponds may be extended by up to 12 months.

The isolated reclaim pond (Years 1 to 5) within the main basin of Second Portage Lake will receive little site contact water (runoff) and, therefore, it will not have an attenuation function. It must provide a minimum free-water volume (under an ice cover if ice is present) of 550,000 m^3 for process purposes plus an allowance for winter ice formation of approximately 350,000 m^3 for a total of 900,000 m^3. Prior to the construction of the tailings dike, Second Portage Lake will require dewatering down to elevation 105 m amsl within the area bounded by the east dike. The total lake volume to a lake level elevation of 133 m amsl is estimated to be 12.8 Mm^3, within the area to the west of the East dike. The dewatering volume is estimated to be 12.2 Mm^3, excluding the volume of water contained below elevation 105 m amsl, and assuming that water contained in the elevated northwest basin (approximately 1.6 Mm^3) drains to the main basin during dewatering.

The volume of water below elevation 105 m amsl is estimated to be 580,000 m^3. This volume would have to be increased to 900,000 m^3 for the winter period in order to meet the process requirements stated above. This could be achieved by directly pumping fresh water to the tailings main basin from the northwest basin or from the nearby lakes once the first construction phase of the tailings dike has been completed. Alternatively, the fresh water makeup into the milling process could be temporarily increased. Once operational, the reclaim pond should maintain a relatively constant volume.

In the case of the pit sump pumps, the pumps must be able to handle the expected maximum monthly flow volume (Tables B.2 to B.9 in Appendix B). The preliminary requirements for sumps in the Portage area are shown in Table 8.2.

Table 8.2: Storage & Pumping Requirements – Portage Area

Description	Tributary Area (ha)	Volume (m^3)	Pump Rate (L/sec)
Sump 1	17.5	7,200	9
Sump 2	24.5	10,100	12
Mill Area Sump	25.0	10,300	12
Portage Pit Sumps[a]	56.7	15,300	170
Goose Portage Pit Sump	10.9	2,900	150
Attenuation Pond (to Year 4)	539	722,000	260
Reclaim Pond (to Year 5)	53	900,000[b]	N/A
Combined Pond (Years 5 to10)	634	2,300,000[b]	305
Combined Pond (Year 11)	539	1,480,000[b]	260

Notes: a. Will likely be distributed among a number of sumps. **b**. Includes minimum free-water volume of 550,000 m^3 for process reclaim water plus an ice allowance of 350,000 m^3.

8.4.2 Interceptor Channels

The interceptor channels are sized to accommodate the peak runoff discharge rate from a 1:100 year, 24-hour storm. Although no specific overburden information has been collected along the proposed interceptor alignments, properly designed excavated channels are considered feasible. The design must recognize the potential challenges presented by ice-rich ground, including icing, localized thawing, local ground instabilities, subsidence, and transport of fine-grained soils. The design and maintenance procedures for the diversion infrastructure will take into consideration these challenges. Design features that can be adopted to avoid problems include alignment of channels to take advantage of favourable foundation conditions, oversizing of the drainage structures, the provision of training berms instead of, or in combination with, channels, and lining and insulating of channels to prevent sedimentation and permafrost degradation.

For practical purposes, interceptor channels with a minimum uniform base width of 1 m and minimum depths adjusted to suit discharge requirements have been assumed. Specific channel configurations will be developed during the detailed engineering design.

The preliminary requirements of the interceptor channels in the Vault and Portage areas are shown in Tables 8.3 and 8.4, respectively.

Table 8.3: Minimum Interceptor Ditch Requirements – Vault Area

Description	Length (m)	Depth[a] (m)	Lining D_m[b] (mm)
Leading to Sumps around Rock Storage (total of six ditches)	4,700	0.75	50
East Perimeter of Rock Storage (to attenuation pond)	600	0.75	50
Southeast Perimeter of Rock Storage (to attenuation pond)	1,700	1.50	100
Diversion from Unnamed Lake (non-contact water to Phaser Lake)	380	1.10	75

Notes: a. Assumes trapezoidal channel with 2H:1V side slopes, 1 m base width, 0.5% longitudinal slope, and includes 0.3 m freeboard. **b.** Minimum median size of rock lining material.

Table 8.4: Minimum Interceptor Ditch Requirements – Portage Area

Description	Length (m)	Depth[a] (m)	Lining D_m[b] (mm)
Leading to Sumps around Rock Storage (total of four ditches)	1,800	0.75	50
East Perimeter of Rock Storage (to South Perimeter Interceptor)	600	0.75	50
South Perimeter of Rock Storage (to attenuation pond)	800	1.50	100
Diversion North of Attenuation Pond (non-contact water to 3rd Portage)	1,300	1.50	100
South Perimeter of Tailings Disposal (to attenuation pond)(optional)	1,700	1.10	75
South Perimeter of Mill Area	1,100	0.75	50

Notes: a. Assumes trapezoidal channel with 2H:1V side slopes, 1 m base width, 0.5% longitudinal slope and includes 0.3 m freeboard. **b.** Minimum median size of rock lining material.

SECTION 9 • WATER BALANCE

To assist in the evaluation of the proposed water management infrastructure on a monthly basis over the life of the mine and under closure conditions a water balance model was developed using GoldSim. The model includes a water balance along with a mass balance of geochemical parameters.

The following section presents the parameters and assumptions adopted in the water balance model along with a summary of the results for both the Vault and Portage mining areas.

9.1 MODEL ASSUMPTIONS

A brief description of the input parameters selected for the GoldSim water balance model, along with a list of assumptions, are provided in Tables B.1 to B.9 in Appendix B. Parameters that only affect the model geochemistry computations are identified by this note: [geochem]. A simulation calendar correlating the GoldSim simulation time steps (in months) with the mine years and actual calendar years is presented in Appendix C.

9.2 WATER BALANCE MODEL RESULTS

The results of the GoldSim site water balance model are summarized in Table 9.1 and Table 9.2 and in the flow logic diagrams presented in Figures 9.1 to 9.9. Results for hydraulic years 1, 3, 6, and 11 were selected to coincide with those presented in the waste management plan. Time series of the water storage facilities are presented in Figures 9.10 to 9.12.

As described previously, the segregated reclaim pond functions as a closed loop during the first four years of production. During the fifth year, the segregated reclaim pond will be unable to maintain the minimum free water requirement and the stormwater attenuation and reclaim ponds will be joined. The water within the segregated reclaim pond will be gradually displaced to the combined pond. Therefore, from Year 5 onward, the water being decanted to treatment will have a component of process water.

Table 9.1: Water Balance Model Summary – Portage Mining & Milling Area[a]

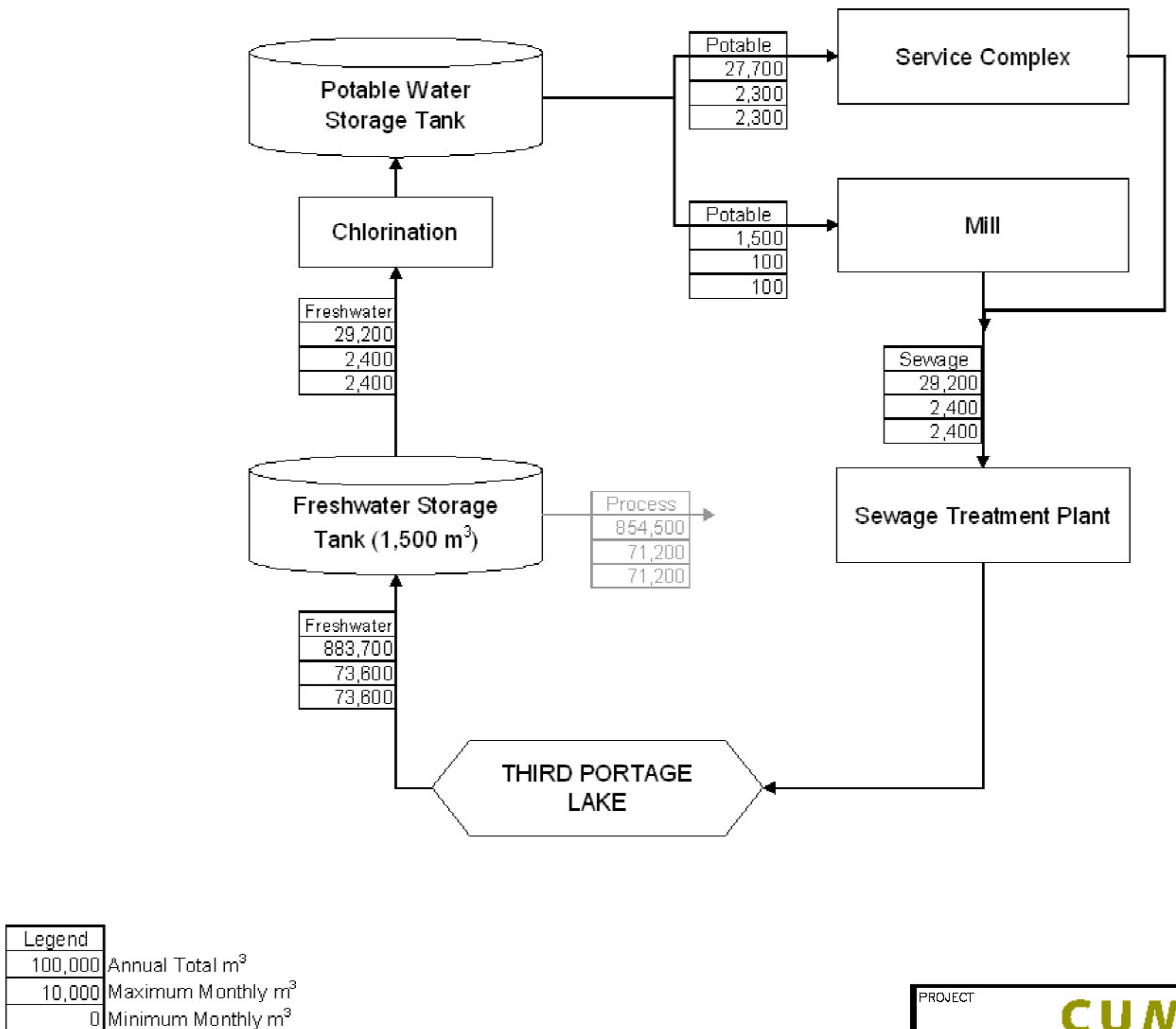
Description	Year 1 (2006/07) Inflow m³/a	Year 1 (2006/07) Outflow m³/a	Year 3 (2008/09) Inflow m³/a	Year 3 (2008/09) Outflow m³/a	Year 6 (2011/12) Inflow m³/a	Year 6 (2011/12) Outflow m³/a	Year 10/11 (2016) Inflow m³/a	Year 10/11 (2016) Outflow m³/a
Segregated Reclaim Pond[b]								
Tails Storage Runoff	-	-	33,900	-	-	-	-	-
Tailings Transport Water	1,670,400	-	2,227,600	-	742,500	-	-	-
Direct Runoff	44,400	-	36,900	-	-	-	-	-
Direct Evaporation	-	47,800	-	37,700	-	-	-	-
Tailings Pore Water	-	727,200	-	969,500	-	323,200	-	-
Reclaim Water	-	812,600	-	1,258,200	-	-	-	-
Decant to Storm Pond			-	-	-	818,800[e]	-	-
Subtotal	*1,714,800*	*1,587,600*	*2,298,400*	*2,265,400*	*742,500*	*1,142,000*	-	-
Change in Storage[c]	*127,200*		*33,000*		*-399,500*		-	
Stormwater Attenuation & Combined Pond[b]								
Goose Pit[d]	-	-	-	-	309,500	-	520,400	-
North Portage[d]	205,000	-	384,200	-	381,300	-	368,500	-
Third Portage Pit[d]	159,300	-	303,300	-	254,800	-	240,100	-
Rock Storage Runoff	67,900	-	158,000	-	271,800	-	271,800	-
Other Areas Runoff	909,600	-	738,600	-	709,500	-	662,600	-
Tails Storage Runoff	-	-	-	-	84,900	-	164,100	-
Decant from Reclaim Pond	-	-	-	-	818,800[e]	-	-	-
Tails Transport Water	-	-	-	-	1,485,100	-	2,227,600	-
Direct Runoff	10,700	-	14,000	-	90,200	-	38,700	-
Direct Evaporation	-	13,300	-	22,300	-	95,100	-	38,800
Dust Control	-	12,000	-	12,000	-	12,000	-	12,000
Tailings Pore Water	-	-	-	-	-	646,300	-	969,500
Reclaim Water	-	-	-	-	-	1,258,200	-	1,258,200
Decant to Treatment	-	1,351,200	-	1,589,100	-	2,113,100	-	2,315,900
Subtotal	*1,352,500*	*1,376,500*	*1,598,100*	*1,623,400*	*4,405,900*	*4,124,700*	*4,493,800*	*4,594,400*
Change in Storage[c]	*-24,000*		*-25,300*		*281,200*		*-100,600*	
System Total	**3,067,300**	**2,964,100**	**3,896,500**	**3,888,800**	**5,148,400**	**5,266,700**	**4,493,800**	**4,594,400**
Site Change in Storage[c]	**103,200**		**7,700**		**118,300**		**-100,600**	

Notes: a. Based on average climate conditions and hydraulic year – 1 October to 30 September. **b.** Stormwater attenuation and reclaim ponds are combined during the course of Years 5 & 6 (2011/12). **c.** Positive change in volume indicates an increase in stored water volume. **d.** Pits include runoff and seepage (groundwater, faults, and dike seepage). **e.** Tailings pond supernatant decanted to stormwater attenuation pond during Years 5 & 6 (2011/12).

Table 9.2: Water Balance Model Summary – Vault Mining Area[a]

Description	Year 1 (2006/07) Inflow m³/a	Year 1 (2006/07) Outflow m³/a	Year 3 (2008/09) Inflow m³/a	Year 3 (2008/09) Outflow m³/a	Year 6 (2011/12) Inflow m³/a	Year 6 (2011/12) Outflow m³/a	Year 10 (2016) Inflow m³/a	Year 10 (2016) Outflow m³/a
Stormwater Attenuation Pond								
Vault Pit Runoff	48,400	-	84,800	-	84,800	-	84,800	-
Rock Storage Runoff	38,100	-	194,700	-	391,500	-	391,500	-
Other Areas Runoff	851,200	-	635,000	-	438,200	-	438,200	-
Direct Runoff	13,400	-	13,400	-	13,400	-	13,400	-
Direct Evaporation	-	31,000	-	31,000	-	31,000	-	31,000
Dust Control	-	4,000	-	4,000	-	4,000	-	4,000
Decant to Wally Lake	-	2,681,200	-	893,000	-	893,000	-	893,000
System Total	**951,100**	**2,716,200**	**927,900**	**928,000**	**927,900**	**928,000**	**927,900**	**928,000**
Change in Storage[b]	**-1,765,100[c]**		**-**		**-**		**-**	

Notes: **a.** Based on average climate conditions and hydraulic year – 1 October to 30 September. **b.** Positive change in volume indicates an increase in stored water volume, values of 100 m^3 or less are reported as 0 because they are due to rounding error. **c.** Vault Lake dewatered in Year 1.



Runoff/milling process circuit not shown for clarity (see Figures 10.2-10.5)

PROJECT: CUMBERLAND RESOURCES LTD.

TITLE

POTABLE WATER BALANCE

Golder Associates

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CADD	NV	4MAR04	
CHECK	SD	4MAR04	
REVIEW			

FILE No. 03-1411-427-5200 Sk01

SCALE NTS REV. –

Figure 9.1

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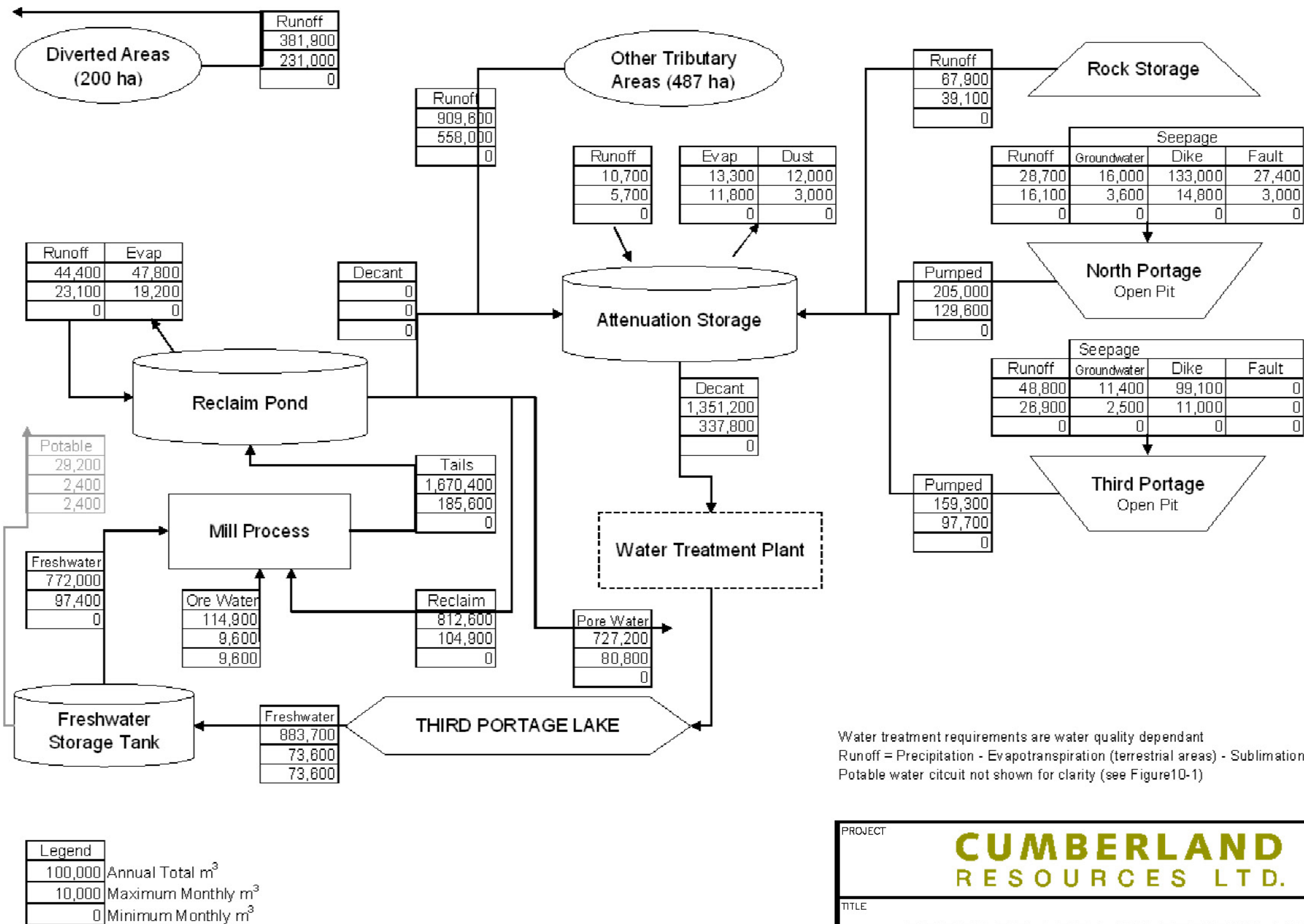

Water treatment requirements are water quality dependant
Runoff = Precipitation - Evapotranspiration (terrestrial areas) - Sublimation
Potable water citcuit not shown for clarity (see Figure10-1)

PROJECT
CUMBERLAND RESOURCES LTD.

TITLE
PORTAGE AREA WATER BALANCE YEAR 1

Golder Associates

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REVIEW			

Figure 9.2

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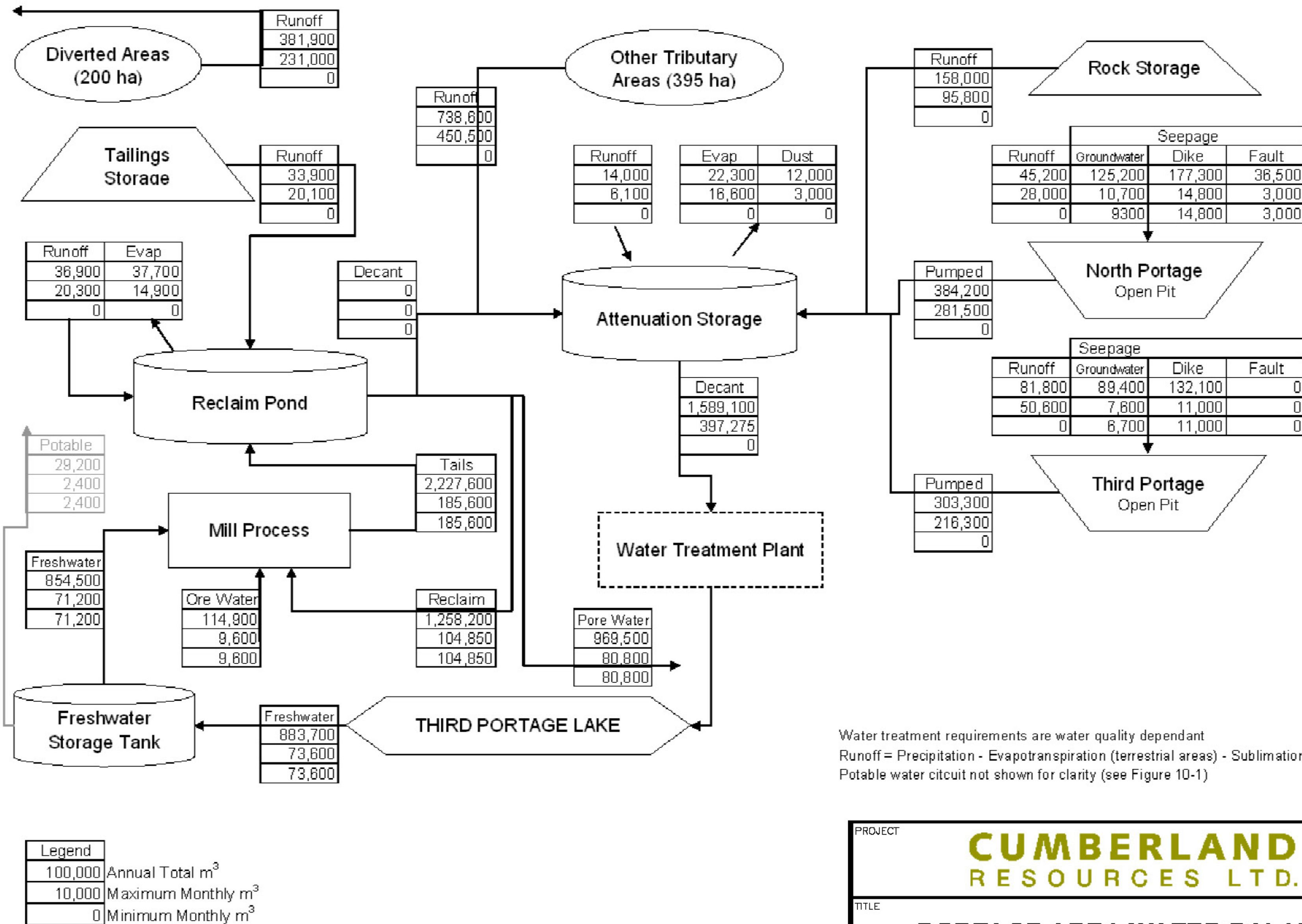

Water treatment requirements are water quality dependant
Runoff = Precipitation - Evapotranspiration (terrestrial areas) - Sublimation
Potable water citcuit not shown for clarity (see Figure 10-1)

PROJECT
CUMBERLAND RESOURCES LTD.

TITLE
PORTAGE AREA WATER BALANCE YEAR 3

Golder Associates

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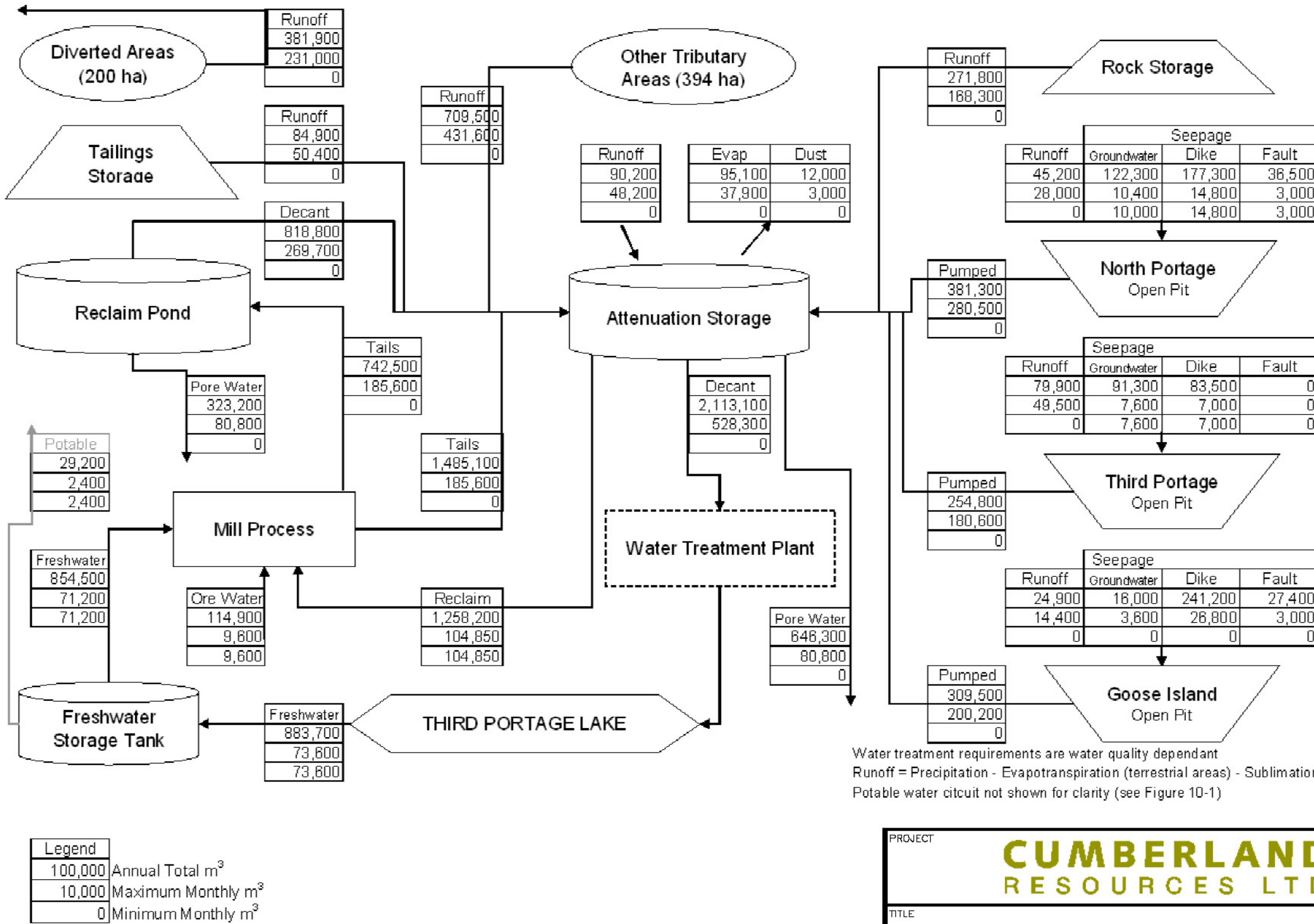
REVIEW			



PROJECT

CUMBERLAND RESOURCES LTD.

TITLE

PORTAGE AREA WATER BALANCE YEAR 6

Golder Associates

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REVIEW			

Figure 9.4

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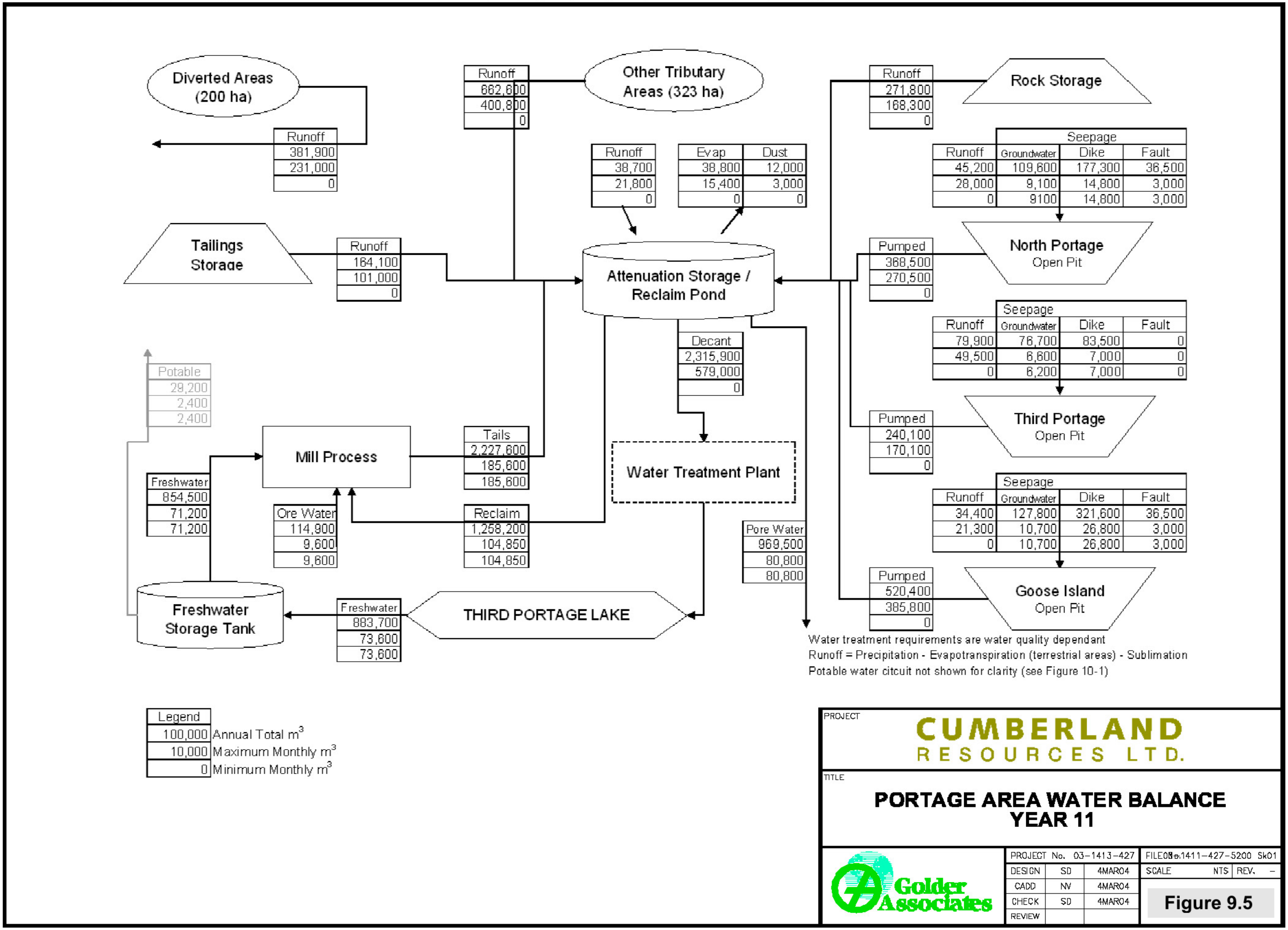

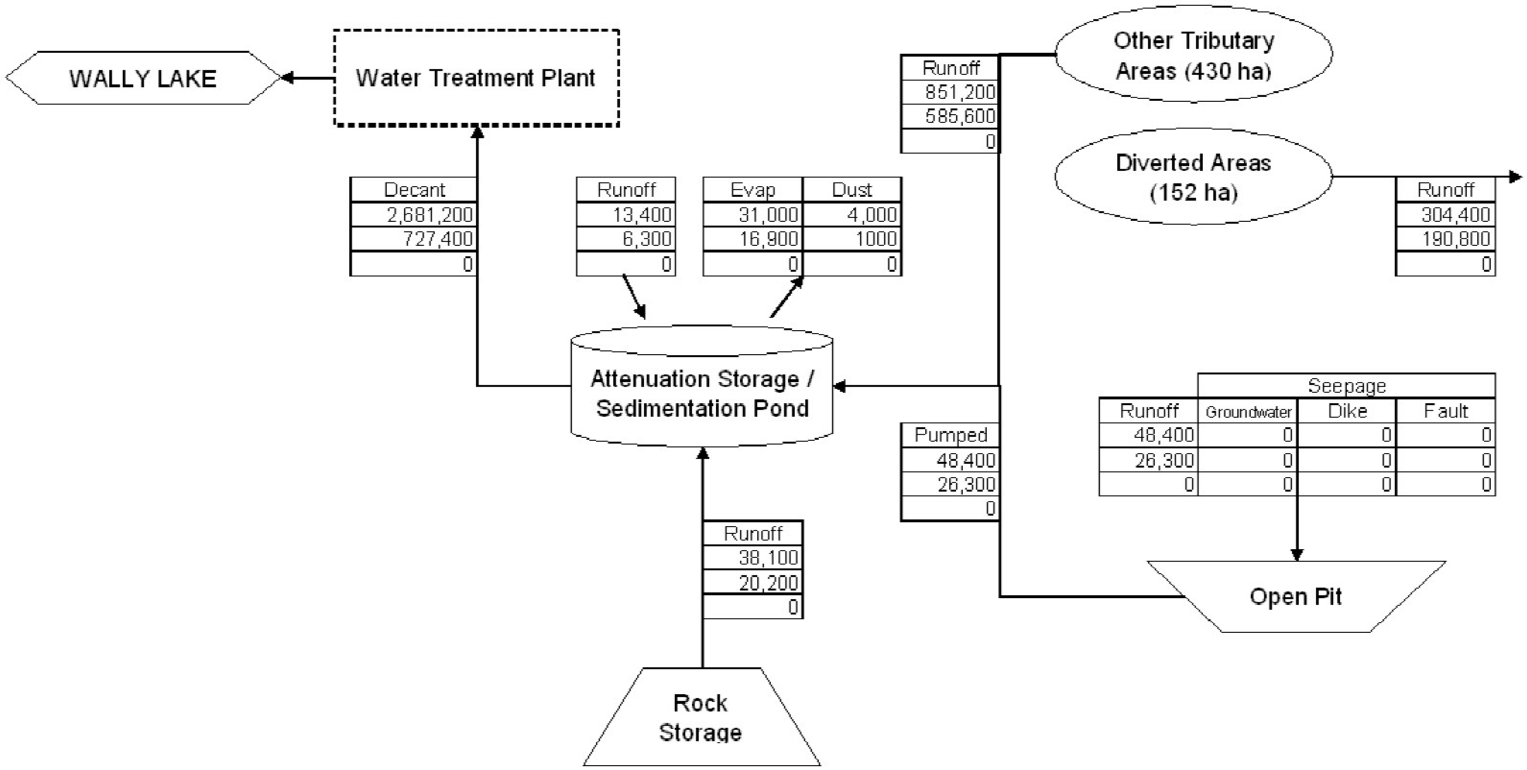

Runoff = Precipitation - Evapotranspiration (terrestrial areas) - Sublimation
Water treatment requirements are water quality dependant

Legend	
100,000	Annual Total m^3
10,000	Maximum Monthly m^3
0	Minimum Monthly m^3

PROJECT
CUMBERLAND RESOURCES LTD.

TITLE
VAULT AREA WATER BALANCE - YEAR 1

Golder Associates

PROJECT No. 03-1413-427			FILE No. 03-1411-427-5200 Sk01
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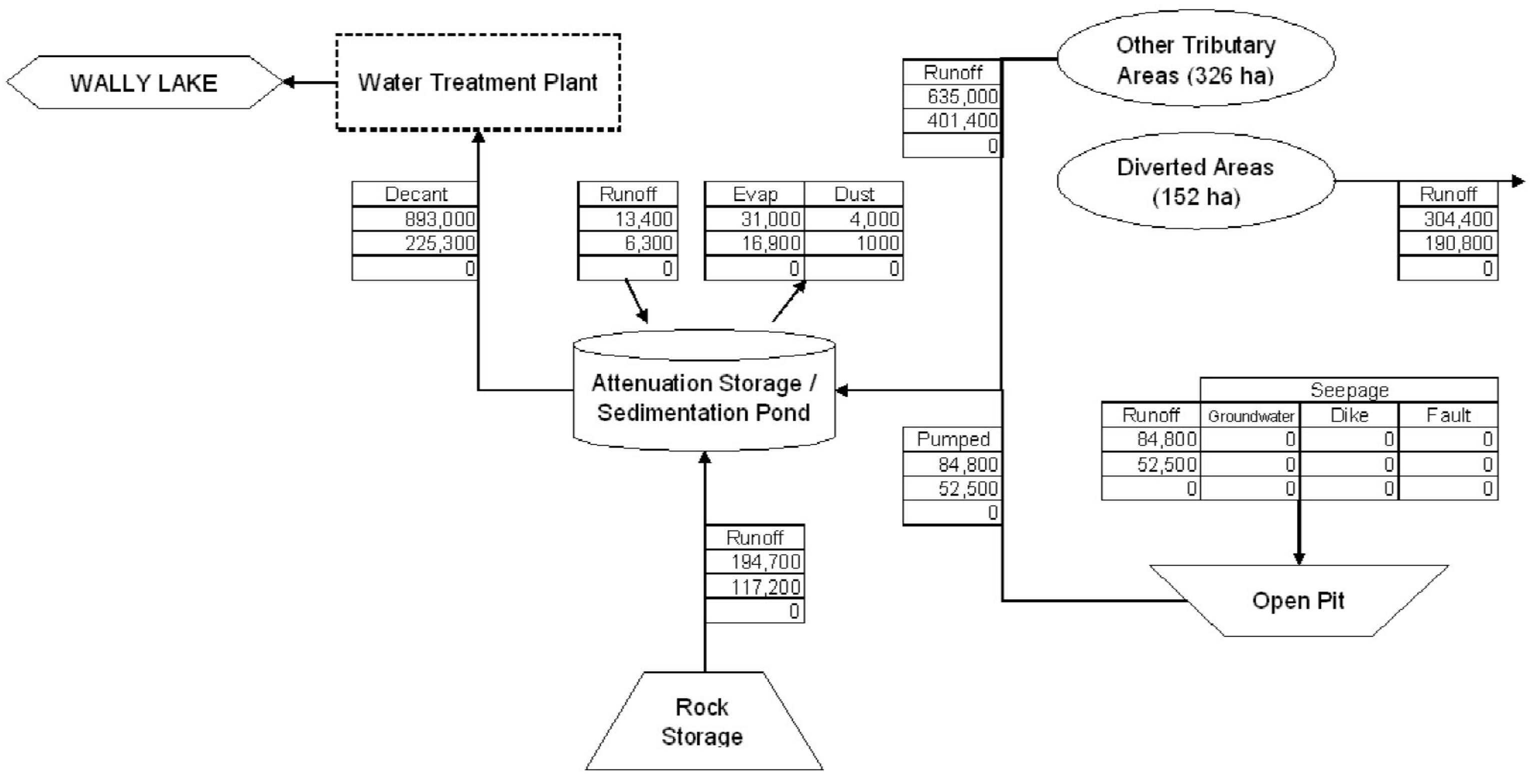
REVIEW			



Runoff = Precipitation - Evapotranspiration (terrestrial areas) - Sublimation
Water treatment requirements are water quality dependant

Legend	
100,000	Annual Total m^3
10,000	Maximum Monthly m^3
0	Minimum Monthly m^3

PROJECT
CUMBERLAND RESOURCES LTD.

TITLE
VAULT AREA WATER BALANCE - YEAR 3

Golder Associates

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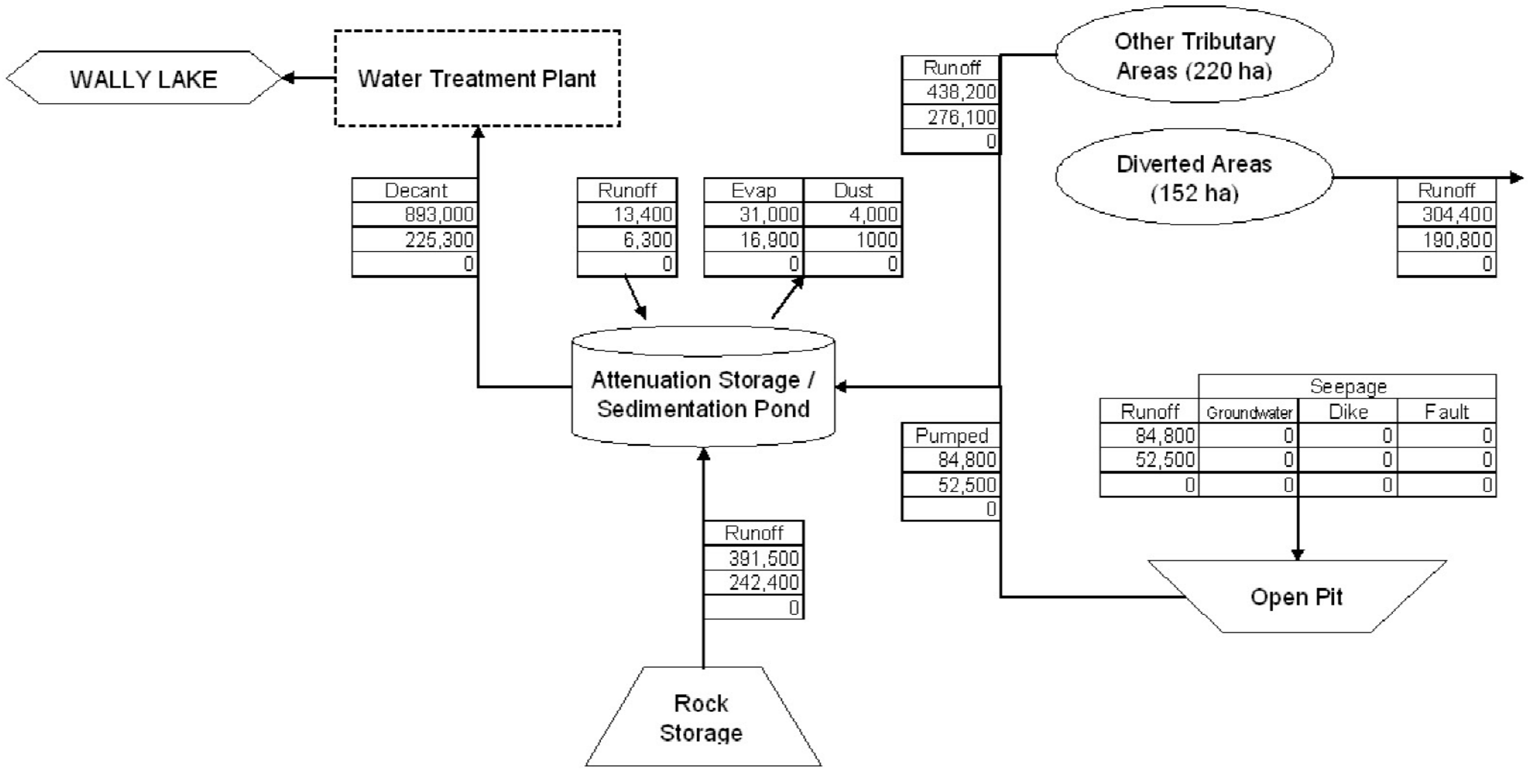
REVIEW			



Runoff = Precipitation - Evapotranspiration (terrestrial areas) - Sublimation
Water treatment requirements are water quality dependant

Legend	
100,000	Annual Total m^3
10,000	Maximum Monthly m^3
0	Minimum Monthly m^3

PROJECT
CUMBERLAND RESOURCES LTD.

TITLE
VAULT AREA WATER BALANCE - YEAR 6

Golder Associates

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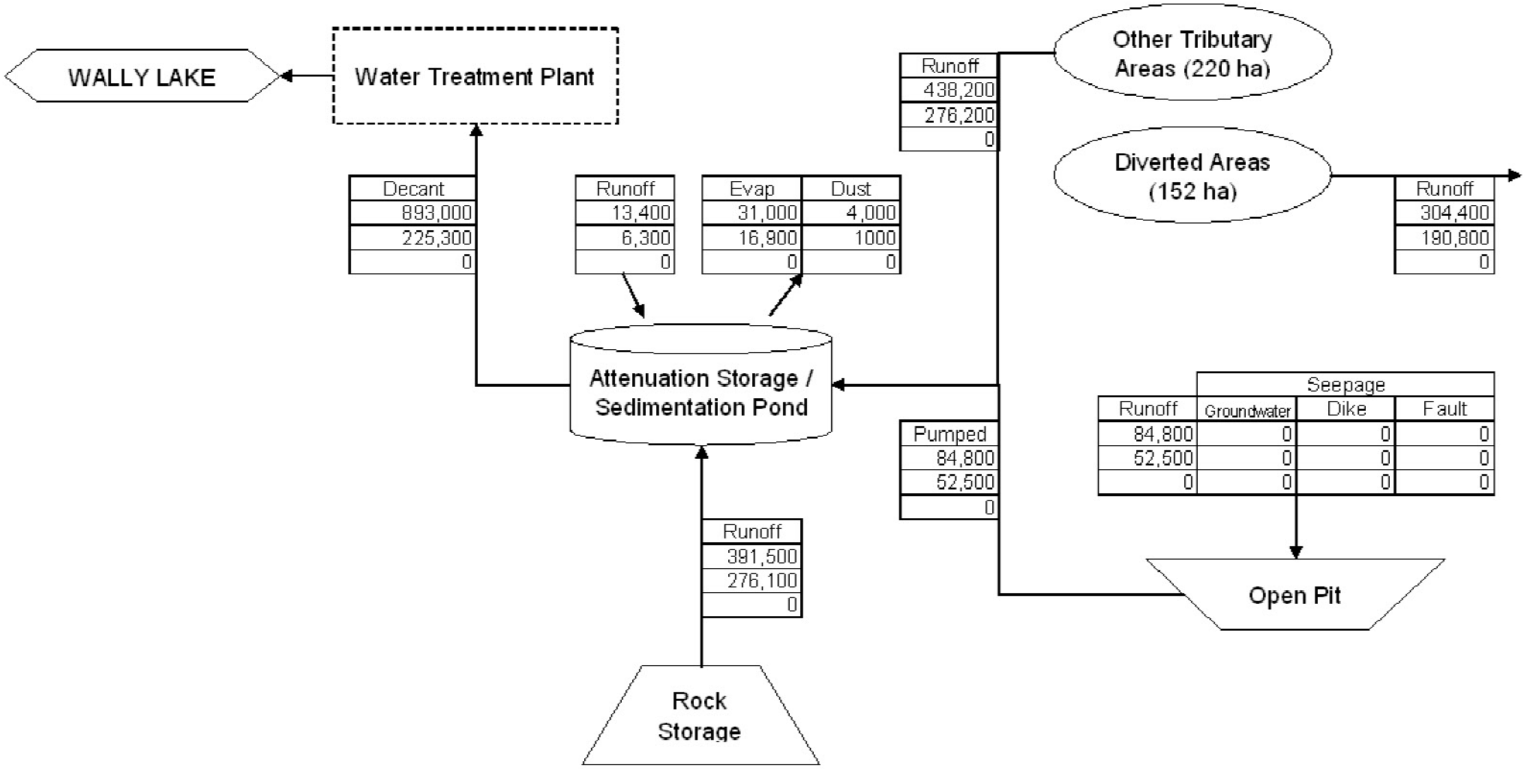

Runoff = Precipitation - Evapotranspiration (terrestrial areas) - Sublimation
Water treatment requirements are water quality dependant

Legend	
100,000	Annual Total m^3
10,000	Maximum Monthly m^3
0	Minimum Monthly m^3

PROJECT
CUMBERLAND RESOURCES LTD.

TITLE
VAULT AREA WATER BALANCE - YEAR 11

Golder Associates

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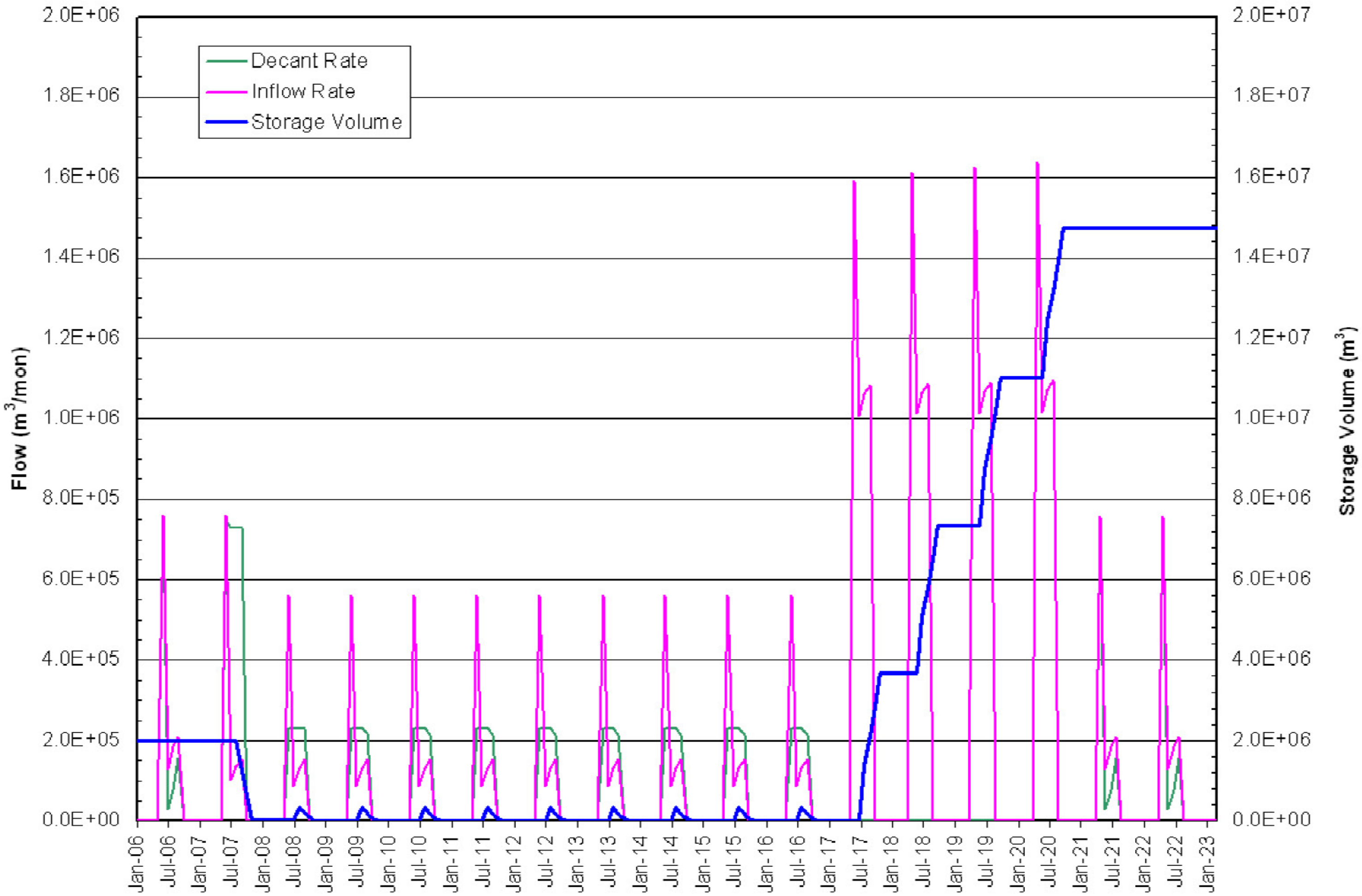

PROJECT

CUMBERLAND RESOURCES LTD.

TITLE

MODEL RESULTS FOR VAULT ATTENUATION POND (LAKE) - AVERAGE CLIMATE CONDITIONS

Golder Associates

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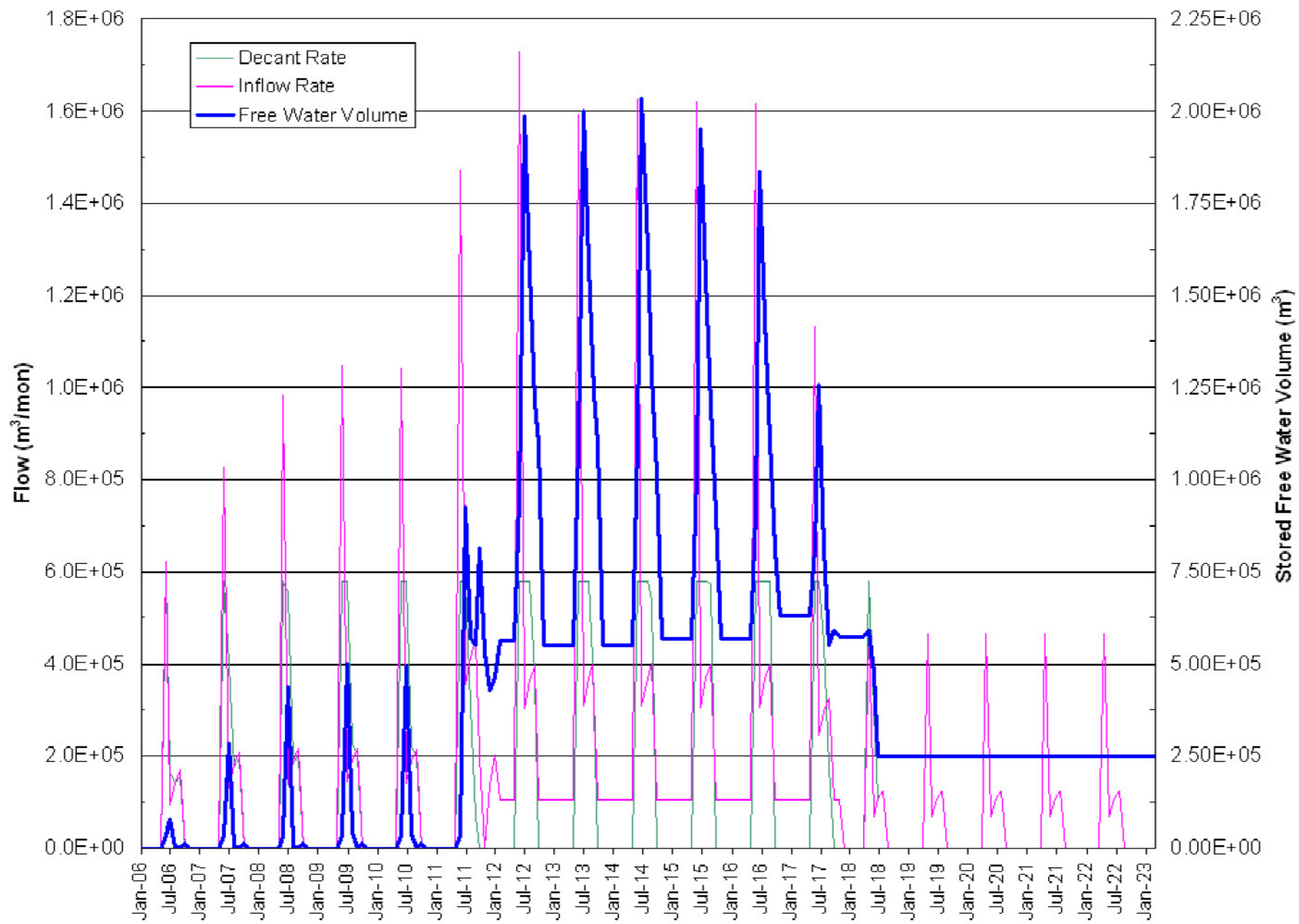

PROJECT

CUMBERLAND RESOURCES LTD.

TITLE

MODEL RESULTS FOR PORTAGE ATTENUATION/COMBINED POND - AVERAGE CLIMATE CONDITIONS

Golder Associates

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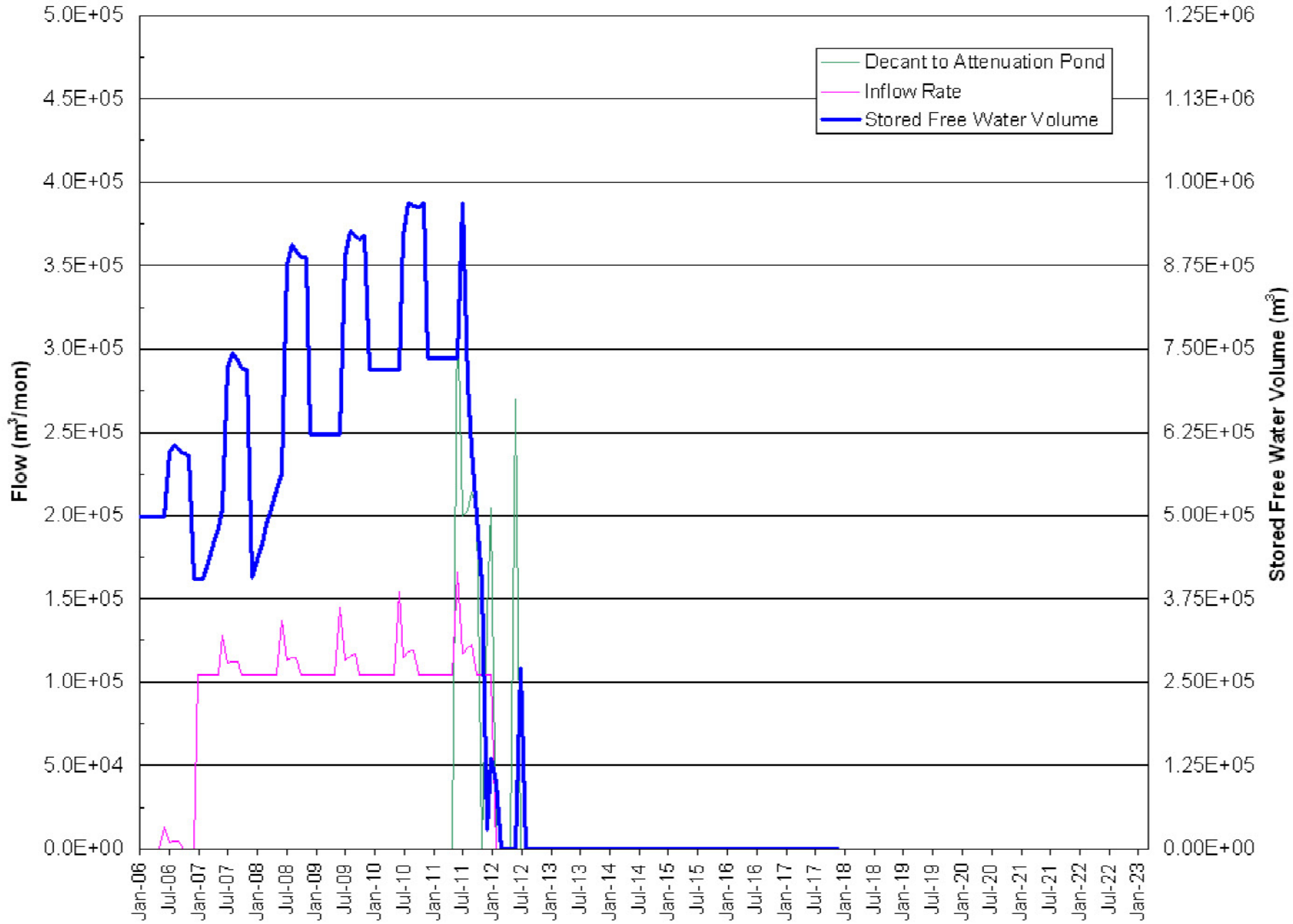
REVIEW			



PROJECT

CUMBERLAND RESOURCES LTD.

TITLE

MODEL RESULTS FOR PORTAGE RECLAIM POND - AVERAGE CLIMATE CONDITIONS

Golder Associates

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DESIGN	SD	4MAR04	SCALE NTS REV. -
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CHECK	SD	4MAR04	
REVIEW			

SECTION 10 • CONCLUSIONS

10.1 ROCK STORAGE

Waste rock from the North Portage, Third Portage, and Goose Island open pits will be stored in the Portage rock storage facility located to the north of Second Portage Arm and to the west of the Vault haul road. The storage area will be constructed to minimize the disturbed area, and will be capped with a layer of non-acid-generating rock to constrain the active layer within relatively inert materials. The waste rock below the capping layer will freeze, resulting in low rates of ARD generation in the long term.

Waste rock from the Vault open pit will be stored in the Vault rock storage facility to the north-west of the Vault open pit. Current geochemical predictions indicate that a capping layer will not be required over the Vault waste rock storage area.

10.2 TAILINGS IMPOUNDMENT

Tailings will be stored in Second Portage Arm. Initially the tailings will be deposited in a subaqueous environment, but the majority of tailings will be deposited subaerially. A reclaim pond will be operated within the tailings impoundment.

A dry cover of non-acid-generating ultramafic rockfill will be placed over the tailings to confine the permafrost active layer within relatively inert materials. The results of thermal modelling suggest that the tailings will freeze in the long term, and that the talik below Second Portage Arm will freeze before seepage from the tailings impoundment reaches the groundwater below the permafrost. Therefore, the potential for groundwater contamination to occur as a result of seepage from the tailings impoundment is considered to be low.

10.3 WATER MANAGEMENT

The water management plan objectives are to minimize potential impacts to the quantity and quality of surface water and groundwater resources at the site. Diversions are proposed to avoid the contact of clean runoff water with areas affected by the mine or mining activities. Contact water originating from mine affected areas will be intercepted, collected, conveyed to central storage facilities, and decanted to treatment, if needed, or to receiving lakes.

Portions of the dewatered Vault Lake and Second Portage Arm will serve as the central water attenuation storage facilities. Second Portage Arm will have two segregated water storage facilities for the storage of process reclaim water (main basin) and the Portage area mine site runoff (northwest basin) until approximately Year 5. From Year 6 of the mine life onward, the reclaim and runoff attenuation pond will be combined and will be operated at the western end of Second Portage Arm.

SECTION 11 • REFERENCES

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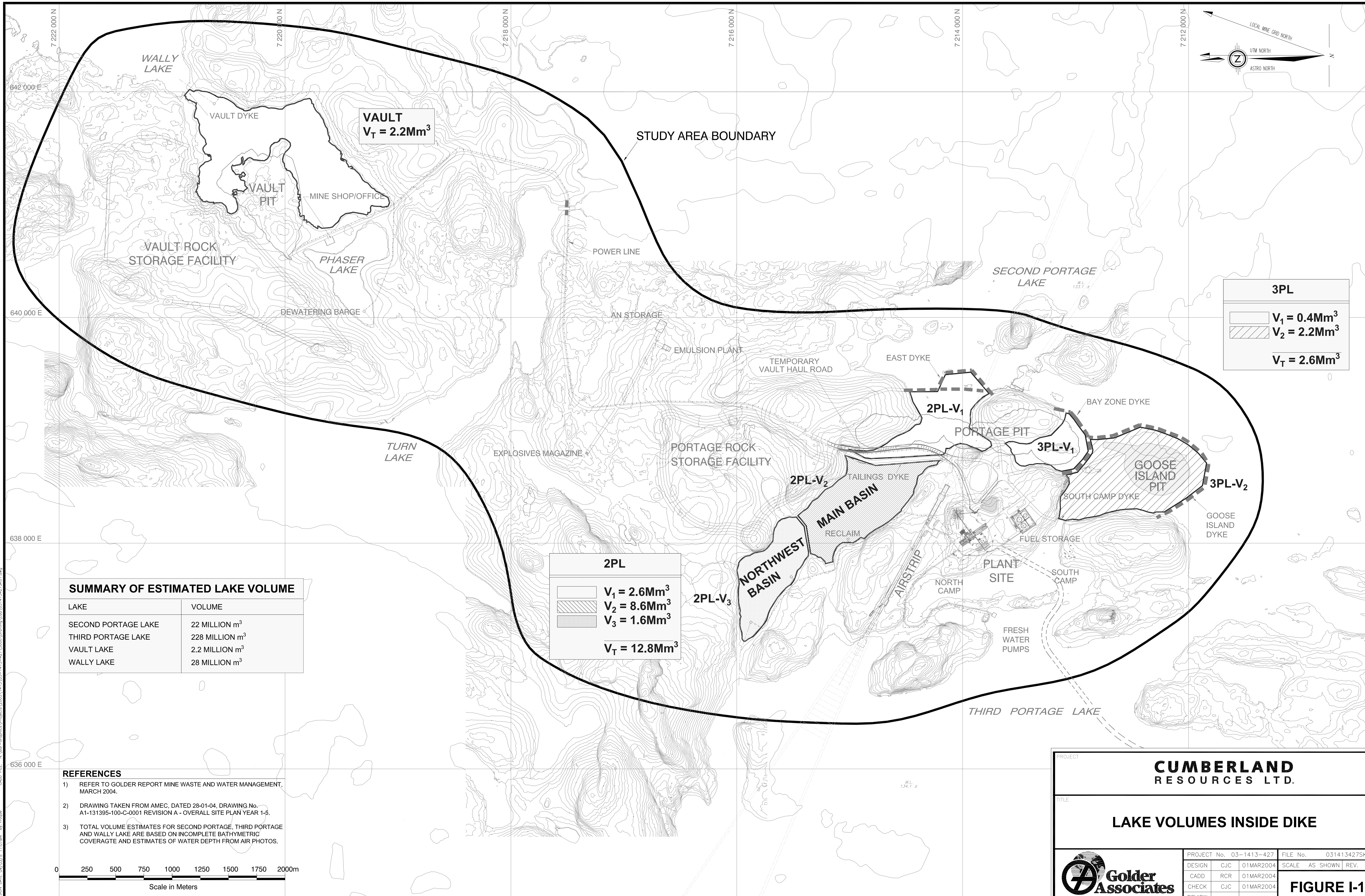
APPENDIX A

Lake Volumes



SUMMARY OF ESTIMATED LAKE VOLUME

LAKE	VOLUME
SECOND PORTAGE LAKE	22 MILLION m^3
THIRD PORTAGE LAKE	228 MILLION m^3
VAULT LAKE	2.2 MILLION m^3
WALLY LAKE	28 MILLION m^3

REFERENCES

1) REFER TO GOLDER REPORT MINE WASTE AND WATER MANAGEMENT, MARCH 2004.
2) DRAWING TAKEN FROM AMEC, DATED 28-01-04, DRAWING No. A1-131395-100-C-0001 REVISION A - OVERALL SITE PLAN YEAR 1-5.
3) TOTAL VOLUME ESTIMATES FOR SECOND PORTAGE, THIRD PORTAGE AND WALLY LAKE ARE BASED ON INCOMPLETE BATHYMETRIC COVERAGTE AND ESTIMATES OF WATER DEPTH FROM AIR PHOTOS.

PROJECT

CUMBERLAND RESOURCES LTD.

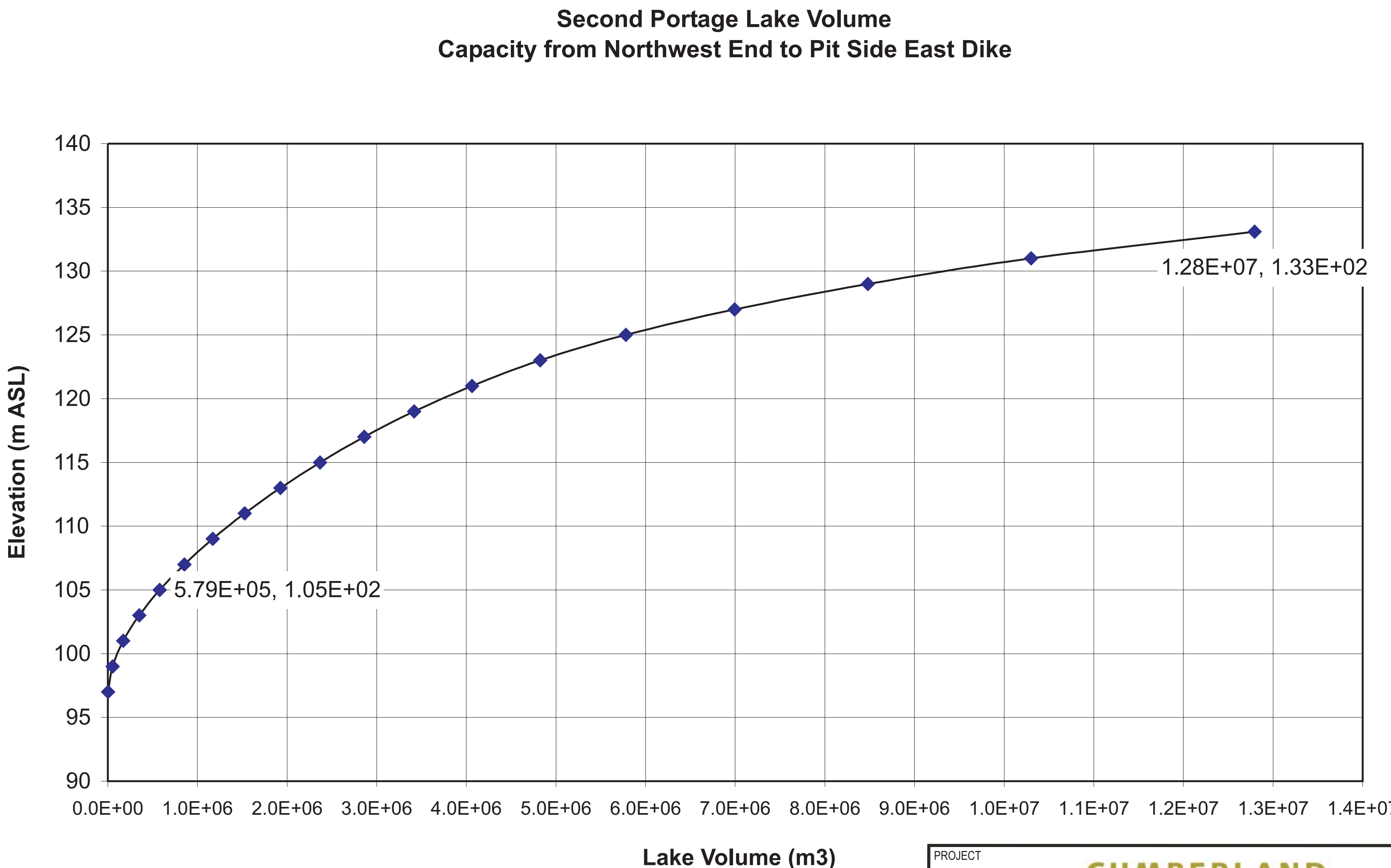
TITLE

LAKE VOLUMES INSIDE DIKE

Golder Associates

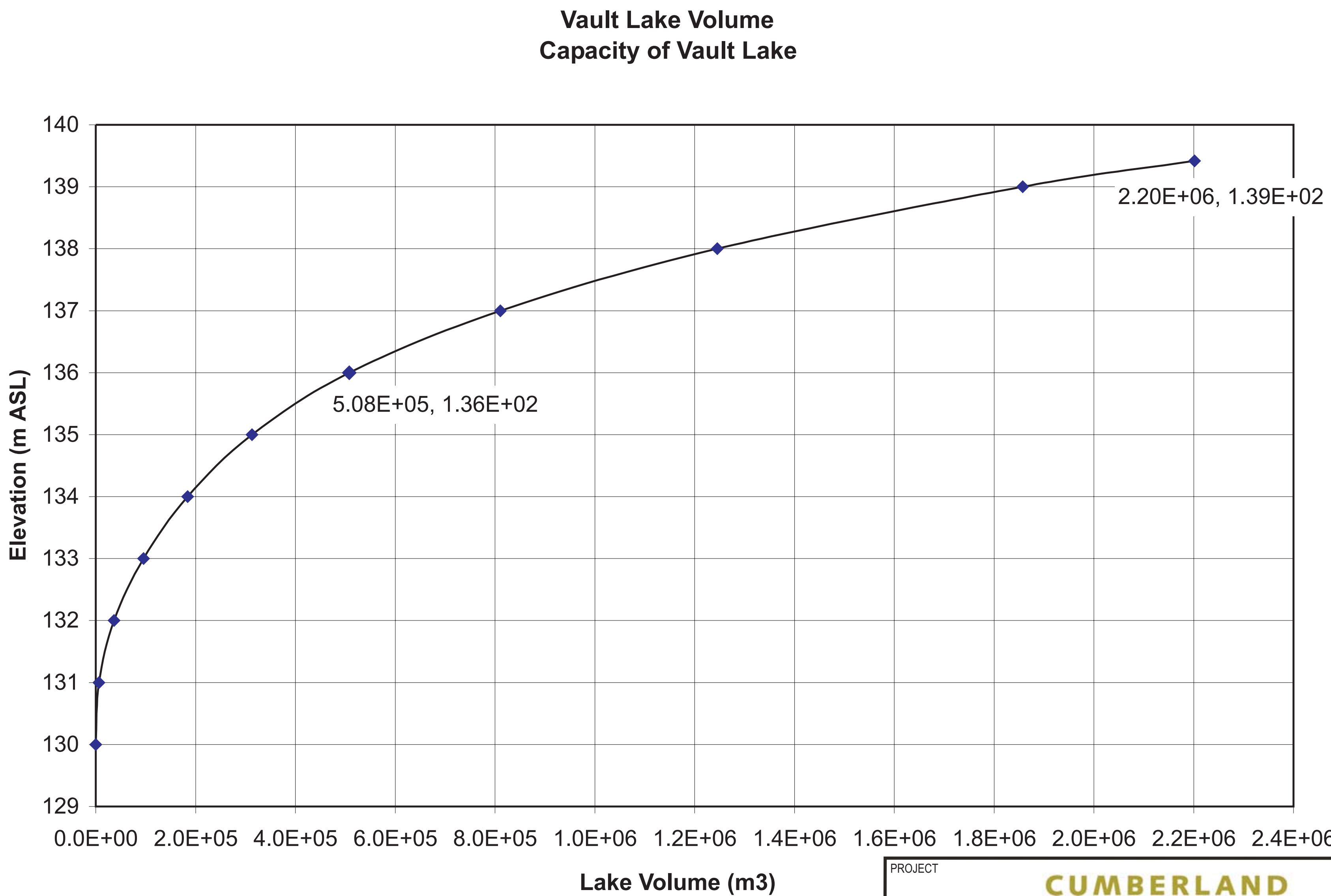
PROJECT No.	03-1413-427		FILE No.	031413427SK01
DESIGN	CJC	01MAR2004	SCALE AS SHOWN	REV. A
CADD	RCR	01MAR2004		
CHECK	CJC	01MAR2004	**FIGURE I-1**	
REVIEW				

REVISION DATE:01MAR04 BY: SS COREL FILE:N:\Bur-Graphics\Projects\2003\1413\03-1413-078\Drafting\corel\Charts.cdr



PROJECT	CUMBERLAND RESOURCES LTD.				
TITLE	SECOND PORTAGE LAKE ARM VOLUME INSIDE EAST DIKE				
Golder Associates	PROJECT No.	03-1413-078		FILE No. CHARTS	
	DESIGN	CJC	01MAR04	SCALE NTS	REV. 0
	CADD	SS	01MAR04	FIGURE I-2	
	CHECK	CJC	01MAR04		
	REVIEW				

REVISION DATE:01MAR04 BY: SS COREL FILE:N:\Bur-Graphics\Projects\2003\1413\03-1413-078\Drafting\corel\Charts.cdr



PROJECT

CUMBERLAND RESOURCES LTD.

TITLE

VAULT LAKE
VOLUME INSIDE VAULT DIKE

Golder Associates

PROJECT No.	03-1413-078		FILE No. CHARTS	
DESIGN	CJC	01MAR04	SCALE NTS	REV. 0
CADD	SS	01MAR04	FIGURE I-3	
CHECK	CJC	01MAR04		
REVIEW				

APPENDIX B

GoldSim Water Balance Model Assumptions

Table B.1: Water Balance Model Assumptions – General

Property	Value	Comment/Assumptions
Time Step	1 month	Runoff generation based on monthly precipitation totals. Water quality regulations are generally based on mean monthly water quality.
Simulation Start	1 Oct 2004 (month 0)	End of year -3 of project. GoldSim model is based on hydrologic year (October 1 to September 30).

Table B.2: Water Balance Model Assumptions – Mill/Process

Property	Value	Comment/Assumptions
Active Life (i.e., mill operational from / to)	1 Jan 2007 31 Dec 2017	Mill is active from start of year 1 (month 27) to end of year 11 (month 158)
Feed Rate	262.2 t/h	Mass including water
Feed Moisture Content	5%	
Solids Specific Gravity	2.90	
Tails Solids Content	49.5%	Slurry to tailings facility
Maximum Reclaim Rate	143.5 m^3/h	Based on 20% bulking of settled tails due to ice entrapment and a corresponding water content of 45% (Ww/Ws). (10% entrapment results in reclaim/makeup rates of 160 m^3/h/ 82 m^3/h whereas 30% entrapped ice results in rates of 128 m^3/h/ 113 m^3/h).
Min. Freshwater Makeup Rate	97.5 m^3/h	

Table B.3: Water Balance Model Assumptions – Climate/Runoff Generation

Property	Value	Comment/Assumptions
Precipitation	285 mm/a	This is the 1:2 year return period annual precipitation total and is equal to average conditions. GoldSim deterministic modeling uses the 1:2 year total. In probabilistic modeling mode, the model samples the annual total based on frequency analysis (between 1:100yr dry and 1:100yr wet) presented in AMEC BHR (2003).
Sublimation	40 mm/a	
Evapotranspiration	41 mm/a	Geometric mean of "ET & other losses" of AMEC Lake Water Balance (AMEC BHR, 2003) applied to terrestrial areas, assuming 25% sublimation. Monthly distribution as per site measured pan evaporation rates.
Lake Evaporation	258.4 mm/a	Applied to attenuation storage ponds
Terrestrial Runoff	204 mm/a	= precip. – sublimation - evapotranspiration Precipitation from October to May stored and released in month of June over a period of one month. Equivalent to a 72% runoff coefficient. Seepage to or from groundwater stores assumed negligible due to permafrost.

Table B.4: Water Balance Model Assumptions – Rock Storage Piles

Property	Value	Comment/Assumptions
Infiltration (shallow)	0, 30 & 50% of total runoff	Infiltration = 0% (winter), 30% (during June freshet) or 50% (through summer) of total available runoff. Assumed to be shallow infiltration which reports to base of pile in same month. Surface runoff = total runoff less infiltration. [geochem]
Surface Runoff	Total less Infiltration	
Water Retention	none	Conservatively assumed that the runoff generated by the rock piles is equal to the terrestrial runoff i.e., storage (freezing) of water within pile is not accounted for in model.
Pile Area Growth Rate		Linear, piles are assumed to reach the final surface area at half their active life. [geochem]
Vault Pile Final Area	193 ha	
Vault Pile Active Life	Month 27 to 146	Pile is active from Jan 1, 2007 (year 1) to Dec 31, 2016 (year 10)
Portage Pile Final Area	134 ha	
Portage Pile Active Life	Month 15 to 158	Pile is active from Jan 1, 2006 (year -1) to Dec 31, 2017 (year 11)
Pile Water Content	10%	Volumetric content [geochem]

Table B.5: Water Balance Model Assumptions – Attenuation/Storage Ponds

Property	Value	Comment/Assumptions
Ice Thickness	1.5 m	Average value over pond surface areas, assumed to form in November and thaw in June
Dust Control Vault	4,000 m^3	30 m^3/d from June to September, otherwise 0 m^3/month, assumed that the entire volume applied is evaporated.
Dust Control Portage	12,000 m^3	100 m^3/d from June to September, otherwise 0 m^3/month, assumed that the entire volume applied is evaporated.
Min. Free Water Portage Reclaim Pond	550,000 m^3	For mill reclaim/operation, excluding ice. Equal to 90 days X tailings water discharge rate of 6100 m^3/d. Water age of 60 to 90 days recommended for reclaim.
Pumping / Treatment		Any pumping to receiving environment or treatment facility occurs over the four summer months (June to September).
Seepage		Seepage to or from ponds through Taliks assumed negligible.

Table B.6: Water Balance Model Assumptions – Tributary Areas

Property	Value	Comment/Assumptions
Vault Area	607 ha	Natural drainage area to Vault dike of 556 ha + 56 ha affected by north end of rock storage pile
Vault Diversion	152 ha	Natural areas to the south of “Vault Lake” that drain to Phaser Lake and which could be diverted away from the attenuation storage.
Portage Area	577 ha	Natural drainage area to Second Portage Arm and Tailings dike of 563 ha + 14 ha affected by east end of rock storage pile / haul road and airstrip.

Mill Area	25 ha	Area of mill which does not naturally drain to Second Portage Arm is collected and directed to Portage attenuation ponds.
Goose Pit Area	95 ha	Area within dikes and to height of land to the west excluding pit footprint. Assumed that runoff from within these areas is collected and directed to the Portage attenuation pond. It may be possible, depending on the water quality, to direct some non-contact water from within these areas directly to the receiving environment.
North-Third Pits Area	137 ha	
Portage Diversion	200 ha	Natural area to the northwest of Second Portage Arm that can be intercepted via an interceptor ditch and diverted away from the attenuation storage.
Haul Road		Dust control for haul roads outside of Vault or Portage tributary areas is clean lake water.

Table B.7: Water Balance Model Assumptions – Tailings Disposal Facility

Property	Value	Comment/Assumptions
Ice Bulking	20%	Expected range 10 to 30%
Solids Specific Gravity	2.9	
Settled Solids Content	69.2%	Ws/(Ws+Ww)
Void Ratio	1.3	Vv/Vs
Water Content	45%	Ww/Ws, Assumes voids are saturated with ice.
Infiltration (shallow)	0, 15 & 40% of total runoff	Infiltration = 0% in winter, 15% during June freshet and 40% through summer. Assumed to be shallow infiltration which reports to base of tailings in same month. Surface runoff = total runoff less infiltration. [geochem]
Surface Runoff	0, 85 & 60%	
Active Life - to / from	Jan. 1, 2007 Dec 31, 2017	Pile is active from start of year 1 (month 27) to end of year 11 (month 158) – same as mill
Water Content of Exposed Tails	10 and 32%	Volumetric content assuming 40% void ratio and 25% or 80% saturation respectively for the surface runoff layer or infiltration active layer [geochem]
Surface Area of Exposed Tailings		Varies with time – deposition plan

Table B.8: Water Balance Model Assumptions – Open Pits

Property	Value	Comment/Assumptions
Dike Seepage Flux	5.87E-3 L/s/m	Most likely value - range of 6E-4 to 1.5E-2 L/s/m used in probabilistic simulation
Portion of Dewater to Attenuation (initial dewatering of lakes or portion thereof)	0%	Assume that dewatering of lakes within dikes can be managed so as to eliminate the need for centralised treatment i.e., use local sumps for sedimentation before discharging
Growth Rate of Pit Footprints	Linear	Pits are assumed to reach their final footprint in 12 months
Growth Rate of pit Surface Area	Linear	Pits are assumed to reach their final surface area at the end of their life. [geochem]
Runoff Volume		Computed based on pit footprint (in plan)
Seepage Storage		All seepages (through dikes, faults and groundwater) are assumed to produce year round. Volumes are stored through the winter and released / pumped in June over a one month period.
Groundwater Seepage		Rates vary by pit and with pit development.
Pit Wall Water Content	2.8%	Volumetric content [geochem]

Note: For other pit parameters see Table B.9.

Table B.9: Water Balance Model Assumptions – Open Pit Parameters (By Pit)

Parameter	Vault[a]	Goose	North Portage	Third Portage
Final Footprint (m^2)[b]	418,077	108,838	189,305	378,358
Flooded Footprint (m^2)[c]	4,729	0	7,354	8,743
Final Surface Area (m^2)[b] [geochem]	583,754	149,476	274,786	546,687
Flooded Surface Area (m^2)[c] [geochem]	47,299	0	8,674	9,745
Fault Seepage Rate (m^3/d)	0	100[d]	100	0
Groundwater Seepage Rate	N/A	Varies	Varies	Varies
Dike Length (m)	0	1,729	953	710 / 449[e]
Dike Rockfill [geochem] (m^3)	0	0	167,000	161,000 / 101,800[e]
Dike Surface Area [geochem] (m^2)	0	60,515	33,355	15,715
Lake Dewatering Volume (m^3)	$2.0x10^6$	$2.2x10^6$[f]	$11.0x10^6$[g]	$0.4x10^6$[h]
Lake Dewatering Period (mo)	June 2007 to Sept. 2007	June 2011 to Sept. 2011	June 2006 to Sept. 2006	June 2006 to Sept. 2006
Active Period	Jan. 2007 to Dec. 2016	Jan. 2012 to Dec. 2016	June 2006 to Dec. 2015	June 2006 to Dec. 2017
Commencement of Pit Flooding	Dec. 2016	Dec. 2016	Dec. 2017	Dec. 2017

Notes: a. Vault groundwater seepage assumed to be zero due to presence of isolated Talik. **b.** Ultimate operational footprint (in plan) and surface area (including walls) of pits. **c.** Exposed footprint (in plan) and surface area (including walls) of pits once flooded. **d.** In-situ permeability testing of the Bay Fault indicates that it has similar hydraulic conductivity to less fractured rock. A 100 m^3/d fault seepage rate was conservatively used for the Goose pit since the Bay Fault test holes were undertaken in the vicinity of Third Portage pit and greater fault hydraulic conductivities may exist for the Goose pit. **e.** Effective length of dike and associated rockfill (i.e., subject to water on upstream side) is shorter when Goose comes on-line. **f**. Between Goose Island and Bay Zone dikes. **g.** Second Portage Lake volume west of East dike less volume remaining in attenuation pond. **h.** Third Portage Lake volume north of Bay Zone dike.

APPENDIX C

GoldSim Water Balance Simulation Calendar

Gold*Sim* Simulation Schedule (Timestep in Months)
Meadowbank Gold Project

Yr/Month		Mine Yr	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Jul.	Aug.	Sept.
2004	**2005**	**-2**	0	1	2	3	4	5	6	7	8	9	10	11
2005	**2006**	**-1**	12	13	14	15	16	17	18	19	20	21	22	23
2006	**2007**	**1**	24	25	26	27	28	29	30	31	32	33	34	35
2007	**2008**	**2**	36	37	38	39	40	41	42	43	44	45	46	47
2008	**2009**	**3**	48	49	50	51	52	53	54	55	56	57	58	59
2009	**2010**	**4**	60	61	62	63	64	65	66	67	68	69	70	71
2010	**2011**	**5**	72	73	74	75	76	77	78	79	80	81	82	83
2011	**2012**	**6**	84	85	86	87	88	89	90	91	92	93	94	95
2012	**2013**	**7**	96	97	98	99	100	101	102	103	104	105	106	107
2013	**2014**	**8**	108	109	110	111	112	113	114	115	116	117	118	119
2014	**2015**	**9**	120	121	122	123	124	125	126	127	128	129	130	131
2015	**2016**	**10**	132	133	134	135	136	137	138	139	140	141	142	143
2016	**2017**	**11**	144	145	146	147	148	149	150	151	152	153	154	155
2017	**2018**	**12**	156	157	158	159	160	161	162	163	164	165	166	167
2018	**2019**	**13**	168	169	170	171	172	173	174	175	176	177	178	179
2019	**2020**	**14**	180	181	182	183	184	185	186	187	188	189	190	191
2020	**2021**	**15**	192	193	194	195	196	197	198	199	200	201	202	203
2021	**2022**	**16**	204	205	206	207	208	209	210	211	212	213	214	215
2022	**2023**	**17**	216	217	218	219	220	221	222	223	224	225	226	227
2023	**2024**	**18**	228	229	230	231	232	233	234	235	236	237	238	239
2024	**2025**	**19**	240	241	242	243	244	245	246	247	248	249	250	251

Oct. 1 2004 - Start of simulation (Timestep 0)
Jun. 1 2006 - Initiate dewatering activities for North and Third Portage and Vault pit areas
Oct. 1 2006 - Start of milling process
Sept. 30 2006 - End of dewatering activities North and Third Portage pit areas
Jan. 1 2007 - Initiate activity in North, Third and Vault pits
Jun. 1 2010 - Initiate dewatering activities for Goose Pit area
Sept. 30 2010 - End of dewatering activities Goose pit area
Jan. 1 2011 - Initiate activity in Goose pit
Dec. 31 2015 - North pit goes dormant dewatering continues till end of Third pit activity
Dec. 31 2016 - Goose and Vault pits inactive and flooded
Dec. 31 2017 - Third pit inactive and North and Third pits flooded, mill inactive