Mine Closure & Associated Costs

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srk consulting 50 YEARS

Contents

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SRK Consulting, Corporate Consultant (Mine Closure)

BA Geology, Dartmouth 1980

Exploration geologist – 5 years

Research geologist – 3 years

Resource geologist – 2 years

Closure/geochemistry – 34 years

Hobbies: woodworking, cooking, mineral collecting

Sports: sailing, skiing

01

What is Mine Closure?

Impacts of mining

Mining changes the land

Mines changes the social, cultural & economic context

Some bio-physical impacts cannot be mitigated

Levels of wealth created during mining is rarely sustainable after closure

Physical and socioeconomic impacts should be assessed prior to operations and again prior to closure

A plan to mitigate both the biophysical and socioeconomic impacts of closure should be developed before mining starts

Why We Close Mines

Reduce liabilities

Reduce risk

Protect the environment

Create a positive legacy for affected communities

It is the law

It’s the right thing to do

Mine closure plan

A mine closure plan that incorporates both physical rehabilitation and socio-economic considerations should be an integral part of the project life cycle and should be designed so that:

- *Future public health and safety are not compromised;*
- *The after-use of the site is beneficial and sustainable to the affected communities in the long term;*
- *Adverse socio-economic impacts are minimized and socioeconomic benefits are maximized.*

IFC EHS Guidelines - Mining

Closure Plan Strategy

Prepare a strategy to develop a closure plan that includes:

- A vision for the site after closure
- Post-closure land use(s)
- Closure objectives
- Closure actions
- Socioeconomic transitioning
- Post-closure management and monitoring

What have we learned in three decades?

Closure is part of the mine life cycle

Importance of planning early

Each site is different

People are part of the equation

Data needed for mine closure

Potential for unplanned closures

Holistic approach

Financial responsibility

Conclusions

Some mining impacts cannot be eliminated

We rely on models to predict future conditions, perhaps too much

Science and engineering are constantly evolving

Socioeconomic success relies on supporting self-sustaining programs

There is a great need to develop capacity in most communities and governments

02

Socioeconomic Transitioning

“We have two ears and one mouth so that we can listen twice as much as we speak.”

Epictetus

What is socioeconomic transitioning?

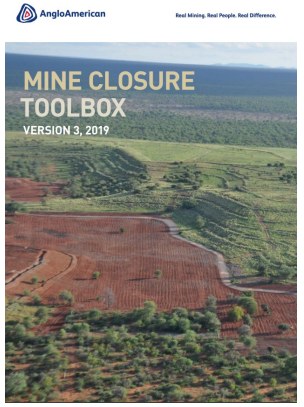
Transition from a mining to post-mining economic context

Closure of a mining operation will cause significant socioeconomic impacts on dependent communities.

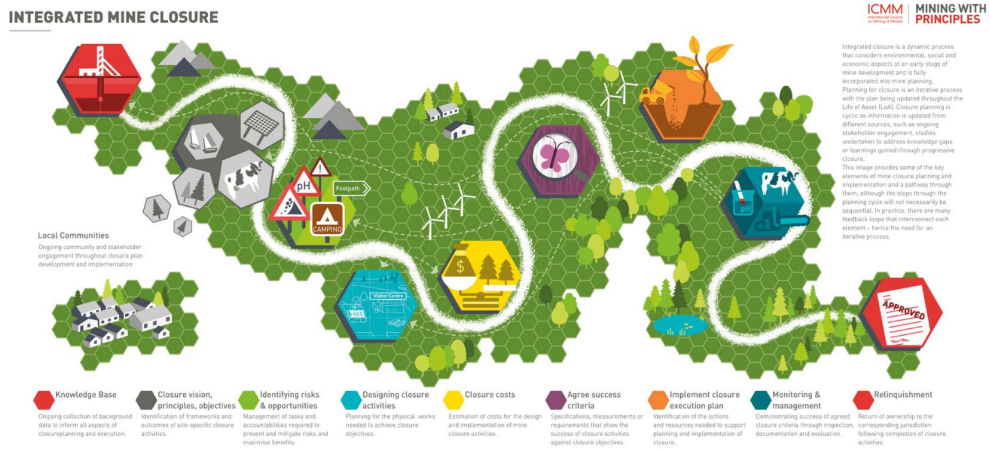
- Direct and indirect employment
- Economic development
- Community services
- Health services
- Social investment programs

A positive legacy can be created through proactive planning and integration of socioeconomic aspects into the closure process.

The World Bank, 2021
For policy makers, governmental administrators, and lawmakers

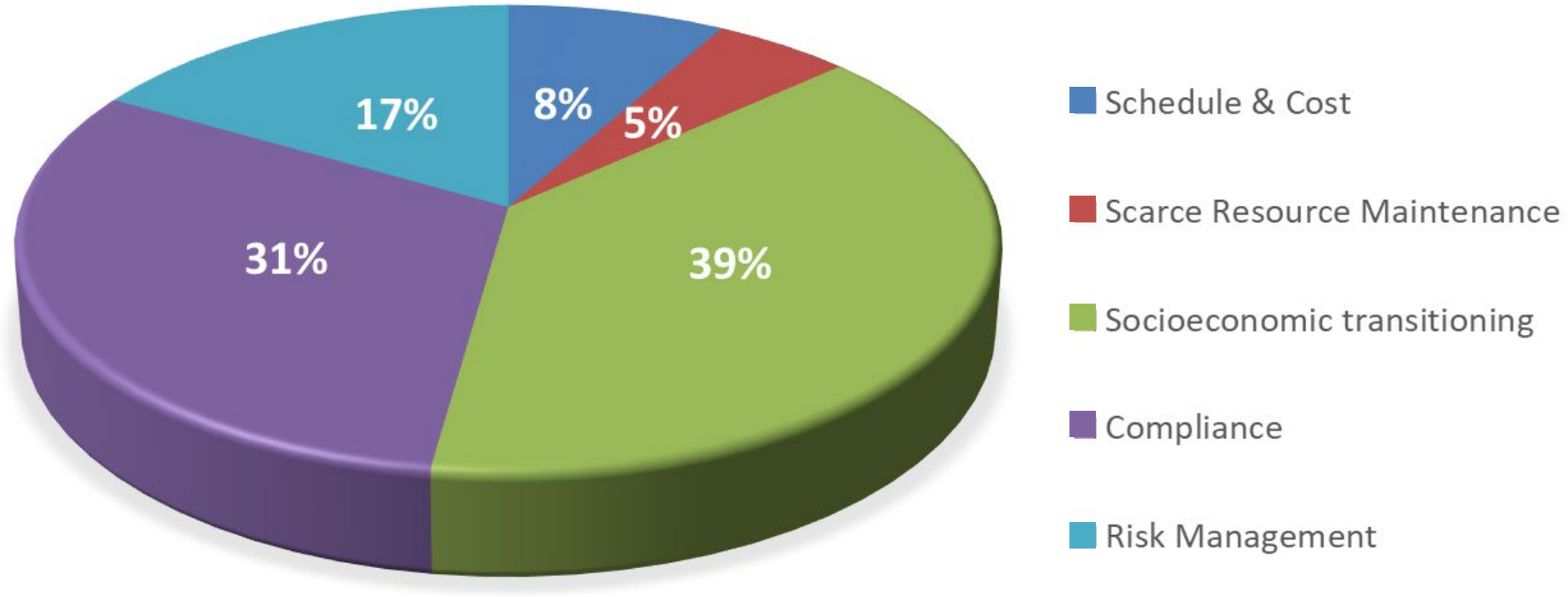


Anglo American, 2019
Internal document



ICMM, 2019
For both large and small mining companies.

MJ survey results: Most important KPI for closure[1]



[1] Mining Journal, Mine Closure Review: Planning for successful rehabilitation, 2020
Over 400 respondents

Responsibilities in mine closure/socioeconomic transitioning

MINING COMPANIES

Operational CSR aimed at socioeconomic transitioning

Pre-closure social baseline and impact assessment

Preparation of site & infrastructure for repurposing

Develop of socioeconomic transitioning & repurposing plan

Retrenchment

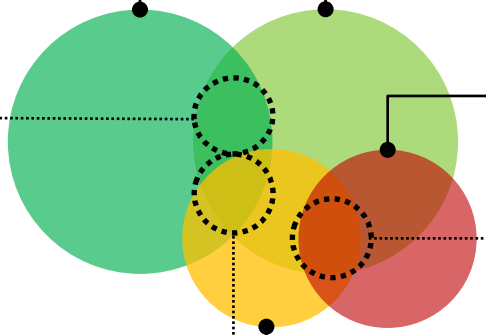
Grievance mechanism

GOVERNMENT

Develop and implement law and policy with regards to social aspects of closure

Review of closure plans including socioeconomic transitioning

Review of post-closure monitoring plans



JOINT RESPONSIBILITIES OF GOVERNMENT AND MINING COMPANY

Stakeholder engagement for closure

Development of post-closure vision

Post-closure socioeconomic monitoring

NGOS AND COMMUNITIES

Input to post-closure vision

JOINT RESPONSIBILITIES OF GOVERNMENT, CORPORATE SECTOR, AND NGOS

Post-closure socioeconomic transitioning & repurposing

CORPORATE SECTOR

JOINT RESPONSIBILITIES OF GOVERNMENT, CORPORATE SECTOR, AND MINING COMPANY

Implementation of post-closure socioeconomic transitioning plan

Funding of post-closure transitioning

Source: World Bank, Mine Closure: A Toolbox for Governments

Stakeholder Engagement Challenges

- Having the initial conversation
- Starting socioeconomic investment programs too late
- Managing expectations
- Balance stakeholder “wants” with what is possible
- Determining who will fund and execute the plan
- Creating effective and sustainable partnerships

03

Closure QP Responsibilities

QP responsibilities

Disclosure

"… all disclosure be based on advice by a "qualified person"…"

A qualified person "…has experience relevant to the subject matter of the mineral project and the technical report."

Mine closure

Closure is a necessary part of the mine life cycle

It will happen

It will cost money – often significant money

Should be managed as a capital project

It is part of public disclosure requirements (in varying degrees)

Reporting Codes

Canada’s NI 43-101 requires disclosure of closure risks and costs

The United States Securities and Exchange Commission (SEC) updated the disclosure rules for US listed companies with mining assets

The new disclosure system is similar to, but different than Canada’s NI 43-101

NI 43-101

Environmental Studies, Permitting and Social or Community Impact

Discuss reasonably available information on environmental, permitting and social or community factors related to the project. Consider and, where relevant, include

a) a summary of the results of any environmental studies and a discussion of any known environmental issues that could materially impact the issuer's ability to extract the mineral resources or mineral reserves;

b) requirements and plans for waste and tailings disposal, site monitoring and water management both during operations and post mine closure;

c) project permitting requirements, the status of any permit applications and any known requirements to post performance or reclamation bonds;

d) a discussion of any potential social or community related requirements and plans for the project and the status of any negotiations or agreements with local communities; and

e) a discussion of mine closure (remediation and reclamation) requirements and costs.

S-K 1300 Relevant Factors in Technical Studies

Factors	Initial Assessment	Preliminary Feasibility Study	Feasibility Study
Environmental Compliance & Permitting	List of required permits & agencies are drawn. Significant obstacles to obtain permits have been determined. Identify pre-mining land uses. Assess requirements for baseline studies. Assume post-mining land uses. Assume tailings disposal, reclamation, and mitigation plans.	Identification and detailed analysis of environmental compliance and permitting requirements has been completed. Detailed baseline studies with preliminary impact assessment (internal) are completed. Detailed tailings disposal, reclamation, and mitigation plans have been determined.	Identification and detailed analysis of environmental compliance and permitting requirements are finalized. Baseline studies are completed with a final impact assessment (internal). Tailings disposal, reclamation, and mitigation plans are finalized.
Other Relevant Factors	Appropriate assessments have been completed of other reasonably assumed technical and economic factors necessary to demonstrate reasonable prospects for economic extraction.	Reasonable assumptions, based on appropriate testing, on the modifying factors are sufficient to demonstrate that extraction is economically viable.	Detailed assessments of modifying factors necessary to demonstrate that extraction is economically viable have been completed.
Capital Costs	Optional. If included: Accuracy: ±50% Contingency: 25%	Accuracy: ±25% Contingency: 15%	Accuracy: ±15% Contingency: 10%
Operating Costs	Optional. If included: Accuracy: ±50% Contingency: 25%	Accuracy: ±25% Contingency: 15%	Accuracy: ±15% Contingency: 10%

04

Closure Costs - Introduction

Closure cost estimate uses

Technical studies

Project planning

Budgeting/reconciliation

Financial reporting

Permitting/financial assurance

Closure costs

Closure (cost) requirements can vary greatly between jurisdictions

Closure costs can be material

Some jurisdictions require financial assurance for closure

Key factors include:

- Receptors of impacts
- Point in the mine life cycle
- Proximity to communities
- Water

Closure cost accuracy

Only as good as the plan

Typically based on the level of report being prepared

Closure costs may be less accurate than overall cost

AACE International Cost Estimate Classes

	Primary Characteristic	*Secondary Characteristic*			
ESTIMATE CLASS	**LEVEL OF PROJECT DEFINITION** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]	**PREPARATION EFFORT** Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/ Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

Notes: [a] The state of process technology and availability of applicable reference cost data affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

[b] If the range index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

05

Closure Cost Estimate Types

Mine Closure Cost

Generic term often applied to any number of more specific types of mine closure cost estimates including:

- Financial Assurance Cost Estimates
- Life-of-Mine (LOM) Closure Cost Estimates
- Asset Retirement Obligation (ARO) Estimate

Without clarification or context, can be confusing or potentially misleading

Financial Assurance Cost

Estimated cost for responsible regulatory agency to perform all of the actions required to implement an approved reclamation/closure plan

Usually used to determine the amount of financial security required under governing regulations

- Typically assumes third-party costs
- May be subject to govt. contracting laws
- Generally uses current or maximum near-term cost

Financial assurance – country requirements

Many jurisdictions have no financial assurance requirement

Some do not consider post-closure

Some require financial assurance for only a portion of the liability

Some allow the asset value of the mine to be used as financial assurance

Others allow Net Present Value (NPV) and corporate guarantees

Some require 100% in hard securities

Life-of-Mine (LOM) Cost

Estimated cost for mine operator to perform all of the actions required to fulfill an approved reclamation/closure plan in the context of operations

Usually used for planning, financing, budgeting and cost tracking

- Prefeasibility/feasibility
- Due diligence
- Accrual allocation

Includes all planned development

Cash flow basis

Asset Retirement Obligation (ARO)

Fair value of abandonment liabilities associated with mining and mineral processing operations for financial reporting

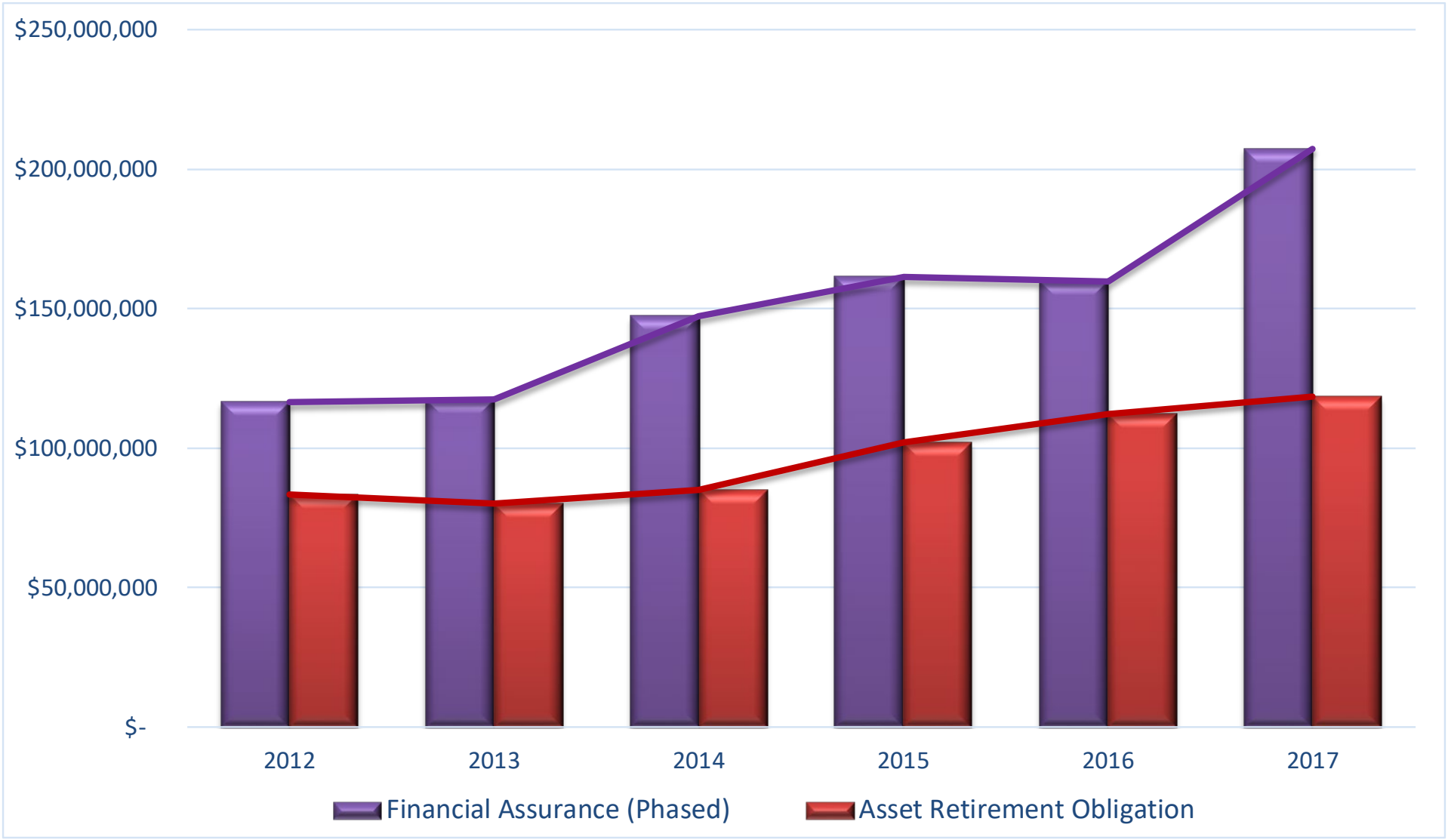
Amount company would pay a third party to assume responsibility (including a profit margin)

Includes both Legal and Constructive Obligations

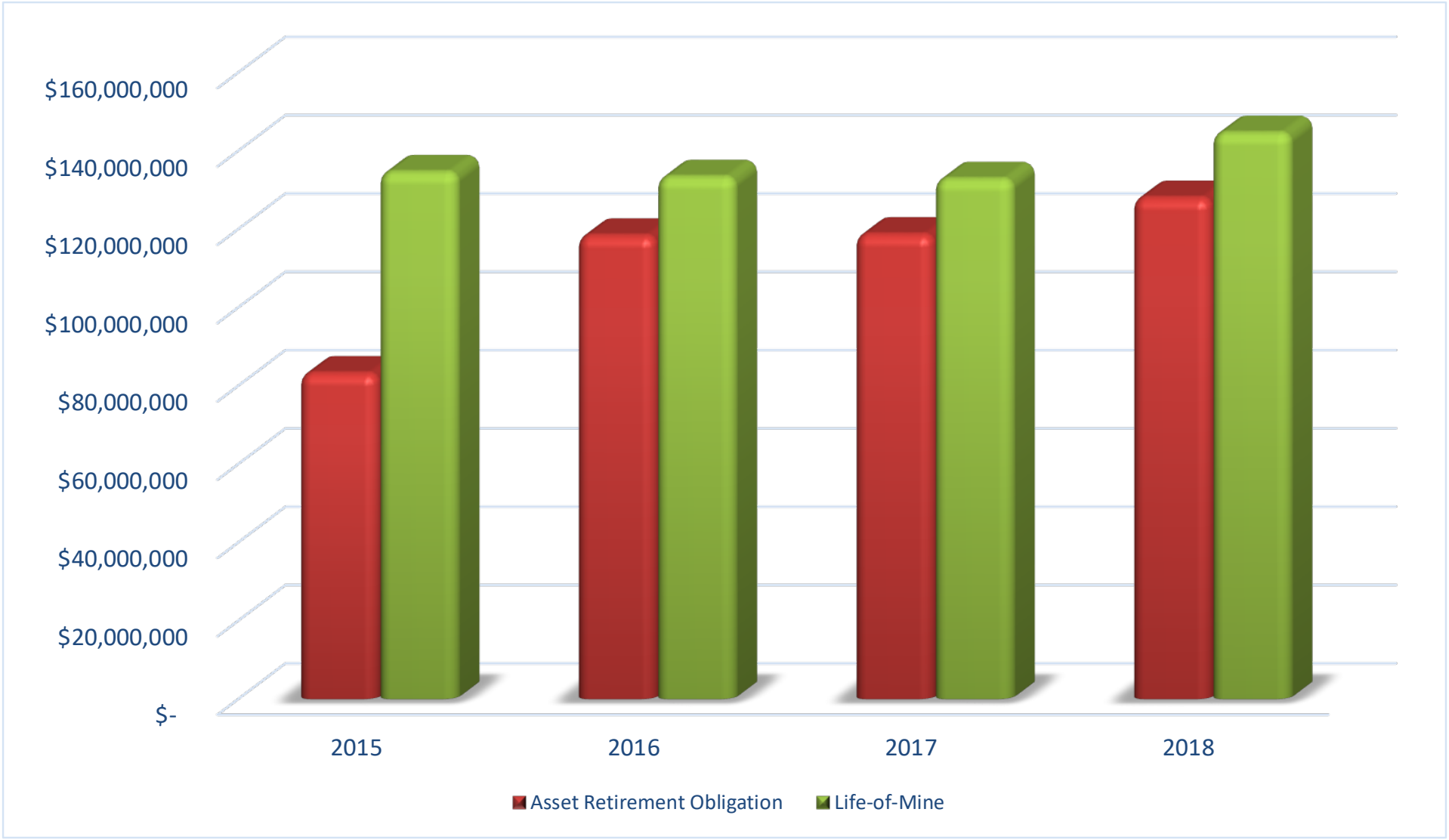
Only includes liability existing in reporting year

Cash flow basis

Financial Assurance vs. ARO



ARO vs. LOM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$100,000,000
$80,000,000
$60,000,000
$40,000,000
$20,000,000
$-
2015
2016
2017
2018
Asset Retirement Obligation
Life-of-Mine

Closure cost types

	Financial Assurance	LOM	ARO	Early Closure
Use(s)	Financial security	Planning (prefeas, feas), budgeting, etc.	Financial Reporting to Shareholders	Planning, financial decision
Rate Basis	Third-party	Operator & Third-party	Operator & Third-party	Operator & Third-party
Included Development	Maximum (near-term)	All Planned	Current Financial Year	Current + Permit
Govt. Contracting Rules	Maybe	No	No	Maybe
Cost Basis	Current Cash/Cashflow	Cash Flow	Cash Flow	Either/both
Salvage Value	No (varies)	Yes	No	No (generally)

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Closure Costs

Direct costs

Earthworks

- Reshaping
- Cover placement
- Stormwater controls

Decommissioning & demolition

Revegetation

Water/solution management

Remedial works

Closure planning

General & administration

Mobilization/ demobilization

Indirect costs

Design

Site operations

- Camp
- Water supply

Engineering

Contract administration

Project management

Corporate support

Insurance

Performance bonds

Contingency

Indirect costs

Costs that are typically used included as percentages of direct costs:

- Contractor OH & profit
- Performance bonds
- Contract administration
- Contingency

Some costs are often included as percentages but can usually be calculated/estimated:

- Mobilization/demobilization
- Engineering
- Permitting
- Camp costs

AACE International Cost Estimate Classes

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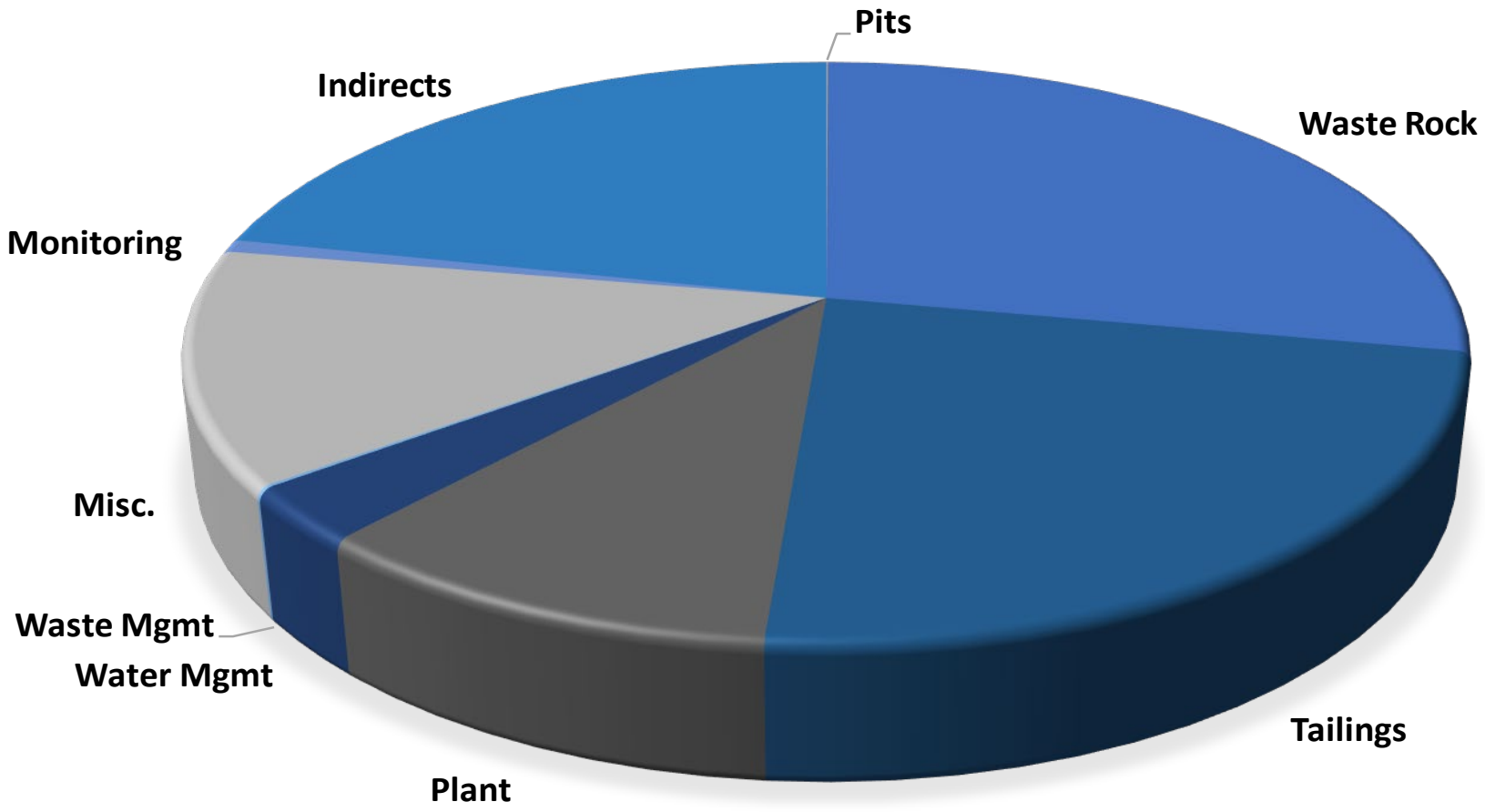
[b] If the range index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

Typical closure costs



07

Estimating Closure Costs

Estimating closure liabilities

Every site is different, every closure plan is different

A cost estimate is only as good as the plan it is based upon

There is more than one way estimate closure costs

It is an estimate

Level of accuracy depends on

- Detail of design
- Input data
- Intended use

Cost estimate setup

Know your plan

Understand plan objectives

Gather the data

How will the mine be built?

How & when will it be closed?

How often will it be updated?

Realize there is more than one way

What information is needed?

- Current mine plan
- Proper closure plans
- Site-specific data
- Available equipment
- Fluid management requirements
- Materials balance
- Additional permitting requirements
- Long-term maintenance and monitoring obligations
- Mobilization requirements

Common estimating methods

Engineer's estimate

Contractor bid

Site data

Cost databases

Standardized unit costs

Benchmarking

First principles

Public domain tools:

- Standardized Reclamation Cost Estimator (SRCE) www.nvbond.org
- New South Wales www.resourcesregulator.nsw.gov.au
- others

Standardized unit costs (SUC)

One unit cost for each facility type or activity

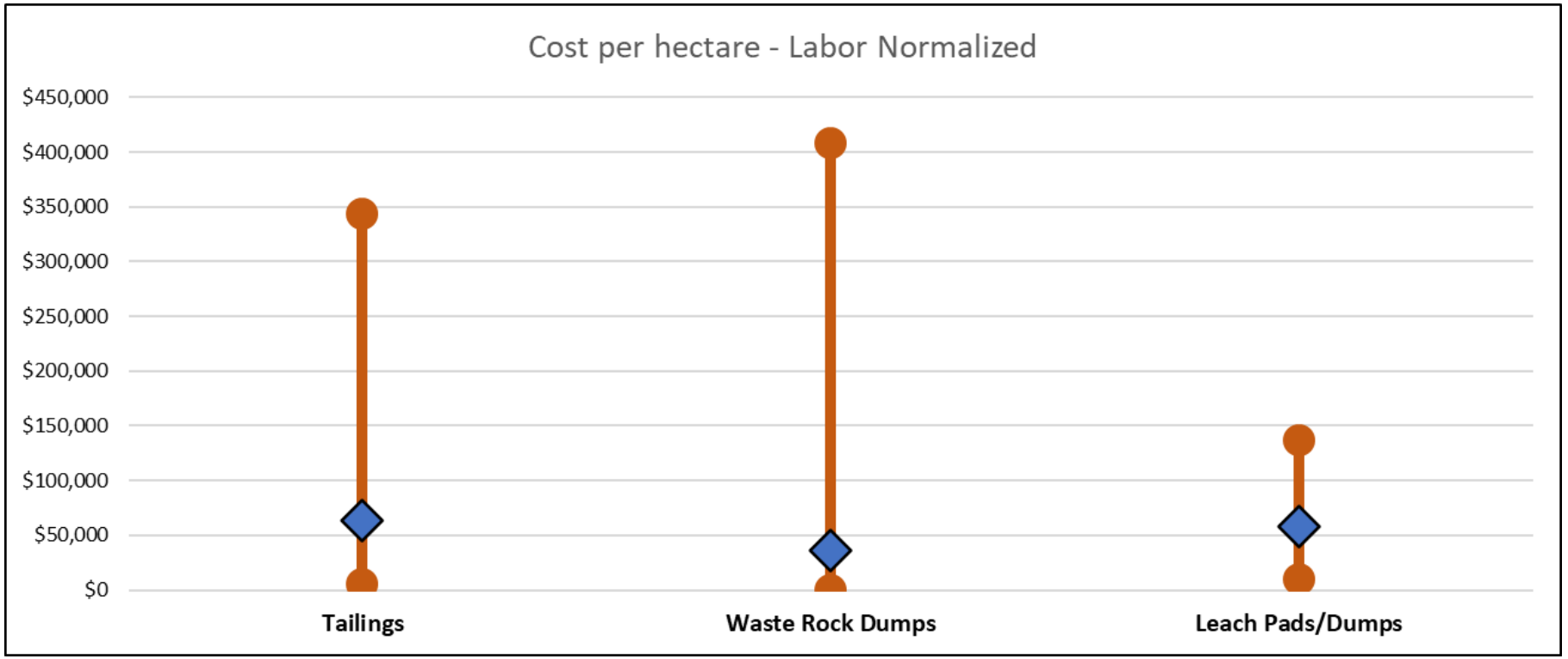
- Cost/ha for tailings impoundment
- Cost/m^3 topsoil placement

Usually based on average or average + xSD

Does not consider

- Site specific conditions
- Individual facility configurations
- Site specific closure plan

Benchmarking – Total Cost



First principles

Estimate costs by determining:

- Type of work to be done
- Quantity of work to be done
- Equipment and personnel needed

Calculate amount of time to complete the work

- How much work can crew do in 1 hour

Calculating costs – first principles

Time = $quantity \div productivity$

Cost = $time \times rates$

Things to consider

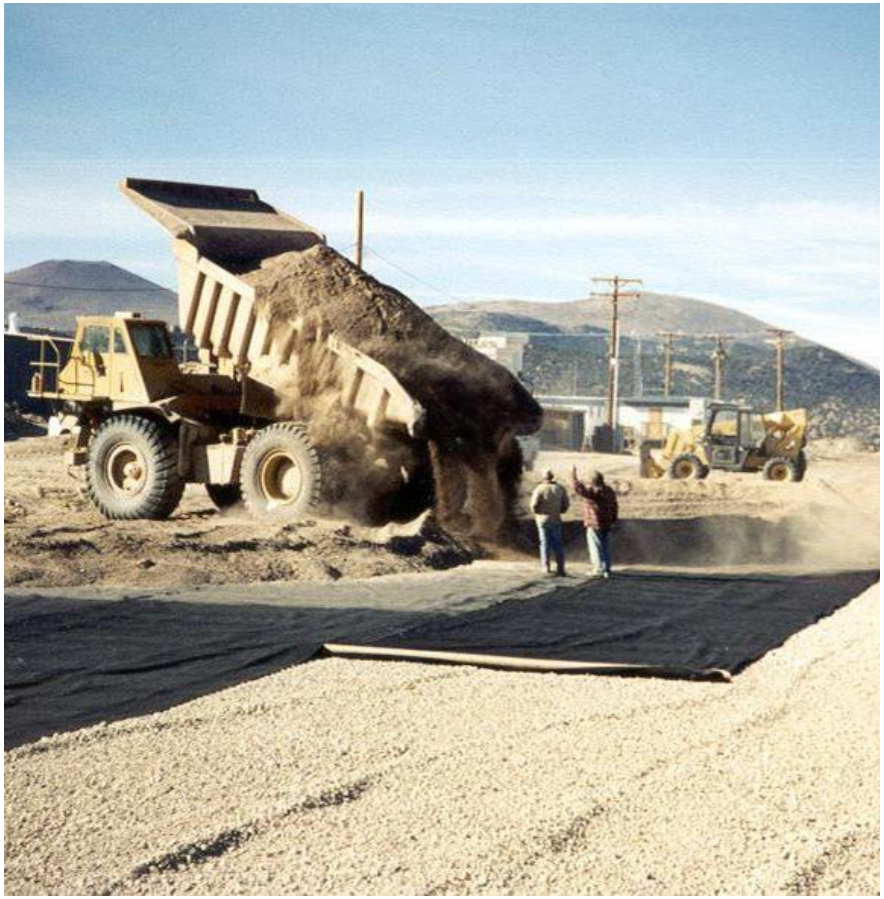
Cost estimate is only as good as the plan

It is an estimate

- Rounding
- Volume calculations
- Productivity calculations

Level of accuracy depends on

- Input data
- Level of design
- Ontended use



Cost estimating models

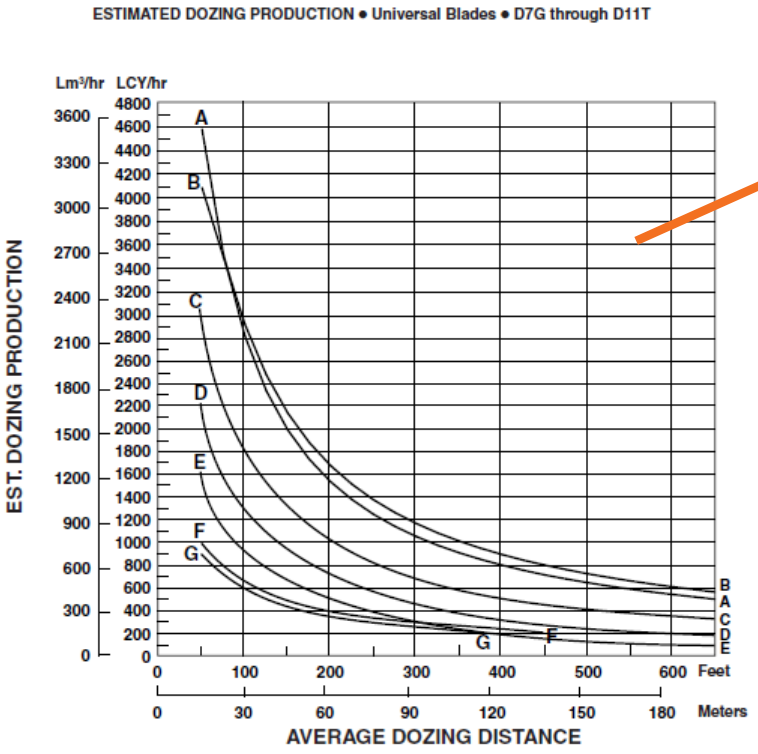
"… all models are wrong; the practical question is how wrong do they have to be to not be useful."

George Box - Box & Draper (1987)

08

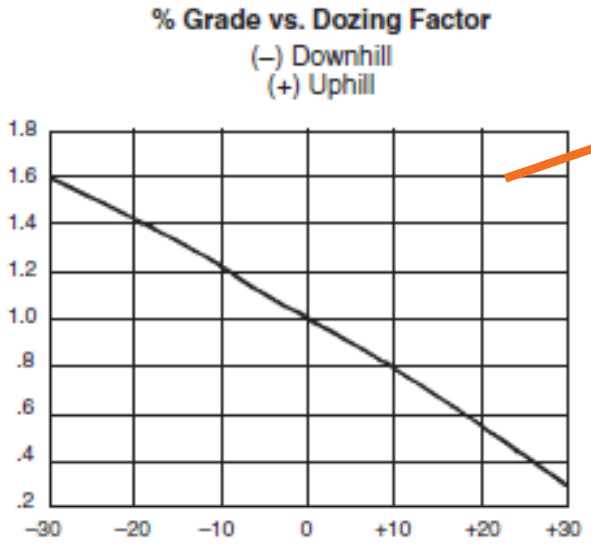
Calculating Productivities

Dozer productivities



Correction Factor	Method	Value
Productivity vs. Dist.	Calculated	Varies
Grade	Calculated	Varies
Operator	Average	0.75
Material Condition	User selected	Varies
Slot Dozing	User selected	1.2
Side by Side Dozing	User selected	1.2
Job Efficiency	50 min/hr.	0.83
Altitude Deration*	Calculated	Varies

Dozer productivities



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Altitude Deration*	Calculated	Varies

Dozer productivities

JOB CONDITION CORRECTION FACTORS

	TRACK-TYPE TRACTOR	WHEEL-TYPE TRACTOR
OPERATOR —		
Excellent	1.00	1.00
Average	0.75	0.60
Poor	0.60	0.5[illegible]
MATERIAL —		
Loose stockpile	1.20	1.20
Hard to cut; frozen —		
with tilt cylinder	0.80	0.75
without tilt cylinder	0.70	—
Hard to drift; "dead" (dry, non-cohesive material) or very sticky material	0.80	0.80
Rock, ripped or blasted	0.60-0.80	—
SLOT DOZING	1.20	1.20
SIDE BY SIDE DOZING	1.15-1.25	1.15-1.25
VISIBILITY —		
Dust, rain, snow, fog or darkness	0.80	0.70
JOB EFFICIENCY —		
50 min/hr	0.83	0.83
40 min/hr	0.67	0.67
BULLDOZER*		
Adjust based on SAE capacity relative to the base blade used in the Estimated Dozing Production graphs.		
GRADES — See following graph.		

*NOTE: Angling blades and cushion blades are not considered production dozing tools. Depending on job conditions, the A-blade and C-blade will average 50-75% of straight blade production.

Correction Factor	Method	Value
Productivity vs. Dist.	Calculated	Varies
Grade	Calculated	Varies
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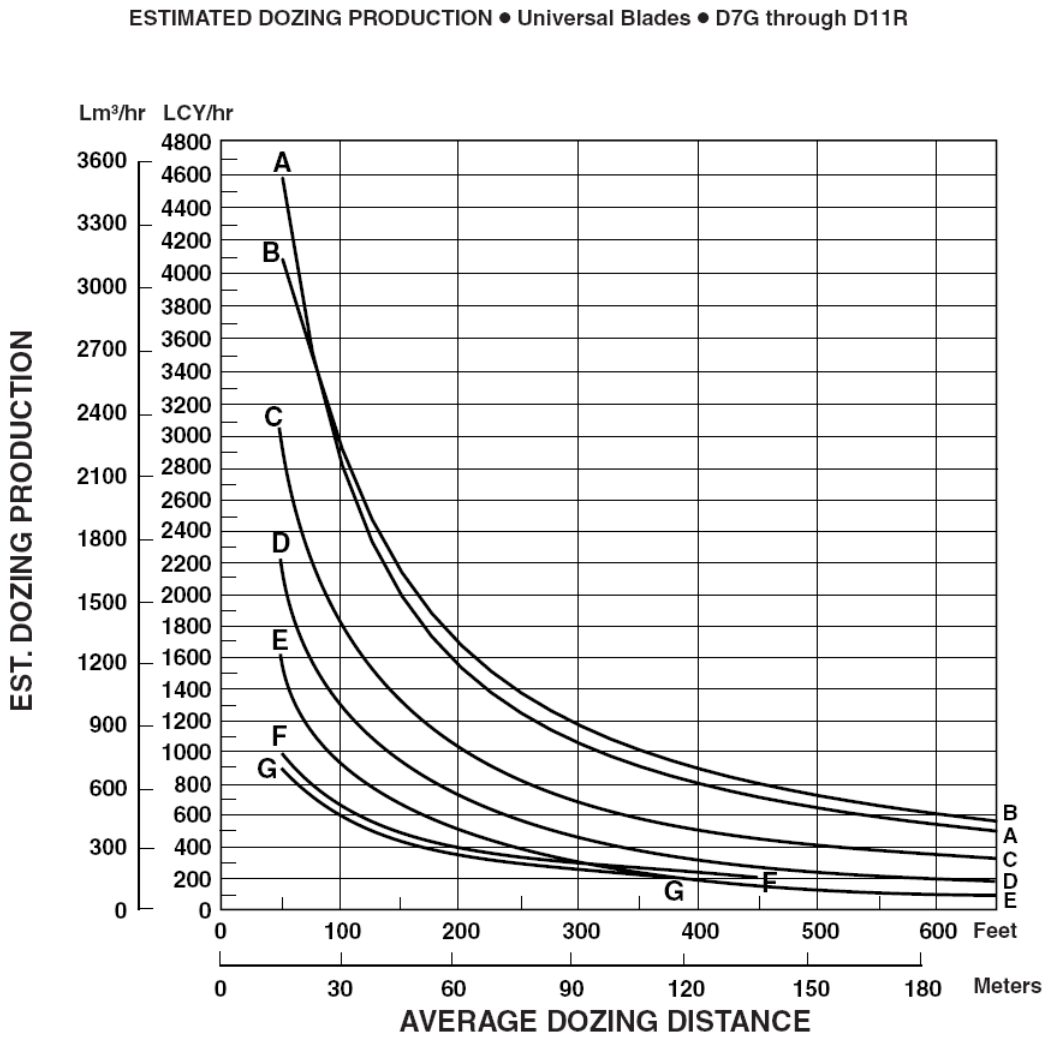
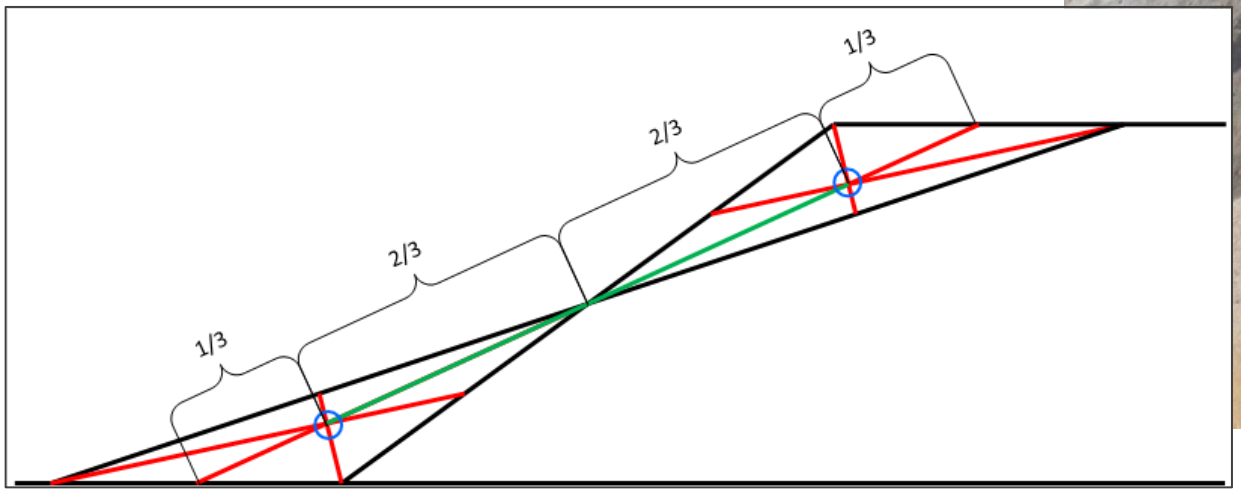
Dozer productivities



Grading Distance

Centroid-to-centroid

2/3 distance from intersection to opposing sides



09

Post-Closure Costs

Post-closure costs

Water!!!

How long will it last?

How will it be funded?

Post-closure costs

Monitoring

Maintenance

- roads
- water conveyance (pipes/ditches)

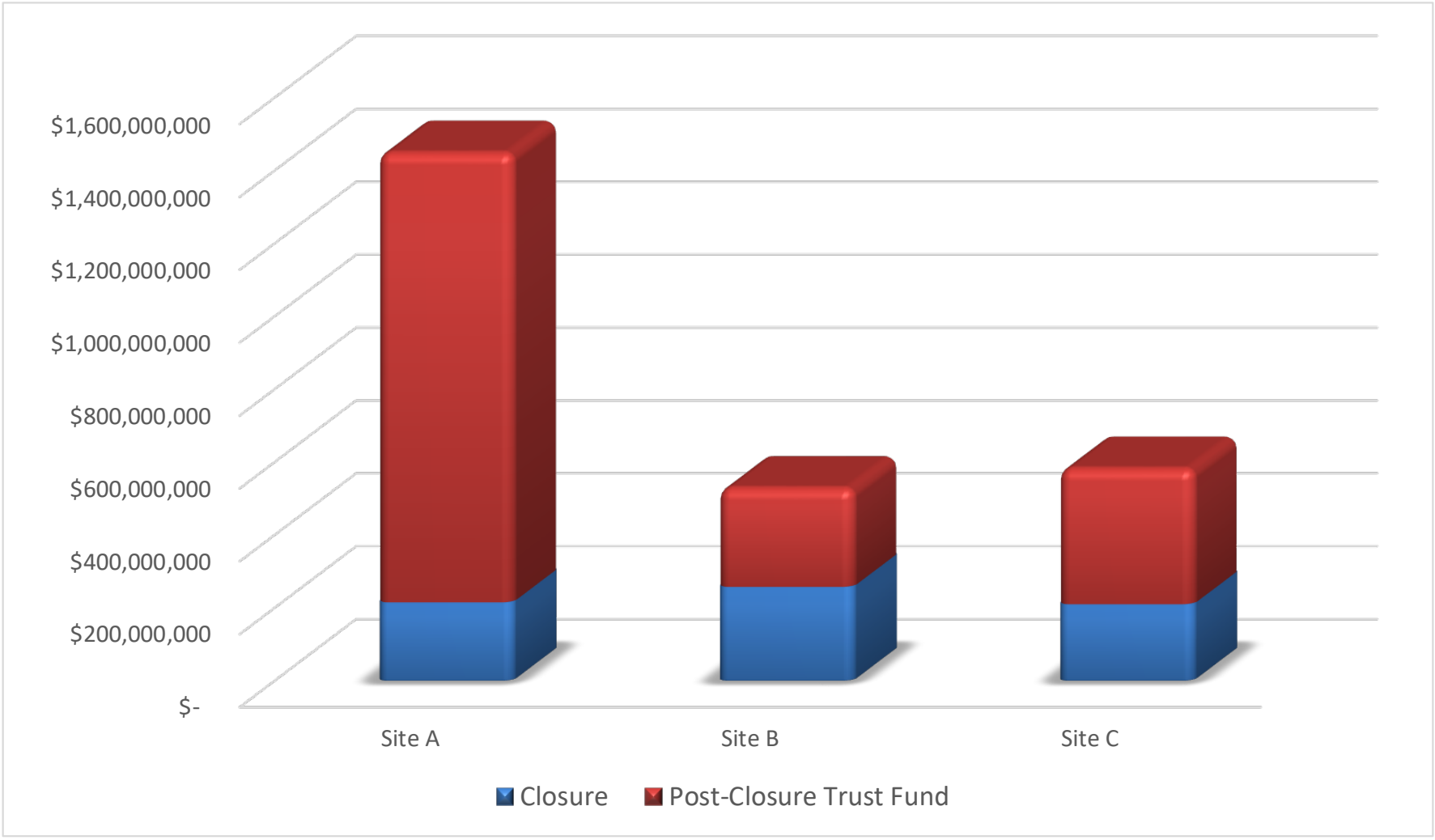
Operating costs

- labor
- water management
- pumping

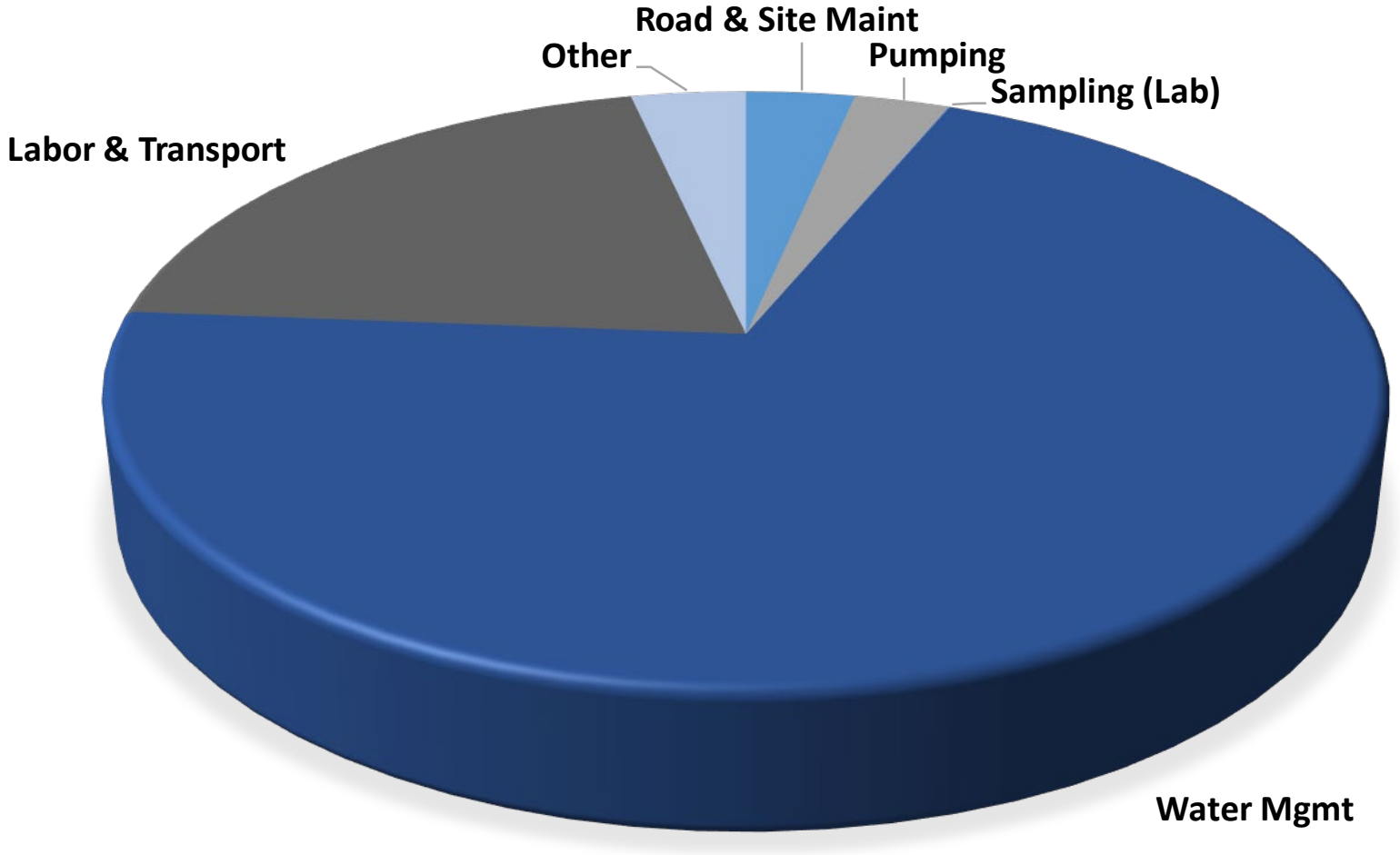
Sustaining capital costs

- water treatment plant rebuild/replacement
- pond liner replacement

Closure vs. post-closure



Post-closure costs



10

Closing Comments

Identifying “red flags”

Does the closure plan comply with Good International Industry Practice?

Do the costs seem reasonable for the site?

Are the calculation methods used transparent and appropriate?

Are the calculations for all unit rates documented?

Is inflation being addressed by inflating the entire estimate over years/decades?

Is the equipment proposed available and appropriate?

Does the schedule seem reasonable?

Conduct calculation checks

Is there enough annotation?

Basis of Estimates

Report/Memo that describe and explains the details of the estimate:

- Methodology
- Unit rate criteria or origin
- Assumptions
- Results

NPV vs. current costs

Out of sight, out of mind

Does not consider early closure risk

Project cost vs. portfolio costs

Closure component will become more significant as mine winds down

Questions?