Attachment D
Residual Risks of Example Alternatives

1 Introduction

This attachment presents the results of three facilitated workshops held in early 2006 to assess the risks associated with the example alternatives that were under consideration at that time.

The workshop participants included representatives of the Faro Mine Closure Planning Office, SRK, the Type II Mines Office, affected First Nations, and Environment Canada. All participants were provided with draft copies of the example alternatives report prior to the workshop. A preparatory day was held immediately prior to the first workshop to review the draft report and introduce the risk rating method.

2 Method

The workshops used a modified form of the "Risk Rating" method developed by the INAC Contaminated Sites Program.

The risk rating method employs the three charts on the following pages.

The "Consequence-Severity Matrix" lists various types of negative outcomes, and classifies their severity from "Low" to "Critical". The matrix shown here is taken directly from the INAC-CSP guidance. The examples show how consequence severities have been classified at other mine sites.

The "Likelihood" chart defines a series of terms used to define the likelihood that a consequence (from the previous chart) will be realized. The columns of the table give examples to guide the selection of the appropriate term.

The "Risk Matrix" assigns each combination of severity and likelihood to a "risk" level. The significance of the risk levels is only apparent when one considers the resulting actions. For the assessment of example alternatives, the following set of "required actions" was adopted.

- For "Very High", "High" and most "Moderately High" risks, available mitigation measures were added to the alternative and included in the cost estimate.

- For "Moderate", "Low" and "Moderately High" risks with low probabilities, contingencies were added to the cost estimates.

- All risks that, after mitigation measures and contingencies are added, still classified as "Very High", "High" or "Moderately High" were identified as "residual risks" in subsequent presentations of the example alternatives.

The workshops were held at SRK's Vancouver offices in January and February 2006. Within the workshops, the risk rating tools were applied as follows for each example alternative:

- The example alternative was introduced and its components described by the SRK and FMCPO engineers. Workshop participants asked questions where needed to clarify their understanding of the alternative.

- For each component of that alternative, the workshop participants were then asked to identify scenarios or conditions leading to risks. Each scenario or condition was followed through to one of the consequences shown on the C-S matrix. For example, if a "dam failure" scenario was suggested, the group was asked to work though the subsequent chain of events, such as "tailings release leading to severe long-term contamination of Rose Creek".

- The group then agreed where the consequence lies on the C-S scale. In the above example, it would likely be a "Major" or "Critical" consequence in the "Environmental" category.

- The group then assessed likelihood of the final consequence. Again using the above example, the likelihood of a dam failure is one quantity, but the quantity needed in the risk rating system is the likelihood of a dam failure leading to tailings release leading to a "Major" or "Critical" environmental consequence.

- Other consequences were briefly examined in the same manner. The above example would certainly have "Consequence Costs". It would also have "Legal" and "Community/Media/Reputation" consequences. However, the workshop was directed towards technical risks, so the "Environmental" and "Consequence Cost" categories were the focus.

- Once all components were assessed, the group returned to risks where mitigation measures are available, discussed the mitigation measure and its likely costs.

- The "mitigated alternative" was then re-assessed and the risk ratings revised.

Figure 1. Consequence Severity Matrix (*with examples from other Type II sites*)

Consequence Categories	Very Low	Minor	Moderate	Major	Critical
1. Environmental Impact	No impact.	Minor localized or short-term impacts.	Significant impact on valued ecosystem component.	Significant impact on valued ecosystem component and medium-term impairment of ecosystem function.	Serious long-term impairment of ecosystem function.
		UKHM: Ice plug release at Onek 400 adit	*UKHM: Tailings dam breach*	*Mt. Nansen: Failure of Main Dam leads to release of contaminated water & tailings into Victoria Creek*	
2. Special Considerations	Some disturbance but no impact to traditional land use.	Minor or perceived impact to traditional land use.	Some mitigable impact to traditional land use.	Significant temporary impact to traditional land use.	Significant permanent impact on traditional land use.
		Clinton Creek: Ongoing erosion of tailings into creek			*Mt. Nansen: Tailings dam breach*
3. Legal Obligations	No non-compliance but lack of conformance with departmental policy requirement. Informal advice from a regulatory. agency. No land claim or other agreement.	Technical/Administrative non-compliance with permit, approval or regulatory requirement. Warning letter issued. Land claim or other agreement requires the Crown to satisfy administrative obligations (e.g. notification).	Breach of regulations, permits, or approvals (e.g. 1 day violation of discharge limits). Order or direction issued. Land claim or other agreement requires the Crown to respond, but no time frame is specified.	Substantive breach of regulations, permits or approvals (e.g. multi-day violation of discharge limits). Prosecution. Land claim or other agreement requires the Crown to exercise its obligations within a specified time frame (i.e. 2-5 years)	Major breach of regulation – wilful violation. Court order issued. Land claim or other agreement requires the Crown to exercise its obligations within a specified short time frame (i.e. 1-2 years)
			Mt. Nansen: Hydrocarbon from historical spills seeps into receiving water	*UKHM: Tailings dam breach*	
4. Consequence Costs	< $100,000	$100,000 - $500,000	$ 500,000 - $2.5 Million	$2.5-$10 Million	>$10 Million
		Mt. Nansen: Erosion leads to loss of spillway		*Mt. Nansen: fire in mill leads to loss of power and treatment*	*UKHM: Tailings dam breach leading to tailings release*
5. Community/ Media/Reputation	Local concerns, but no local complaints or adverse press coverage.	Public concern restricted to local complaints or local adverse press coverage.	Heightened concern by local community, criticism by NGOs or adverse local /regional media attention.	Significant adverse national public, NGO or media attention.	Serious public outcry/demonstrations or adverse International NGO attention or media coverage.
				UKHM: Tailings dam breach	
6. Human Health and Safety	Low-level short-term subjective symptoms. No measurable physical effect. No medical treatment.	Objective but reversible disability/impairment and /or medical treatment injuries requiring hospitalization.	Moderate irreversible disability or impairment to one or more people.	Single fatality and /or severe irreversible disability or impairment to one or more people.	Multiple fatalities.
			UKHM: Public access to boneyards leads to injury	*UKHM: Snow machine accident on waste rock leads to fatality*	*UKHM: Vehicle accident on poorly maintained road leads to multiple fatalities*

Figure 2. Likelihood Terminology

Likelihood	Descriptor 2	Frequency Descriptor	Probability of occurrence over twenty years	Probability of occurrence in any one year
Almost Certain	Happens often	High frequency (more than once every 5 years)	98%	17.8%
Likely	Could easily happen	Event does occur, has a history, once every 15 years	75%	6.7%
Possible	Could happen and has happened elsewhere	Occurs once very 40 years	40%	2.5%
Unlikely	Hasn't happened yet but could	Occurs once every 200 years	10%	0.5%
Very Unlikely	Conceivable, but only in extreme circumstances	Occurs once every 1000 years	2%	0.1%

Figure 3. Risk Matrix

Likelihood	Consequence Severity				
	Low	Minor	Moderate	Major	Critical
Almost Certain	Moderate	Moderately High	High	Very High	Very High
Likely	Moderate	Moderate	Moderately High	High	Very High
Possible	Low	Moderate	Moderately High	High	High
Unlikely	Low	Low	Moderate	Moderately High	Moderately High
Very Unlikely	Low	Low	Low	Moderate	Moderately High

3 Results

All steps in the risk rating process for each alternative were recorded on a spreadsheet. Print-outs of the spreadsheet were distributed to participants each evening, and reviewed the next day.

The final spreadsheets were then re-sorted by SRK to highlight the "Very High", "High" and "Moderately High" residual risks. The re-sorted results are provided on the following twelve pages.

Although the results have been sorted, they remain the raw output of the workshops. Some of the descriptions and ratings are likely to be understandable only to people who participated in the workshops.

It should also be noted that modifications made to the example alternatives, under the advice of the project's Independent Peer Review Panel, further mitigated many of the risks. The result is that many of the risks identified in the workshop outputs either do not pertain to the revised options or would be characterized as less severe.

Tables

Tailings Alternative 1 - Stabilize in Place - After Mitigation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			21C, 25E		
Possible			10C, 18C, 12E, 13E, 9E, 3C, 20E	15C	
Unlikely			14E, 16C	1C, 5E, 5C, 7E, 8E, 11E, 19E, 22E, 23E, 24E	
Very Unlikely			2E		4E, 4C, 6E, 17E, 17C

Risks of groundwater collection and cover performance estimates not being achieved

8E	Escape of 3 % (or greater) of the groundwater (from Tailings) leads to chronic exceedance of site specific criterion (for current design)
11E	Cover does meet design performance for infiltration leading to increased load in seepage collection bypass causing an exceedance in site specific criterion
22E	Uncertainty in water quality modelings leads to loadings greater than predicted (i.e. Future 3) and leading to chronic exceedance of site specific criterion
12E	Runoff from the north side of the valley leads to increased loading in seepage collection bypass causing an exceedance in site specific criterion

Risks of failure of groundwater collection & treatment system

7E	Water collection and treatment system fails due to technical constraint to operate for 1 year leading to contaminant release
9E	Shutdown or systematic failure of groundwater collection system for more than 2 weeks leads to periodic exceedance of site specific criterion
24E	Institutional upset leads to a year of groundwater seepage discharge without collection and treatment

Risks of tailings dam breach and tailings release

4E	Flood exceeding the design flood, overtops the diversion and causes failure leading to failure of intermediate dam leading to tailings release
5E	Rainfall induced upstream slope movement and rainfall event leads to partial blockage and reduced capacity of channel and overtopping leading to breach of the Inte
6E	Institutional faiilure leads to lack of adequate maintenance leading to breach of the Intermediate Dam
17E	Dam stabilization ineffective leading to a breach of the Intermediate or Secondary Dam during an earthquake

Risks of non-catastrophic maintenance failures

13E	Run-on (from Rose Creek Div) leakage causes inundation of Int. Pond Cover and causes zinc contamination of cover surface
20E	Failure of Guardhouse Creek diversion fails and leads to inundation of Int. Pond Cover and causes zinc contamination o fthe cover surface
19E	Aufeis (Glaciation) leads to partial blockage leads causing diversion overtopping of diversion causing erosion and release of tailings
23E	Vegetation growth and sedimentation cause decrease in capacity and overtopping of diversion
25E	Poor maintenance decisions lead to operational failures

Risks of implementation costs being higher than estimated

1C	Construction of spillway more costly than expected
21C	Soil and/or permafrost conditions cause additional cost in construction of Rose Creek Diversion
18C	Addiitonal measures required to stabilize the downstream face of the intermediate dam

Risks of operating, maintenance and repair costs being higher than estimated

15C	Liquefaction of tailings during an earthquake causes substantial damage to cover leading to significant reconstruction costs
3C	Spillway maintenance costs will be high
4C	Flood exceeding the design flood, overtops the diversion and causes failure leading to failure of intermediate dam leading to tailings release
5C	Rainfall induced upstream slope movement and rainfall event leads to partial blockage and reduced capacity of channel and overtopping leading to breach of the Inte
10C	Collection volume for treatment is substantially higher than allowed for in current design
17C	Dam stabilization ineffective leading to a breach of the Intermediate or Secondary Dam during an earthquake

Moderate and low risks

14E	Upwelling of tailings through the waste rock and wicking causes formation of evaporites to form on the surface of the cover
16C	Differential settlement and erosion of the cover leads to increased maintenance costs
2E	The spillway does not allow fish passage leading to long term impacts

Tailings Alternative 2 - Complete Relocation - After Mitigation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely					
Possible			8C	2C	
Unlikely		7E, 12C, 19C, 20C	3C, 6C, 7C, 13C, 15C, 17E	9C, 10C, 23C	22C
Very Unlikely		21C	6E, 16C	4E, 4C, 5H, 11C, 14E, 18H	

Risks of implementation costs being higher than estimated

2C	Slurry density less than CURRENT estimate 35 % leading to increased operating time and to 20 % increase in operating cost
8C	Local escalation in labour costs leading to higher closure cost
9C	Under-estimation of lime demand leading to increased lime costs
10C	Increase in lime costs (function of fuel costs) leading to increased overall costs
23C	Greater than 2 m thickness of tailings currently allowed for left after minitoring complete leading to increased cost
22C	Changes in government leading to short term stop in funding and resulting in project delays; ongoing care and maintenance

Moderate and low risks

1	Failure of slurry pipeline leads to tailings cleanup and pipeline repair
3C	Slurry density less than DESIGN estimate 35 % leading to increased operating time and to 20 % increase in operating cost
4E, C	Hydrualic mining leads to a significant tailings and/or contaminated water release
5H	Unanticipated movement of faces leading to burying of operator
6C	Water loading to tailings leading to increased contaminant leaching to the aquifer leading to increased treatment costs
7C	Difficulties with final clean-up leads to extended loading to aquifer
11C	Increased power costs leading to increased overall costs
13C	Removal of contaminated material creates need for local reconstruction of Rose Creek between breached sections
14E	Failure of Rose Creek leading to the flooding of the tailings area during relocation and leads to loss of operations for 1 year
15C	Failure of Rose Creek diversion during adaptive management, after tailings relocated, leading to flooding of the valley
17E	Groundwater collection system performance does not meet design efficiency leading to seepage bypass causing an exceedance in the site specific site criterion
18H	Operator error leading to fatality
6E	Water loading to tailings leading to increased contaminant leaching to the aquifer
7E	Difficulties with final clean-up leads to extended loading to aquifer
12C	Use of geosynthetics in channels (dam breach) lead to increased maintenance and replacement costs
16C	Failure of Rose Creek diversion during adaptive management, after tailings relocated, leading to loss of flow in D/S Rose Creek
19C	Power supply to the mine site is interupted leading to loss in production
20C	Failure of the Faro Creek Diversion fails leads to flooding of the pit preventing tailings deposition
21C	Dam construction materials contains contamination that needs to be removed leading to increased closure costs

Tailings Alternative 3 - Partial Relocation - After Mitigation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely		2C			
Possible			7E, 15C, 24C	20C	
Unlikely			1C, 9C, 12E, 13E, 14E, 16C, 21C, 28C	6E, 10C, 11E, 19E, 25C	30C
Very Unlikely			18C	3C, 3E, 4C, 4E, 5C, 5E, 8E, 22C, 22E, 23H, 26C, 27C, 29H	17E, 17C

	Risks of groundwater collection and cover performance estimates not being achieved
11E	Cover design does not meet infiltration performance causing exceedence of site-specific criteria
19E	Uncertainty in WQ modelling leads to loadings greater than predicted and leading to chronic exceedence of site-specific criteria
	Risks of failure of groundwater collection & treatment system
6E	Water collection and treatment system fails to operate for one year leading to contaminant release
7E	2 weeks shutdown or systematic failure of groundwater collection system leads to exceedence of site specific criteria
	Risks of tailings dam breach and tailings release
17E	Dam stabilization ineffective leading to breach of Secondary Dam during earthquake
	Risks of implementation costs being higher than estimated
20C	Slurry density less than current estimate leads to increased operating time and cost
24C	Local escalation in labour costs leads to increase in tailings relocation costs
24C	Underestimation of lime demand leads to increase in liming costs
30C	Changes in government leading to short-term stop in funding and resulting project delays, ongoing C & M
10C	Adaptive management of groundwater is more lengthy and complex than anticipated
	Risks of operating, maintenance and repair costs being higher than estimated
17C	Dam stabilization ineffective leading to breach of Secondary Dam during earthquake
	Moderate and low risks
1C	Soil conditions result in increased costs for Rose Creek diversion channel upgrade
2C	Spillway maintenance costs will be high
3C, 3E	Failure of mtce in RCDC Failure of erosion control along leads to slumping of tailings into creek
4C, 4E	Rainfall induced slope movement liked to flood leads to erosion of Sec Dam and slumping of tailings into creek
5C, 5E	Institutional failure leads to RCDC failure, ersoion of Sec Dam and slumping of tailings into creek
8E	Escape of groundwater from tailings greater than expectations leads to chronic exceedence of site-specific criteria
9C	Long-term groundwater collection volume greater than assumed in design
12E	Runoff from north side of valley leads to increased loading in seepage collection bypass causing exceedence of site-specific criteria
13E	Runoff from north side and cover leads to erosion of dam and release of tailings
14E	Upwelling of tailings through waste rock and wicking causes formation of evaporites to form on the surface of the cover
21C	Slurry density less than design estimate leads to increased operating time and cost
22C	Hydraulic mining leads to significant release of tailings
23H	Unanticipated movement of faces leads to burying of operator
26C	Increased lime cost leads to increased liming costs
27C	Increased power costs leads to increased overall cost
28C	Removal of contaminated material creates need for local reconstruction of rose creek betweeen the breached sections
29H	Operator error leading to fatality
18C	Upon further investigation, additional measures are required to stabilize downstream face of secondary dam

Tailings Alternative 4 - Lowest Capital Cost or "Minimize Construction" - After Mitigation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			20C, 24E		
Possible			3C, 9E, 10C, 12E, 14E, 17C, 19E	8E, 11E, 15C, 21E, 23E, 25E, 25C	22E
Unlikely			13E	1C, 5E, 5C, 7E, 18E	
Very Unlikely			2E		4E, 4C, 6E, 16E, 16C

	Risks of groundwater collection and cover performance estimates not being achieved
8E	Escape of sig greater than 1% of the groundwater (from Tailings) leads to chronic exceedance of site specific criterion (for current design)
11E	Infiltration thru uncovered tailings does meet expectation for infiltration leading to increased load in seepage collection bypass causing an exceedance in site specific
12E	Runoff from the north side of the valley leads to increased loading in seepage collection bypass
21E	Uncertainty in water quality modelings leads to laodings greater than predicted (i.e. Future 3) and leading to chronic exceedance of site specific criterion
	Risks of failure of groundwater collection & treatment system
22E	Vegetation growth and sedimentation cause decrease in capacity and overtopping of diversion
23E	Institutional upset leads to a year of groundwater seepage discharge without collection and treatment
25E, 25C	Delay in detection, implementation or improvement of collection leading to exceedence or additional cleanup cost
7E	Water collection and treatment system fails to operate for 1 year leading to contaminant release
9E	Shutdown or systematic failure of groundwater collection system for more than 2 weeks leads to periodic exceedance of site specific criterion
24E	Poor maintenance decisions lead to operational failures
	Risks of tailings dam breach and tailings release
4E, 4C	Rose Creek diversion does not pass design flood leading to failure of intermediate dam leading to tailings release
5E, 5C	Rainfall induced upstream slope movement and rainfall event leads to partial blockage and reduced capacity of channel and overtopping leading to breach of the Inte
6E	Institutional faiilure leads to lack of adequate maintenance leading to breach of the Intermediate Dam
16E, 16C	Dam stabilization ineffective leading to a breach of the Intermediate (or Secondary) during an earthquake
	Risks of non-catastrophic maintenance failures
18E	Aufeis (Glaciation) leads to partial blockage and overtopping of diversion causing erosion and release of tailings
19E	Failure of Guard House Creek diversion fails and leads to inundation of Int. Pond tailings and causes increased zinc contamination of the aquifer
14E	Dusting from the tailings leads to contamination of surrounding soils and vegetation
26E	Fence causes animal mortality
	Risks of implementation costs being higher than estimated
1C	Soil conditions result in spillway costs significantly greater than present cost estimate
17C	Addiitonal measures required to stabilize the downstream face of the intermediate dam
20C	Soil and/or permafrost conditions cause additional cost in construction of Rose Creek Diversion
	Risks of operating, maintenance and repair costs being higher than estimated
15C	Differential settlement in tailings lead to ponding and increased infiltration through the tailings leading to increased treatment costs
3C	Spillway maintenance costs will be high
10C	Collection volume for treatment is substantially higher than allowed for in current design
	Moderate and low risks
13E	Run-on (from diversion leakage) causes inundation of Intermediate Pond tailings and causes zinc contamination of surface
2E	The spillway does not allow fish passage leading to long term impacts

Faro Mine Alternative 1 - Flow-through Pit - After Mitigation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			14C		
Possible		13C	16E, 21C, 26E	1E, 1C	10C
Unlikely			11C, 17E, 18E, 19E, 20C, 22C, 24C	2E, 3E, 5C, 8C, 9C, 12C, 23E, 23C, 24E, 25E	6E, 7E
Very Unlikely				4E, 15E	

	Risks of groundwater collection and cover performance estimates not being achieved
1E	Failure to meet 95% collection efficiency at S-Well area leads to chronic exceedence of site-specific criteria
23E	Failure to meet groundwater collection design efficiency in Zone II Pit outwash area leading to chronic exceedence exceedence..
24E	Failure to meet groundwater collection design efficiency at ETA leading to chronic exceedence exceedence..
16E	Failure of elevated North Fork channel leads to picking up of contaminated groundwater further contaminating downstream flow
2E	Cover infiltration to the sulphide cell increases from 5% to 10% leading to chronic exceedence of site-specific criteria
3E	Reduction in cover performance due to lack of maintenance leading to chronic exceedence…
7E	Some combination of water chemistry, capture efficeincy and cover failure leads to significant chronic exceedeences of site spec criteria
	Risks of failure of groundwater collection & treatment system
25E	Water collection and treatment system fails to operate for one year leading to contaminant release
26E	2 weeks shutdown or systematic failure of groundwater collection system leads to exceedence of site specific criteria
	Risks that pit lake biological treatment will not perform adequately
10C	Increased loadings to pit exceed biological treatment capacity and requiring perpetual active treatment
6E	Uncertainty in WQ modelling leads to greater loading than anticpiated
9C	In-situ treatment not effective, requiring active treatment for limited period of time
	Risks of implementation costs being higher than estimated
5C	Failure to identify all of the high source material leading to increased cost
14C	Exavation difficulties along outflow ditch lead to increased costs
	Risks of operating, maintenance and repair costs being higher than estimated
1C	Failure to meet 95% collection efficiency at S-Well area leads to chronic exceedence of site-specific criteria
8C	Monitoring shows the need for additional groundwater capture and upgrade of water treatment system
21C	Movement of pit wall below low grade ore stockpile leading to increased cover maintenance costs
12C	Plug dam leaks more than anticipated leading to increased flow thru Zone II Pit and increased loadings and costs
	Moderate risks
4E	Failure to cover or relocate the high source material leading to chronic exceedence..
11C	Contamination from NW Dump leads to increased loadings at X14
13C	Increased grouting requirements at plug dam
15E	Plugging of outflow ditch leading to overtopping and breach of plug dam leading to overflow of Zone II Pit into Rose Creek
17E	Extreme wet year leading to release of contaminated pit water
18E	Pit wall failure leads to disruption of treatment system and requirement to discharge untreated water
19E	Excess phosphate in pit water discharge leads to eutrophication in downstream waters
20C	Technical uncertainties of passive treatment lead to significant increased pit water monitoring/study costs
22C	Cover maintenance costs higher than anticipated

Faro Mine Alternative 2 - Continued Faro Creek Diversion - After Mitigation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely					
Possible			17E, 18C, 21E	4E, 4C	
Unlikely		1C	2C, 10C, 16E, 19C	3E, 3C, 5E, 6E, 8E, 9E, 10E, 11C, 13E 15C, 20E	14E
Very Unlikely				2E, 7E, 11E, 15E	12E

Risks of groundwater collection and cover performance estimates not being achieved

4E	Fail to meet seepage collection design efficiency (95%) at S-Well area leading to chronic exceedance of site specific criterion
3E	Fail to meet seepage collection design efficiency (95%) at Zone II outwash area leading to chronic exceedance of site specific criterion
5E	Fail to meet seepage collection design efficiency (90%) at S-Well area leading to chronic exceedance of site specific criterion
10E	Risk that ETA collection system does not meet design capture efficiency (99%) leading to chronic exceedance of site specific criterion at X14
6E	Cover infiltration to sulphide cells increases from 5 % to 10 % leading to chronic exceedance of site specific criterion
8E	Infiltration through rudimentary cover increses from 20 to 30 % of MAP leading to chronic exceedance of site specific criterion
9E	Reduction in cover performance due to lack of maintenance leading to chronic exceedance of site spefic criterion
12E	Uncertainty in water quality modelings leads to loadings greater than predicted (i.e. Future 3) and leading to chronic exceedance of site specific criterion
13E	Uncertainty in water quality modelings leads to laodiings greater than predicted (i.e. twice the Future 2 estimate) and leading to chronic exceedance of site specific c
14E	Some combination of water chemistry, capture effeiciency and cover failure leads to significant chronic exceedances of site speficic criterion

Risks of failure of groundwater collection & treatment system

20E	Water collection and treatment system fails to operate for one year leading to contaminant release
21E	2 weeks shutdown or systematic failure of groundwater collection system leads to exceedence of site specific criteria
17E	Failure of elevated North Fork channel leads to flushing of contaminated groundwater

Risks of implementation costs being higher than estimated

11C	Failure to identify all of the low grade oxide fines and ores leading to underestimation of total cost for remediation
15C	Monitoring shows the need for additional groundwater capture systems and upgrade of water treatment systems leading to increased costs

Risks of operating, maintenance and repair costs being higher than estimated

4C	Fail to meet seepage collection design efficiency (95%) at S-Well area leading to chronic exceedance of site specific criterion
3C	Fail to meet seepage collection design efficiency (95%) at Zone II outwash area leading to chronic exceedance of site specific criterion
18C	Movement of pit wall below low grade ore leads to cracking of cover

Moderate and low risks

2C, 2E	Failure of the diversion leading to loss of storage capacity and increased water treatment requirements
7E	Cover infiltration to Low and Medium Grade and Oxide fInes increases from 0.5 % to 2%in ETA catchment leading to chronic exceedance of site soecific criterion
10C	Risk that ETA collection system does not meet design capture efficiency (99%) leading to chronic exceedance of site specific criterion at X14
11E	Failure to relocate and/or cover the high source materails (Ox fines + LG and MG ores) leading to continued loading and chronic exceedance of site speficic criteria
15E	Monitoring shows the need for additional groundwater capture systems and upgrade of water treatment systems leading to increased costs
16E	Contamination from Northwest Dump leads to increased loading to X14 and exceedance of site specific criterion
19C	Cover maintenance cost higher than anticipated
1C	Diversion of Faro Creek leads to increased seepage to Faro Valley Dumps leading to increased loading to Faro Pit leading to increased treatment

Faro Mine Alternative 3 - Lowest Capital Cost or "Minimize Construction" - After Mitigation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			3C	4E, 4C, 5E, 12E, 13E, 14E, 15C	
Possible			18E	2E, 2C, 3E, 6E, 7E, 8E, 10E, 10C, 11E, 15E, 17E	
Unlikely		1C	16E, 19C	9E	
Very Unlikely					

Risks of groundwater collection and cover performance estimates not being achieved

3E	Fail to meet seepage collection design efficiency at Zone II outwash area leading to chronic exceedance of site specific criteria
4E	Fail to meet seepage collection design efficiency (99%) at S-Well area leading to chronic exceedance of site specific criterion
6E	Infiltration to sulphide cells increases above 20 % leading to chronic exceedance of site specific criterion
7E	Infiltration to Low and Medium Grade Ore and Oxide fines increases above 20 % in ETA catchment leading to chronic exceedance of site specific criterion
8E	Infiltration through rudimentary cover increases from 20 to 30 % of MAP leading to chronic exceedance of site specific criterion
9E	Reduction in cover performance due to lack of maintenance leading to chronic exceedance of site specific criterion
10E	Risk that Cross Valley Dam collection system does not meet design capture efficiency (99%) leading to chronic exceedance of site specific criterion at X14
12E	Uncertainty in water quality modeling leads to loadings greater than predicted (i.e. Future 3) and chronic exceedance of site specific criterion
13E	Uncertainty in water quality modeling leads to loadings greater than predicted (i.e. twice the Future 2 estimate) and chronic exceedance of site specific criterion
14E	Some combination of water chemistry, capture efficiency and cover failure leads to significant chronic exceedances of site specific criteria

Risks of failure of groundwater collection & treatment system

5E	Delay in montioring or implementing groundwater collection improvements in S-Well Area leads to limited duration impact
11E	Delay in montioring or implementing groundwater collection improvements in CVD Area leads to limited duration impact
17E	Water collection and treament system fails to operate for 1 year leading to contaminant release
18E	2 week shutdown or systmatic failure of groundwater collection system leading to contaminants release

Risks of implementation costs being higher than estimated

2E, 2C	Failure of the diversion leading to loss of storage capacity and overflowing leading to environmental impacts and increased costs

Risks of operating, maintenance and repair costs being higher than estimated

3C	Fail to meet seepage collection design efficiency at Zone II outwash area leading to chronic exceedance of site specific criteria
4C	Fail to meet seepage collection design efficiency (99%) at S-Well area leading to chronic exceedance of site specific criterion
10C	Risk that Cross Valley Dam collection system does not meet design capture efficiency (99%) leading to chronic exceedance of site specific criterion at X14
15E, 15C	Monitoring shows the need for additional groundwater capture systems and upgrade of water treatment systems leading to exceedences and increased costs

Moderate and low risks

16E	Contamination from Northwest Dump leads to increased loadings to X14 and exceedance of site specific criterion
19C	Cover maintenance costs higher than anticipated
1C	Deterioriation of diversion of Faro Creek leads to increased seepage to Faro Valley Dumps leading to increased loading to Faro Pit and increased treatment costs

Faro Mine Alternative 4 - Additional Relocation & Covering with Flow Through or "Minimize Water Treatment"

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			18C		
Possible		5C, 20C	9C, 12E, 14E		
Unlikely			22E, 23E, 24E, 25E, 26E	2E, 3E, 4E, 8E, 10C, 13E, 17C, 19C	7E, 15C, 16E
Very Unlikely			11E	1E, 5E, 6E, 9E, 21E	

Risks of groundwater collection and cover performance estimates not being achieved

2E	Fail to meet seepage collection design efficiency at S-Well area leading to chronic exceedance of site specific criterion
3E	Fail to meet seepage collection design efficiency (95%) at ETA leading to chronic exceedance of site specific criterion
16E	Uncertainty in water quality modelling leads to greater loading to the pit than anticpiated
4E	Cover infiltration to sulphide cells increases to above 5% of MAP leading to chronic exceedance of site specific criterion
8E	Reduction in cover performance due to lack of maintenance leading to chronic exceedance of site specific criterion
7E	Some combination of water chemistry, caputure efficiency and cover failure leads to contaminant release and chronic exceedence of site specific criterion

Risks of failure of groundwater collection & treatment system

12E	Failure of elevated North Fork Channel leads to picking up of contaminated groundwater further contaminating downstream flow
13E	Water collection and treament system fails to operate for 1 year leading to contaminant release
14E	2 week shutdown or systmatic failure of groundwater collection system leading to contaminant release

Risks of implementation costs being higher than estimated

9C	Failure to identify all of the low grade oxide fines and ores leading to underestimation of total cost for remediation
18C	Excavation difficulties along the outflow channel leads to increased costs
19C	Plug dam leaks more than anticipated leading to greater flow thru Zone II Pit and increased loadings and costs

Risks of operating, maintenance and repair costs being higher than estimated

10C	Monitoring shows the need for additional groundwater capture systems and upgrade of water treatment systems leading to increased costs
15C	Increased loadings to pit exceed biological treatment capacity requiring perpetual active treatment
17C	In-situ treatment not effective requiring active treatment for limited time

Moderate and low risks

1E	Fail to meet seepage collection design efficiency (80%) at Zone II outwash area leading to chronic exceedance of site specific criterion
5E, 5C	Neutralization of low to medium grade ore and oxide fines in pit lake not as effective as expected
6E	Infiltration through low infiltration cover increases from 5 to 10 % of MAP leading to chronic exceedance of site specific criterion
9E	Failure to identify and relocate all of the high source materails (Ox fines + LG and MG ores) leading to continued loading and chronic exceedance of site specific cri
20C	Increased grouting requirement at plug dam
21E	Plugging of outflow ditch leading to overtopping and breach of plug dam with overflow to Zone II Pit into Rose Creek
22E	Extreme wet year leading to relase of contaminated pit water
23E	Pit wall failure leads to disruption of treatment system and requirement to discharge untreated water
24E	Excess phosphate in pit water discharge leads to eutrophication in downstream waters
25E	Technical uncertainties of passive treatment lead to significant increased pit water monitoring/study costs
26E	Cover maintenance costs higher than anticipated
11E	Contamination from Northwest Dump leads to increased loadings to X14 and exceedance of site specific criterion

Vangorda/Grum Alternative 1 - Backfill Vangorda Pit - After Mitigation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely				20C	
Possible		22E	12E		
Unlikely			2E, 4E, 8H, 9E, 10E, 11C, 17E, 18C, 19C	1E, 1C, 3E, 7E, 15C, 16C, 21E	
Very Unlikely			13E	5H, 14H	7C

Risks of groundwater collection and cover performance estimates not being achieved

1E	Failure to meet groundwater collection targets below Grum Dump
3E	Low infiltration covers do not meet design performance leading to higher infiltration
7E	Grum Dump goes more acidic than expected

Risks of failure of or damage to Vangorda Creek diversion

12E	Failure of channel leading to increased leakage into pit
21E	Failure of Vangorda diversion during backfilling leads to solids release

Risks of implementation costs being higher than estimated

15C	Under-estimation of lime demand leads to increased costs

Risks of operating, maintenance and repair costs being higher than estimated

20C	Grum pit unable to passively treat groundwater collected below Grum Dump
1C	Failure to meet groundwater collection targets below Grum Dump
7C	Grum Dump goes more acidic than expected
16C	Increase in lime costs due to fuel costs

Moderate and low risks

2E	Shutdowm or systematic failure of the Grum Dump collection system leads to 2 weeks of release
4E	Rudimentary cover at Grum Dump does not meet design performance for infiltration leading to increased seepage (>20% infiltr)
5H	Person or passerby falls into pit leading to fatality
8H	Exposure to contaminated sediment and soli leads to uptake in particular of As leading to an increased risk of cancer on human health
9H	Contaminant release from ore transfer pad leads to contamination of Vangorda Creek
10E	Backfill cover performance is less than expected leading to increased seepage from backfill pit
11C	Failure of channel leads to erosion damage of cover leading to increased cost of repair
14H	Rockfall in pit leads to fatality during relocation
17C	Predicted porewater quality not achived due to not adding sufficient lime leading to impacts on Vangorda Creek
18C	Residual contaminantion in Vangorda Dump foundation soils leading to increased relocation costs
19C	Temporary groundwater cleanup required under the Vangorda footprint area
22E	Release of algae from the pit lake leads to downstream eutrophication
3C	Failure to meet groundwater collection target in the Vangorda Dump Seepage collection system leading to contaminant release to Vangorda Creek
10C	Vangorda Creek Diversion fails during a flood year leading to an increase of water to be treated (est. 3 million m3)

Vangorda/Grum Alternative 2 - Stabilize Current Situation - After Mitigation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely					
Possible			11C, 19C	9C	
Unlikely			2E, 4E, 5E, 7E, 12E, 17H, 18E, 19E	1E, 6E, 9E, 16E	
Very Unlikely			3C, 10C	3E, 8E, 13E, 14H, 20E, 20C	16C

Risks of groundwater collection and cover performance estimates not being achieved

1E	Failure to meet groundwater collection targets below Grum Dump
6E	Low infiltration covers do not meet design performance leading to higher infiltration
16E	Grum Dump goes more acidic than expected

Risks of failure of or damage to Vangorda Creek diversion

9C	Geotechnical failure of pit wall below Vangorda Creekdiversion leading to release of pit water
9E	Geotechnical failure of pit wall below Vangorda Creekdiversion leading to release of pit water

Risks of operating and maintenance costs being higher than estimated

19C	Groundwater leakage from Vangorda Pit requires investigation, capture and treatment
11C	Steeper sections near bottom of Vangorda Creek diversion fail in flood and require costly repairs
16C	Grum Dump goes more acidic than expected

Moderate and low risks

2E	Shutdowm or systematic failure of the Grum Dump collection system leads to 2 weeks of release
3E	Failure to meet groundwater collection target in the Vangorda Dump Seepage collection system leading to contaminant release to Vangorda Creek
4E	Shutdowm or systematic failure of the Vangorda Dump collection system leads to 2 weeks of release
5E	Toe drain failure leeds to short term (2 weks) surface water release at Vangorda Dump leading to impacts on in Vangorda Creek
7E	Rudimentary cover at Grum Dump does not meet design performance for infiltration leading to increased seepage (>20% infiltr)
8E	Vangorda Creek Diversion fails during a 100 year flood leading to discharge to Vangorda Pit leading to overtopping after 16 days and release of contaminated water
12E	Grum Pit water quality worse than predicted leading to release of contaminated water
13E	Water collection and treatment system fails to operate for one year leading to release of contaminated water due to lack of funding
14H	Person or passerby falls into pit leading to fatality
17H	Exposure to contaminated sediment and soli leads to uptake in particular of As leading to an increased risk of cancer on human health
18E	Contaminant release from ore transfer pad leads to contamination of Vangorda Creek
19E	Groundwater Leakage from Vangorda pit daylighting and contaminating Vangorda Creek
20E, 20C	Vangorda dump goes more acidic than expected leading to increased impact on Vangorda Creek
3C	Failure to meet groundwater collection target in the Vangorda Dump Seepage collection system leading to contaminant release to Vangorda Creek
10C	Vangorda Creek Diversion fails during a flood year leading to an increase of water to be treated (est. 3 million m3)

Vangorda/Grum Alternative 3 - Lowest Capital Cost or "Minimize Construction"- After Mitigation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain			11C		
Likely			10C		
Possible			19C	1E, 1C, 6E, 9E, 9C, 16E, 20E, 21E	
Unlikely			2E, 3C, 4E, 5E, 7E, 8C, 12E, 17H, 18E, 19E	3E, 8E, 20C	
Very Unlikely				13E, 14H	16C

Risks of groundwater collection and cover performance estimates not being achieved

1E	Failure to meet groundwater collection target in the Grum Dump Seepage collection System
3E	Failure to meet groundwater collection target in the Vangorda Dump Seepage collection System
6E	Rudimentary covers on Vangorda and Grum sulphide cells do not meet design performance for infiltration leading to increased seepage (>20% infiltr)
16E	Grum dump goes more acidic than expected leading to increased contaminant release
20E	Vangorda dump goes more acidic than expected leading to increased impact on Vangorda Creek

Risks of failure of or damage to Vangorda Creek diversion

21E	Delay in detection and implementation and improvement in collection leading to exceedences of site specific criterion for limited period

Risks of failure or damage to Vangorda Creek Diversion

8E	Vangorda Creek Diversion fails during a 100 year flood leading to discharge to Vangorda Pit leading to overtopping after 16 days and release of contaminated water
9E	Geotechnical failure of the pit wall below the channel leading to a breach of the Vangorda Creek Diversion leading to the overtopping of the pit and release of conta
10C	Vangorda Creek Diversion fails during a flood year leading to an increase of water to be treated (est. 3 million m3)
11C	Vangorda Creek Diversion fails during a flood year flood leading to a cost of mitigation (repair of diversion)

Risks of operating and maintenance costs being higher than estimated

1C	Failure to meet groundwater collection target in the Grum Dump Seepage collection System
9C	Geotechnical failure of the pit wall below the channel leading to a breach of the Vangorda Creek Diversion leading to the overtopping of the pit and release of conta
16C	Grum dump goes more acidic than expected leading to increased collection and treatment costs
19C	Groundwater leakage from Vangorda pit daylighting and contaminating Vangorda Creek
20C	Vangorda dump goes more acidic than expected leading to increased collection and treatment costs

Moderate and low risks

2E	Shutdowm or systematic failure of the Grum Dump collection system leads to 2 weeks of release
3C	Failure to meet groundwater collection target in the Vangorda Dump Seepage collection System leading to increased costs
4E	Shutdowm or systematic failure of the Vangorda Dump collection system leads to 2 weeks of release
5E	Toedrain failure leads to short term (2 weeks) surface water release at Vangorda Dump
7E	Rudimentary cover on Vangorda and Grum Dump other waste does not meet design performance for infiltration leading to increased seepage (>20% infiltr)
8C	Vangorda Creek Diversion fails during a 100 year flood leading to discharge to Vangorda Pit leading to overtopping after 16 days and release of contaminated water
12E	Grum Pit water quality worse than predicted leading to release of contaminated water
13E	Water collection and treatment system fails to operate for one year leading to release of contaminated water due to lack of funding
14H	Person or passerby falls into pit leading to fatality
17H	Exposure to contaminated sediment and soil leads to uptake in particular of arsenic leading to an increased risk of cancer on human health
18E	Contaminant release from ore transfer pad lead to contamination of Vangorda Creek
19E	Groundwater leakage from Vangorda pit daylighting and contaminating Vangorda Creek

Vangorda/Grum Alternative 4 - Additional Covering or "Minimize Water Treatment"

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely					
Possible		22E	12E	20C	
Unlikely			2E, 4E, 8H, 9E, 10E, 11C, 15C, 16C, 17E, 18C, 19C	1E, 1C, 3E, 7E, 21E	
Very Unlikely			13E	5H, 14H	7C

Risks of groundwater collection and cover performance estimates not being achieved

1E	Failure to meet groundwater collection target in the Grum Dump Seepage collection system
3E	Very Low infiltration soil cover on Grum Sulphide cell does not meet design performance for infiltration leading to increased seepage (>5% infiltr)
7E	Grum dump goes more acidic than expected leading to increased contaminant release

Risks of failure of or damage to Vangorda Creek diversion

12E	Failure of channel leads loss of water to the pit leading increased contaminant loadings to Vangorda Creek
21E	Failure of Vangorda Creek diversion during backfilling leading to overtopping and release of contaminated water from the pit

Risks of operating and maintenance costs being higher than estimated

1C	Failure to meet groundwater collection target in the Grum Dump Seepage collection system
7C	Grum dump goes more acidic than expected leading to increased collection and treatment costs
20C	Grum pit water quality does not reach predicted concentrations due to Grum Pit Lake treatment not being able to treat seepage collection from Grum Dump

Moderate and low risks

2E	Shutdown or systematic failure of the Grum Dump collection system leads to 2 weeks of release
4E	Low infiltration cover at Grum Dump does not meet design performance for infiltration leading to increased seepage (>20% infiltr)
5H	Person or passerby falls into pit leading to fatality
8H	Exposure to contaminated sediment and soil leads to uptake in particular of arsenic leading to an increased risk of cancer on human health
9E	Contaminant release from ore transfer pad leads to contamination of Vangorda Creek
10E	Backfill cover performance is less than expected leading to increased seepage from backfill pit
11C	Failure of channel leads to erosion damage of cover leading to increased cost of repair
14H	Rockfall in pit leads to fatality during relocation
15C	Underestimation of lime demand leads to increased closure costs
16C	Increase in lime costs caused by increased fuel costs leads to increased overall costs
17E	Predicted porewater quality not achived due to not adding sufficient lime leading to impacts on Vangorda Creek
18C	Residual contaminantion in Vangorda Dump foundation soils leading to increased relocation costs
19C	Temporary groundwater cleanup required under the Vangorda footprint area
22E	Release of algae from the pit lake leads to downstream eutrophication
13E	Dust release during relocation leads to contaminant release to surrounding vegetation