

Technical Memorandum

To:	File	Date:	March 31, 2008
cc:		From:	Jozsef Miskolczi, Dylan MacGregor
Subject:	Outcomes from 2007/08 Keno Hill Adit Closure Studies	Project #:	1CE012.000.0AC6

1 Introduction

There are upwards of 70 adits within the former UKHM claim boundaries that need to be assessed to determine how each adit will be treated in closure. Previous consideration of the various adits has tended to focus on assigning risk rankings to adits or groups of adits. Many of the adits represent a moderate to high risk for health and safety, due in part to the natural state of degradation and physical instability, as well as the possible accumulation of toxic gases or the development of an oxygen depleted atmosphere due to inadequate ventilation.

The work reported here seeks to build on the existing risk rankings and move towards a framework of selecting a specific closure measure for each adit. There is a broad range of adit conditions to consider, ranging from fully collapsed adits to adits that are expected to require long term water treatment. Several adits develop ice plugs to varying degrees, and where there is a risk of impoundment of water and catastrophic release, adit closure measures will need to address this risk.

2 Adit closure requirements

Closure measures are required in order to mitigate risks posed by adits. As the nature of these risks can vary from adit to adit, it is necessary to first identify the adit-specific closure requirements in order to select appropriate closure measures.

The known adits within the former UKHM claim block are listed in Table 1, which also includes several types of potential closure requirements. This table is intended to be used as a matrix to identify closure requirements for each adit, and to inform the evaluation of adit closure measures. Adit locations are shown in Figures A and B.

Restricting public access is a closure requirement for all adits. Certain adits will require long term drainage control, and in these cases a closure measure must be identified that will restrict public access, yet allow the operational access necessary to service and maintain water control systems. On the other hand, some adits are presently in a fully collapsed state, and require no additional work to prevent public access.

For those adits which produce water, the selected closure measure needs to address water control. Where water quality is acceptable for direct discharge, the closure measure selected must allow for free drainage, while still preventing public access. Where water treatment is required, an additional consideration of how to collect the discharge water is necessary.

3 Conceptual adit closure designs

In general terms, closure options for adits can be grouped into the four broad categories of plugs, seals, barriers, and ‘minimal effort’ approaches.

The schematic sketches of the various closure options are idealized representations of real field conditions, and as such do not account for complications arising from, for example, rough terrain or dense vegetation overgrowth. In addition, access to many of these sites is limited or impossible for construction equipment without either development of roads or upgrading of existing roads. Further, there are several sites where water and electricity are not readily available. The selected closure measure may have to be substantially modified during the detailed design phase and adapted to site conditions and the requirements of each individual opening.

3.1 Adit Plugs

This category refers to any measure that involves a structure that completely fills a drift for some length within the underground portion of the mine with the intent of minimizing or preventing discharge. Plugs are generally intended to be permanent installations, and may require detailed rock characterization and extensive grouting of the surrounding rock to achieve acceptable performance. Further investigations would be required before proceeding to final design.

Adit plugs can be candidate closure options where any of preventing access, controlling adit drainage, or minimizing brow collapse are required. Conceptual designs for three different types of adit plugs are presented in Figures 1a through 1c.

3.2 Adit Seals

The category of adit seals refers to any measure for which the sole purpose is to prevent public access. Seals are typically cheaper than plugs; however, where rehabilitation of the adit is required to ensure safe working conditions, costs can increase significantly. Adit seals are not intended for controlling adit drainage waters, but can be designed to allow free drainage.

Conceptual designs for four different types of adit seals are presented in Figures 2a through 2d.

3.3 Adit Barriers

The category of adit barriers refers to any measure which prevents inadvertent access by the public, but maintains an opening for authorized persons; barriers are also used where the mine workings provide habitat for animals such as bats. Barriers are typically cheaper than seals; however, there remains a requirement for rehabilitation of the immediate portal area to provide safe working conditions for the seal construction period. Adit barriers are not intended for controlling adit drainage waters, but can be designed to allow free drainage.

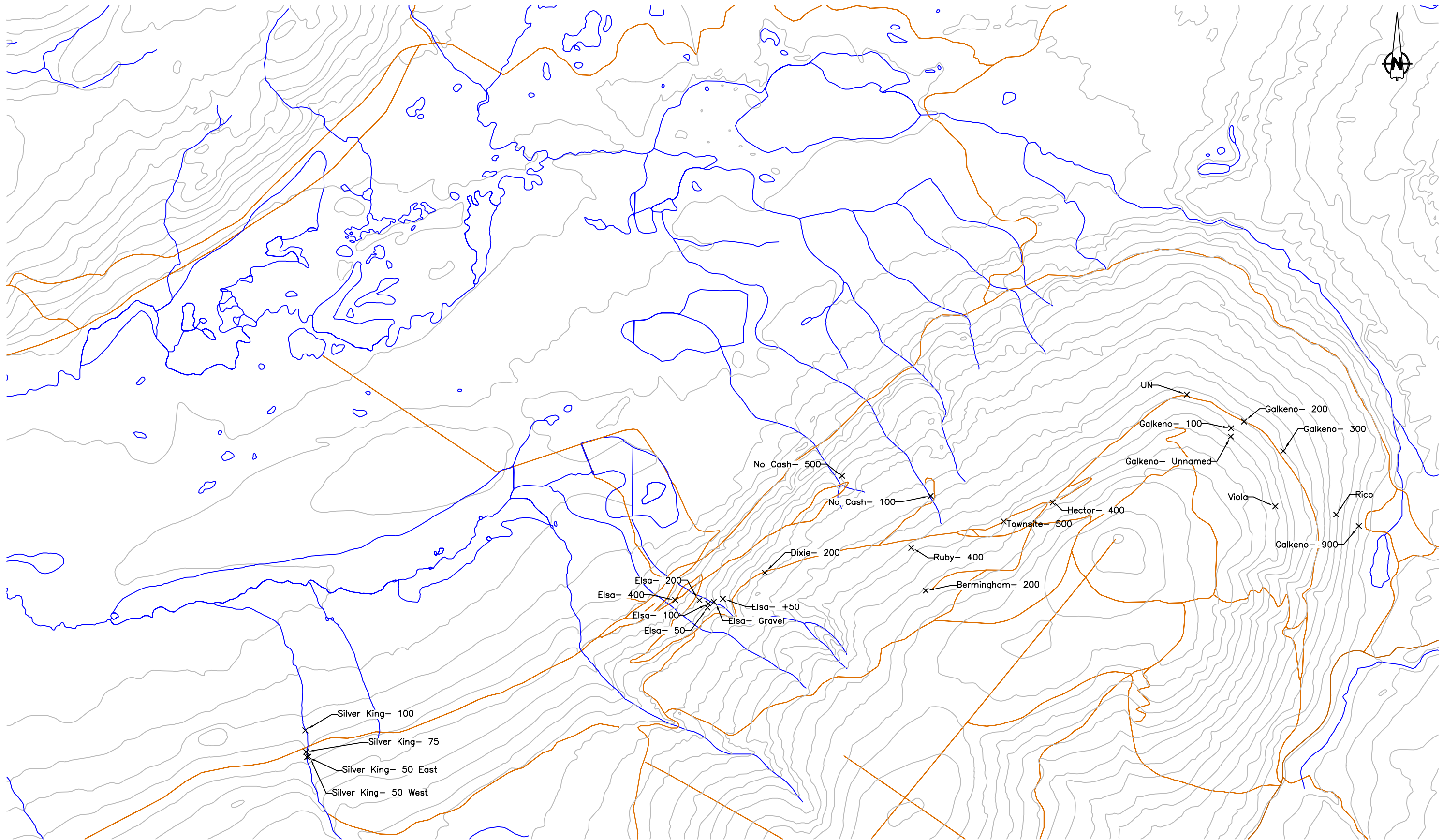
Conceptual designs for three different types of adit seals are presented in Figures 3a through 3c.

3.4 Natural collapses

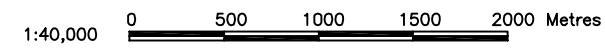
There are numerous cases among the former UKHM adits where adit collapse is sufficiently complete that access is no longer possible and where little risk remains. A ‘Do nothing’ closure option may be appropriate in certain cases, while a ‘Do nothing now and inspect periodically’ option may be appropriate for other cases. The conceptual cross-section of a collapsed adit in Figure 4a illustrates how a sufficiently collapsed adit can pose minimal risk.

4 Candidate adit closure measures

Closure requirements for each former UKHM adit are defined in Table 1, and a limited number of appropriate adit closure options have been identified for each adit. In addition, supplemental information is provided under the heading of 'Considerations for Implementation' to indicate where portal structures require removal, where access improvements would be required, and where a long-term source of electricity could be required depending on the closure measure selected. Table 1 and the accompanying figures are intended to be a starting point for reviewing the closure requirements for each adit and for considering which closure options might be appropriate.



Legend
X Adit



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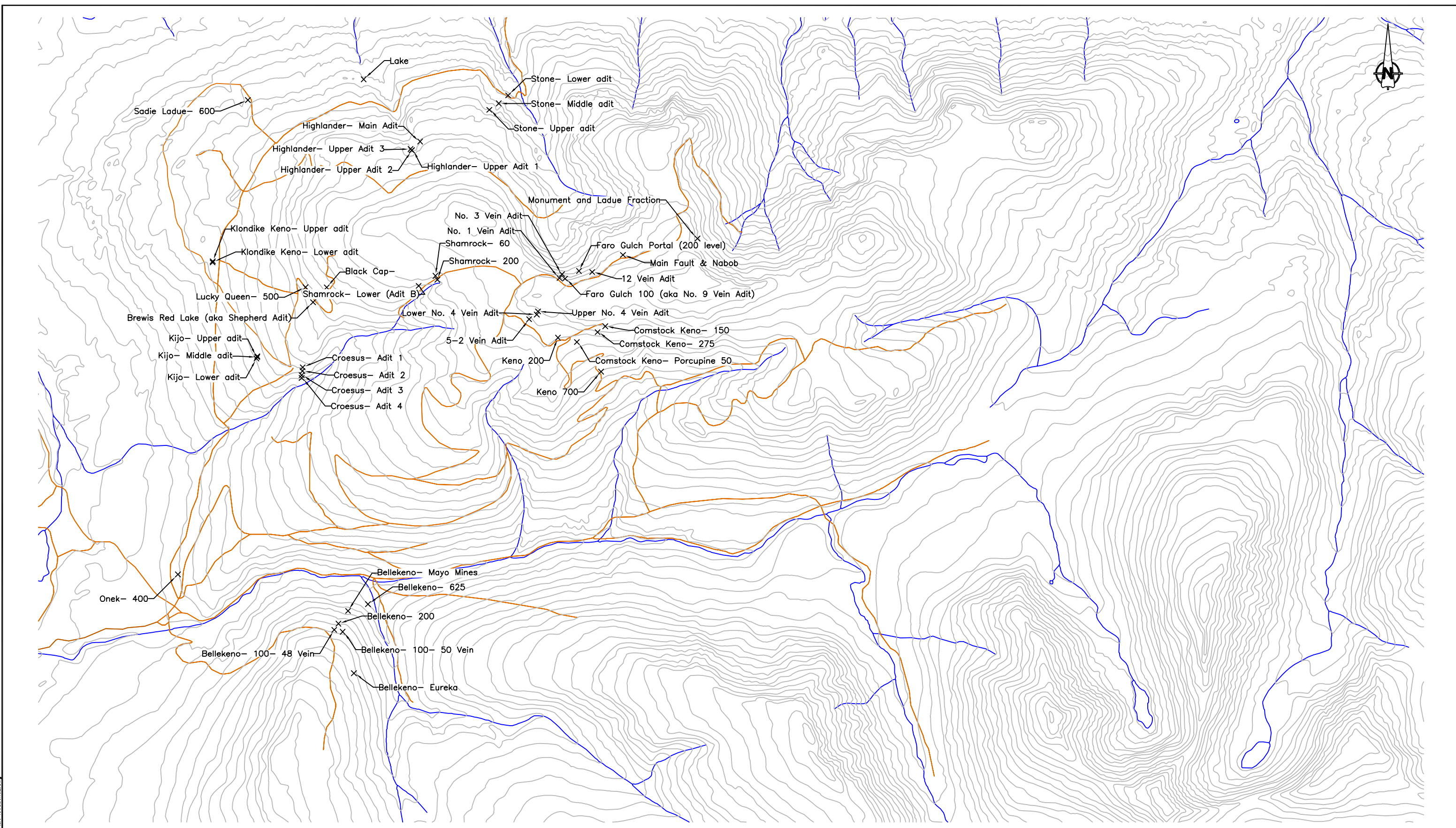
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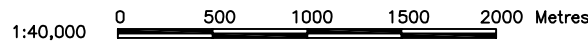
Keno Hill

2007 Adit Closure Studies		
Adit locations Sheet 1 of 2		
DATE: Feb. 2008	APPROVED: DBM	FIGURE: A

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Legend
 X Adit



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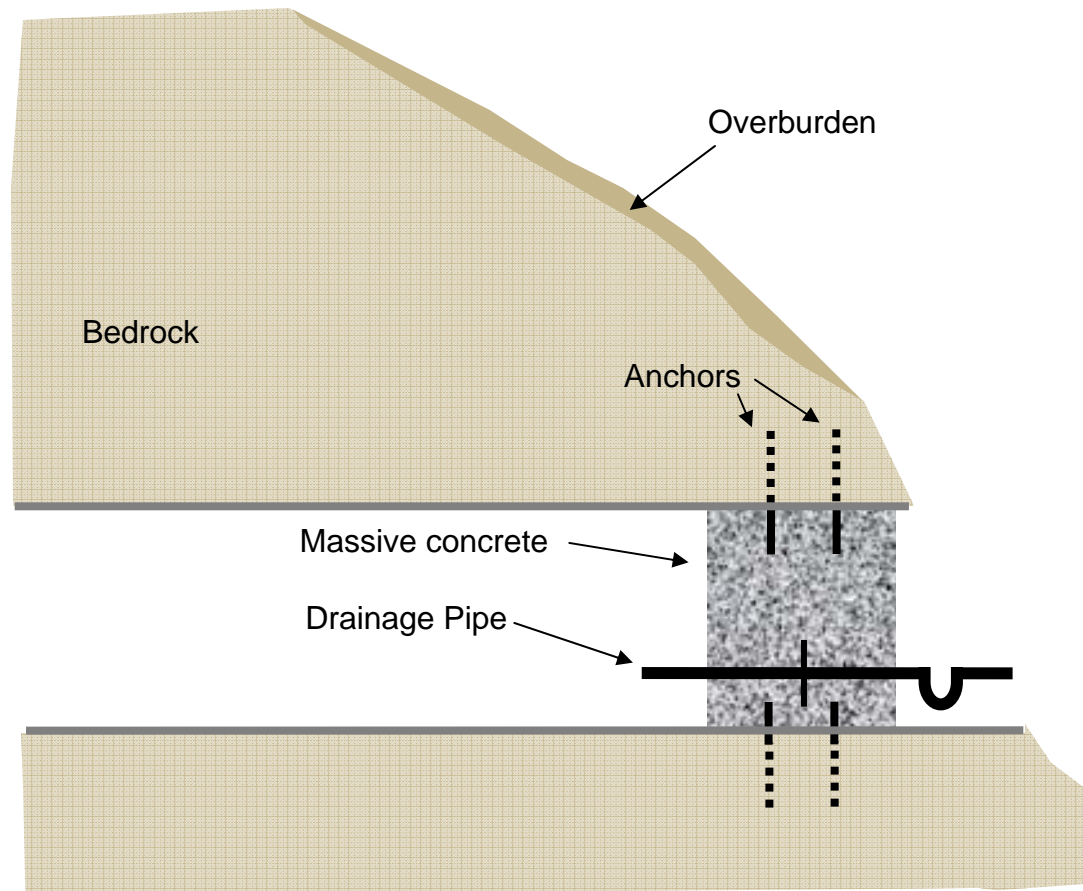
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2007 Adit Closure Studies		
Adit locations Sheet 2 of 2		
DATE: Feb. 2008	APPROVED: DBM	FIGURE: B

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1. Plugs

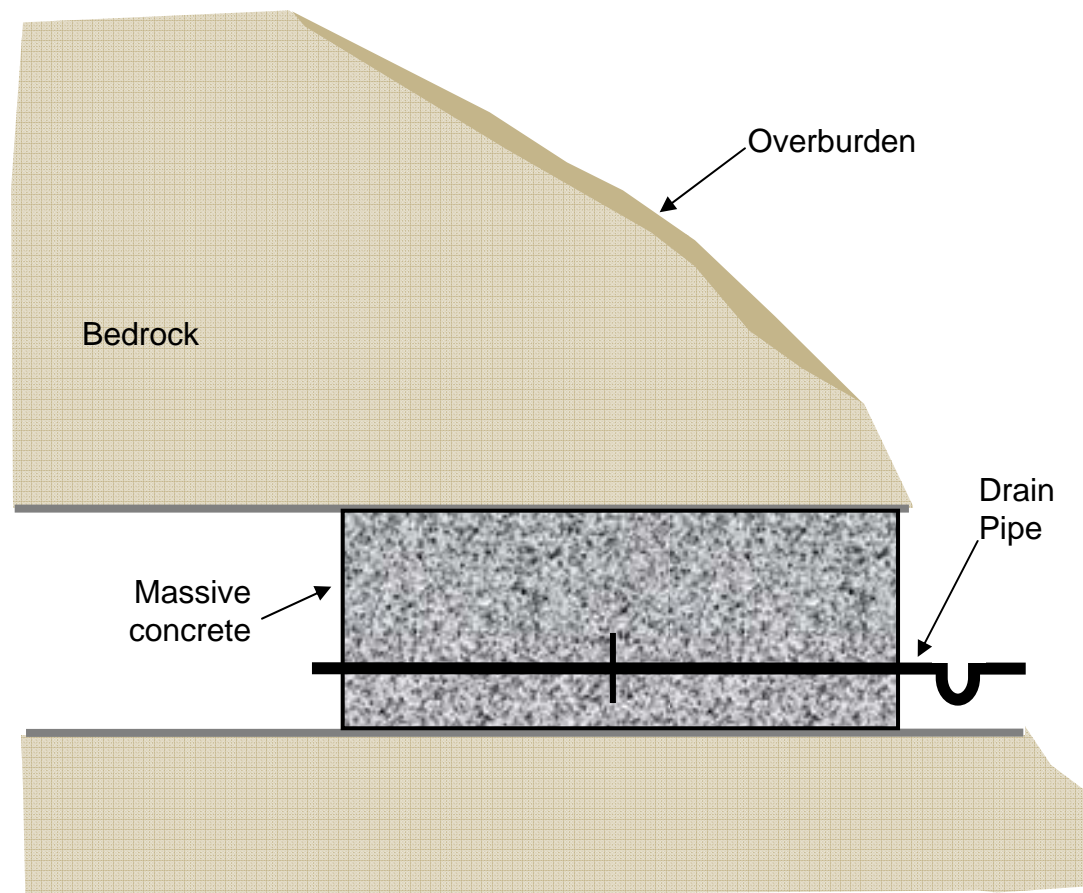
Scope: Water retaining/control structure. Eliminate all types of hazards associated with abandoned mine workings.

Pros:

- Easy to build
- Relatively inexpensive
- Good water retention capacity
- Totally restricted

Cons:

- Leakage around bulkhead possible
- Access required for small equipment
- Drilling required for anchoring (shear bolts)
- Limited life-time
- Not suitable for high water pressure
- Forming required
- Rehabilitation of opening required for safe access into mine working



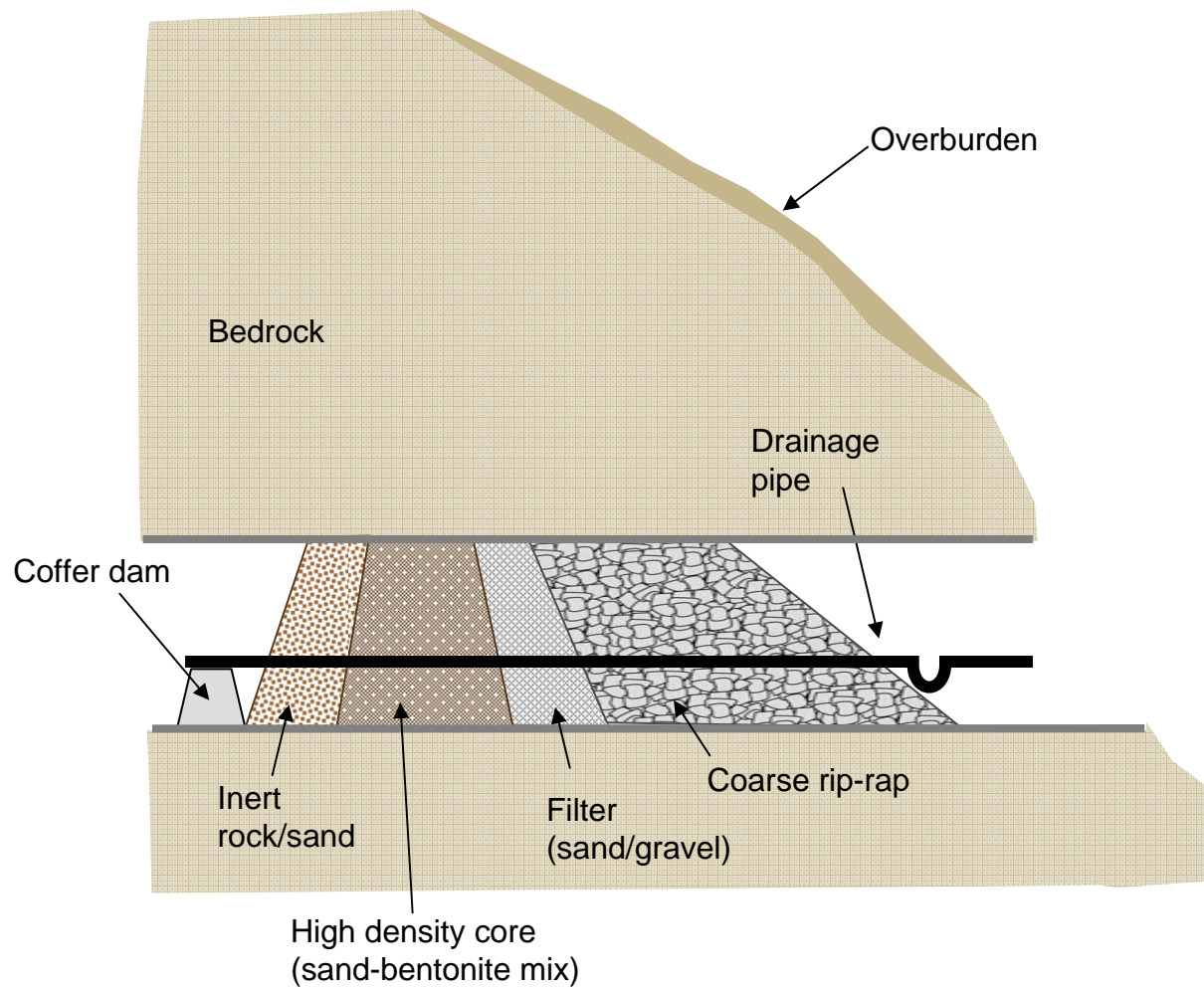
Pros:

- Easy to build
- Good water retention
- Less prone for seepage around plug
- High longevity
- Totally isolates mine workings behind plug

Cons:

- Leakage around bulkhead possible
- High volume of concrete
- Access required for concrete trucks
- Forming required
- Rehabilitation of opening required for safe access into mine working

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		Poured Concrete Massive Plug		
Job No: 1CE012.000 Filename: ConceptualPlugDesigns.1CE012.000.jm.rev9.ppt	Keno Hill Project	Date: March 2008	Approved:	Figure: 1b



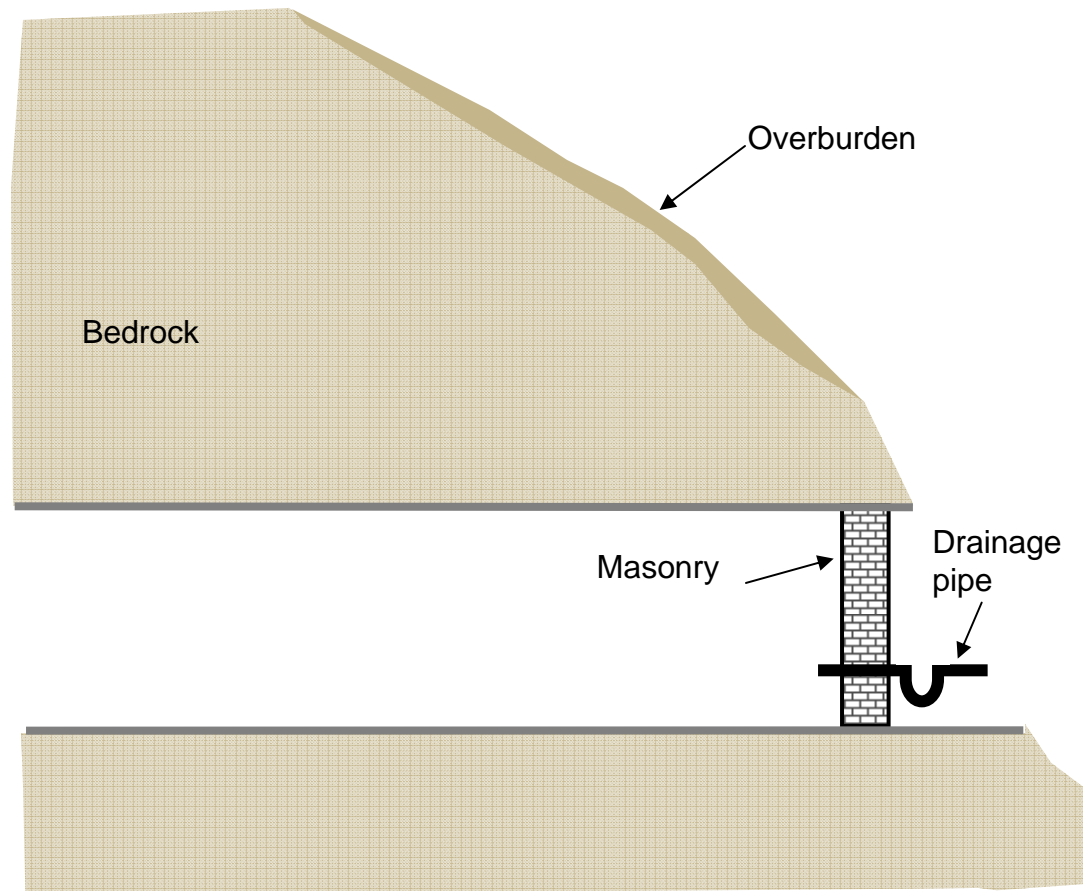
Pros:

- Good water retention capacity
- Great longevity
- Materials available on site
- Walk away solution
- No forming required

Cons:

- Access required for equipment
- Difficulties with compaction of high density core
- Labor intensive
- High cost
- Rehabilitation of opening required for safe access into mine working

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		<p>Composite Soil Plug (a.k.a. Millenium Plug)</p>		
<p>Job No: 1CE012.000 Filename: ConceptualPlugDesigns.1CE012.000.jm.rev9.ppt</p>	<p>Keno Hill Project</p>	<p>Date: March 2008</p>	<p>Approved:</p>	<p>Figure: 1c</p>



2. Seals

Scope: Restrict access into hazardous area of abandoned mine workings

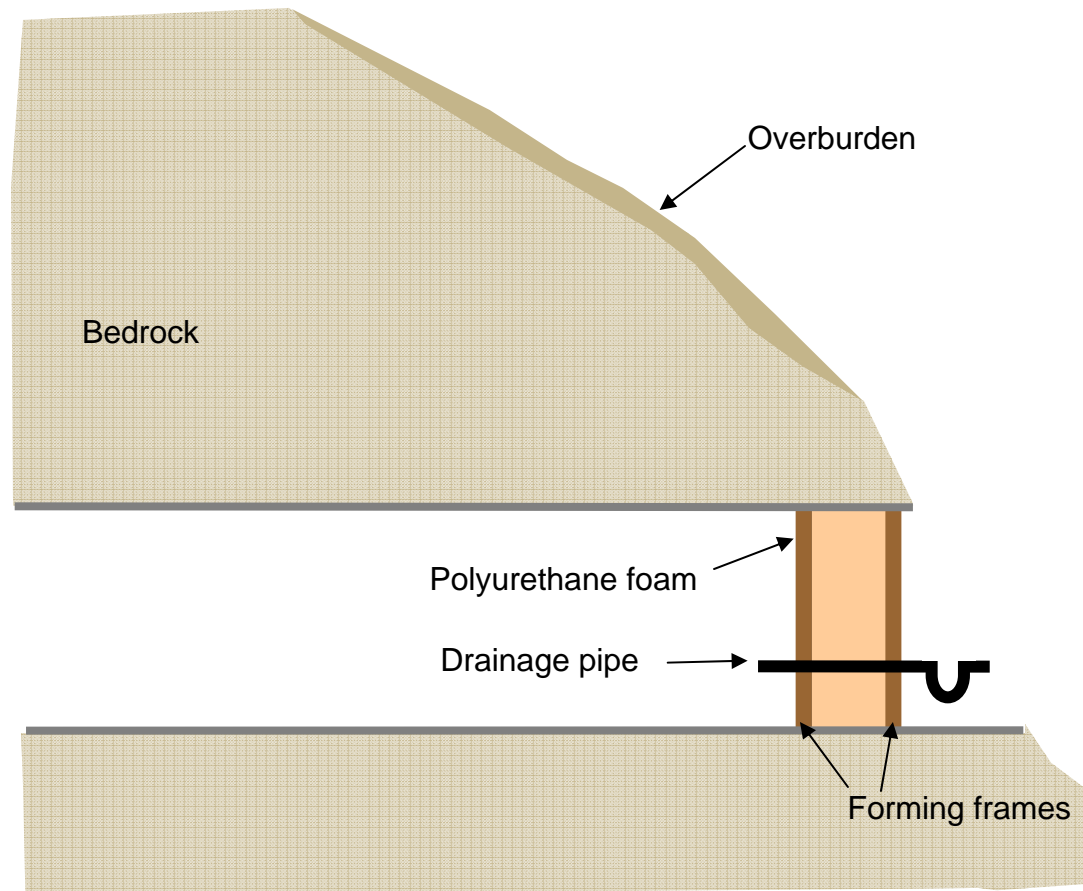
- Not suitable for water retention

Pros:

- Easy to construct
- Inexpensive
- No equipment access required
- Variety of available materials (bricks, concrete blocks, rock)

Cons:

- Maintenance required
- Low longevity
- Vulnerable to adit wall instability



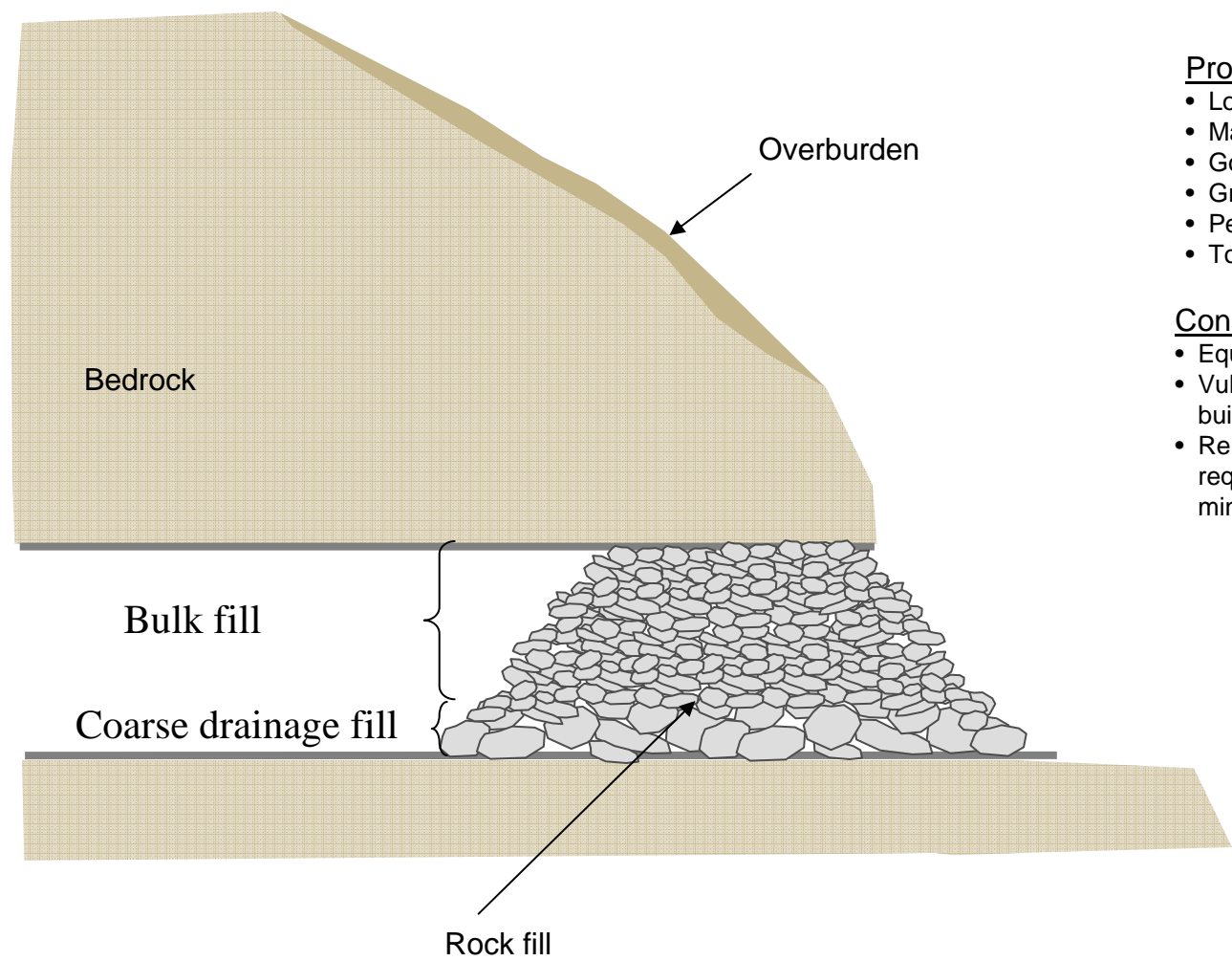
Pros:

- Easy to construct
- Good sealing capacity
- Foam inert when hardened
- Good longevity

Cons:

- Toxic foam components
- High cost of materials
- High risk of vandalism
- Complicated forming required
- No resistance to hydraulic heads developing behind wall
- Vulnerable if opening unstable
- Rehabilitation of opening required for safe access into mine working

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		Polyurethane Membrane		
Job No: 1CE012.000 Filename: ConceptualPlugDesigns.1CE012.000.jm.rev9.ppt	Keno Hill Project	Date: March 2008	Approved:	Figure: 2b



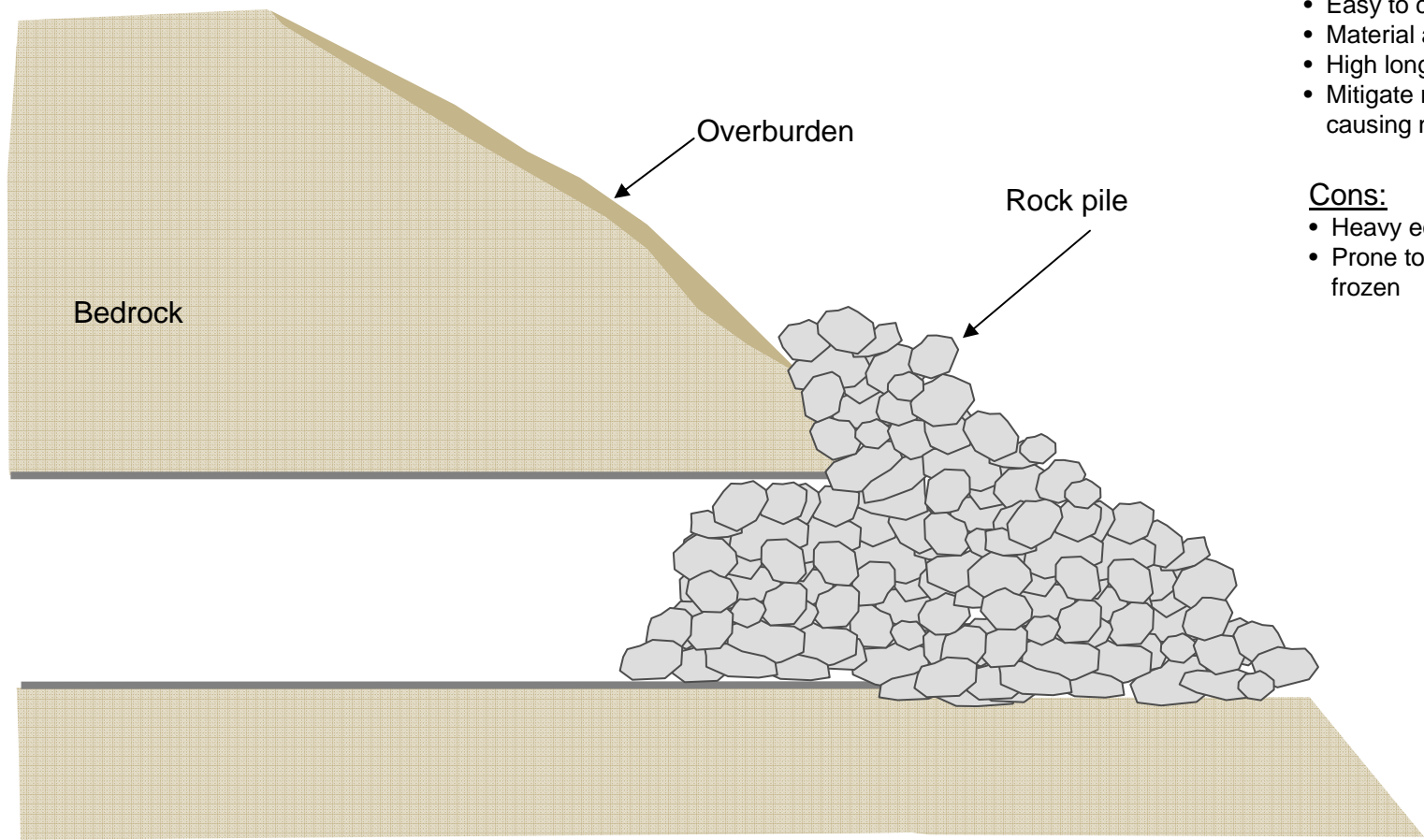
Pros:

- Low cost
- Material available on site
- Good physical stability
- Great longevity
- Permeable to potential seepage
- Totally precludes access

Cons:

- Equipment access required
- Vulnerable to hydraulic head build-up if frozen
- Rehabilitation of opening required for safe access into mine working

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		Rock Fill		
Job No: 1CE012.000 Filename: ConceptualPlugDesigns.1CE012.000.jm.rev9.ppt	Keno Hill Project	Date: March 2008	Approved:	Figure: 2c



Pros:

- Easy to construct
- Material available on site
- High longevity
- Mitigate risk of brow collapse causing new openings

Cons:

- Heavy equipment required
- Prone to accumulating water if frozen


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Job No: 1CE012.000
 Filename: ConceptualPlugDesigns.1CE012.000.jm.rev9.ppt

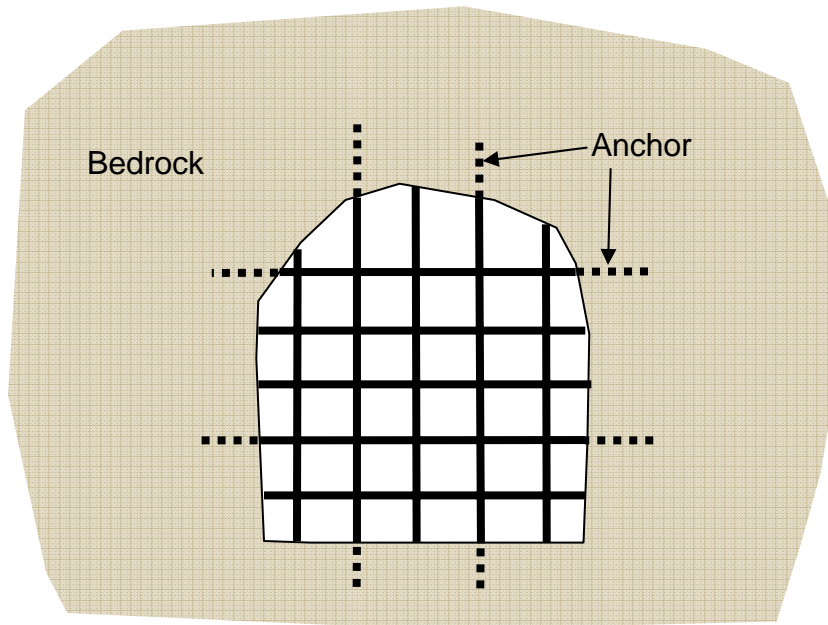

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2007/08 Adit Closure Studies		
Rock Pile		
Date: March 2008	Approved:	Figure: 2d

3. Barriers

Scope: Preclude human access into underground workings, but allow the use of adits by wildlife

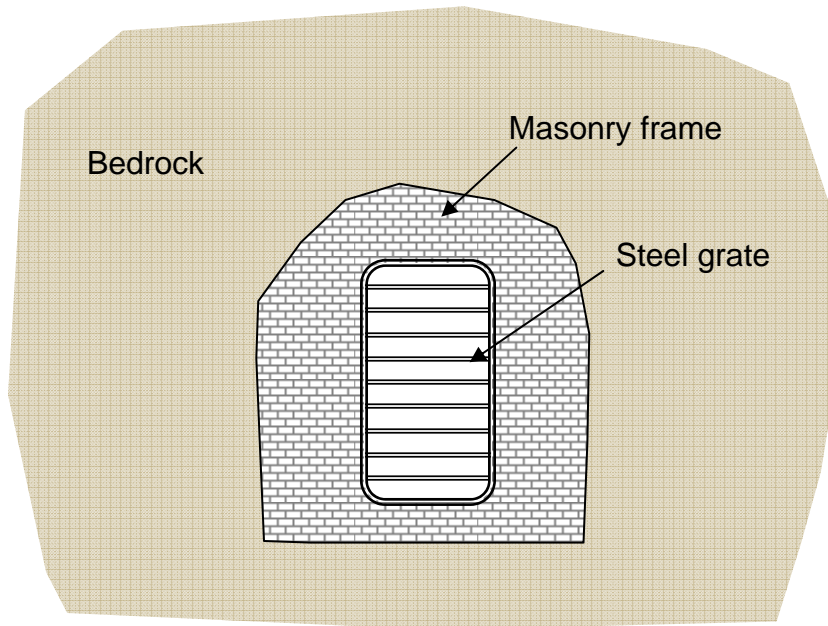


Pros:

- Easy to construct
- No heavy equipment required
- Low cost
- Possibility of entry through locked door

Cons:

- Anchoring required
- Limited longevity ~ 50 years
- Maintenance required



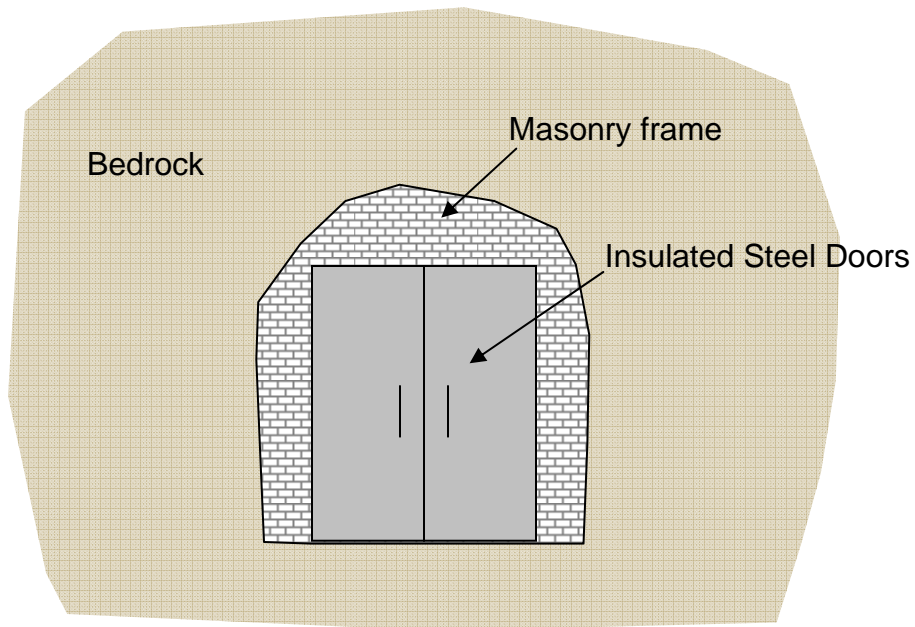
Pros:

- Easy to build
- No heavy equipment required
- No anchoring required
- Locked door for access

Cons:

- Maintenance required
- Highly visible
- Limited longevity

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		Steel Grate with Masonry Frame		
Job No: 1CE012.000 Filename: ConceptualPlugDesigns.1CE012.000.jm.rev9.ppt	Keno Hill Project	Date: March 2008	Approved:	Figure: 3b



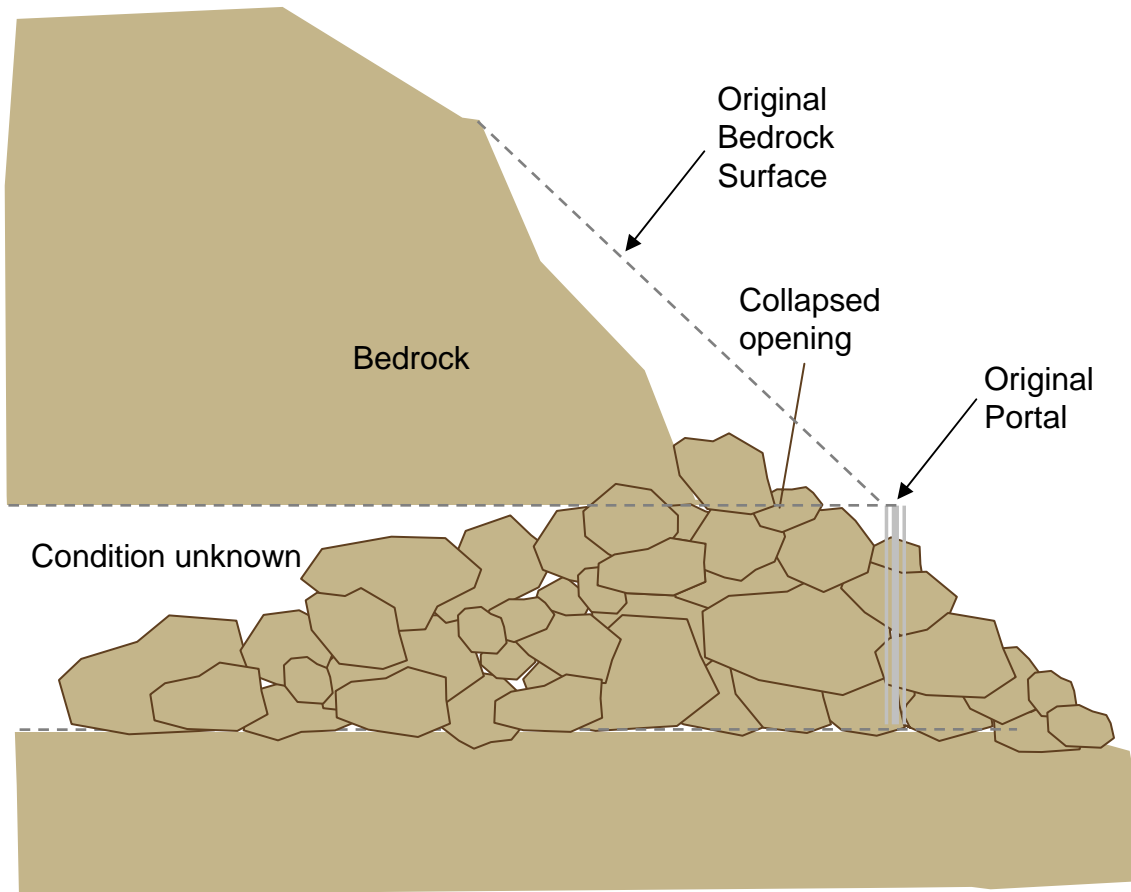
Pros:

- Easy to build
- No heavy equipment required
- No anchoring required
- Locked door for access

Cons:

- Maintenance required
- Highly visible
- Limited longevity

 <p>SRK Consulting Engineers and Scientists VANCOUVER</p>	 <p>ERDC</p>	2007/08 Adit Closure Studies		
		Insulated Steel Doors with Masonry Frame		
Job No: 1CE012.000 Filename: ConceptualPlugDesigns.1CE012.000.jm.rev9.ppt	Keno Hill Project	Date: March 2008	Approved:	Figure: 3c



Pros:

- No additional work required

Cons:

- Potential for further collapse and instability
- Periodic inspection may be necessary

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		Naturally Collapsed Opening		
Job No: 1CE012.000 Filename: ConceptualPlugDesigns.1CE012.000.jm.rev9.ppt	Keno Hill Project	Date: March 2008	Approved:	Figure: 4a