Golder Associates

TECHNICAL MEMORANDUM

DATE	May 26, 2011	**PROJECT No.**	09-1427-0006/6000/6200
TO	Des O'Connor PWGSC	**AECOM DOC. No**.	313-UG-13-MEM-0005-Rev1_20110526
CC	Rudy Schmitke, AECOM	**GAL DOC. No.**	060
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OPINION ON THE STABILITY OF ARSENIC STOPE B2-12/13/14 AND SURFACE ACCESS CONTROLS

PWGSC has requested an opinion on the stability of the crown pillar over arsenic stopes B2-12, B2-13, and B2-14 and recommendations on surface access controls above the area. A site plan showing the B1 pit area and nearby arsenic stopes and chambers is included in Figure 1.

Our review of existing stability assessments for all of the arsenic stopes and chambers is still undergoing internal review and discussion. Draft comments and guidance regarding arsenic stopes B2-12, B2-13, and B2-14 are outlined herein.

The geometry of a crown pillar is a key aspect of an assessment of its stability and some information gaps exist for these stopes, specifically the actual thickness of the crown pillars and the size and shape of the arsenic stopes themselves. Some mine drawings suggest that the vertical rib pillars between individual arsenic stopes B2-12, B2-13, and B2-14 are not present or may be so thin that they are ineffective. Previous stability assessments considered the possibility that they are not present. Golder has assessed these stopes as both individual openings and as one large opening, termed arsenic stope B2-12/13/14. Golder has developed an updated overburden / bedrock contact surface in the vicinity of B1 pit using the Giant Mine drillhole database and geological interpretations shown in the mine geology sections. This work suggests that the crown pillar over this arsenic stope is thinner than assumed in previous stability assessments.

No obvious evidence of crown pillar failure has been observed in exposure rock in B1 pit or in nearby underground openings. However, there is some evidence suggesting that crown pillar above arsenic stope B2-12/13/14 has exhibited some deformation including:

- Comparison of a level survey carried out on the B1 pit access road in 2011 and contours derived from air photos taken in 2003 suggests up to 1.0 m of subsidence within the zone outlined in Figure 1 over the last 8 years. This road is on soil backfill placed in the pit.
- Surface soil cracking has been observed well back from the crest of B1 pit that could be related to subsidence of the crown pillar. The location of the cracks is shown in Figure 1.
- Spalling of rock from the walls was observed in the B2-12/13/14 upper arsenic drift that could indicate changing ground stresses in the nearby crown pillar that would accompany movement. However it was also reported that this drift was subjected to recent scaling effort that would remove some of this potential evidence.
- There is very little space between the back of the stope and the dust (possibly indicative of local back sag) in a borehole drilled in 2004 into the top of arsenic stope B2-13.

Empirical stability analyses carried out using the information currently available to Golder suggest that the crown pillar over arsenic stope B2-12/13/14 is marginally stable with a likelihood of failure of ***possible*** using the INAC system (failure once every 10 to 100 years). When conservative, yet plausible assumptions are included in the analyses the likelihood of failure approaches ***likely*** (failure once every 1 to 10 years). Golder therefore agrees with the current INAC risk register (Section 5.2.2) that ranks the risk of this event, and other, crown pillar(s) as ***HIGH*** for environmental and community/media/reputation consequences and would suggest that without the access controls mentioned below that human health & safety also might rank as high.

The range of predictions is due to uncertainty and complexity in the geometry of the arsenic stopes and in the variability of the rock quality derived from previous investigation data. The highest probability of failure exists in the central area of the stope if the lower end of rock quality encountered in the drilling dominates stability. Time dependant processes such as frost action may be gradually degrading the strength of this crown pillar. Additional geotechnical investigation may reduce the uncertainty in the analyses but Golder is not optimistic that a likelihood of less than ***possible*** could be supported by any new information.

In order to understand the zone of impact of a potential crown pillar failure a subsidence zone was drawn from the top of the stope to surface using the following cave angles a shown in Figure 1:

- Dipping portion of the stope (B2-12/13):
  - 55° on the footwall (east) side
  - 75° on the hangingwall (west side)
- Vertical portion of the stope (B2-14):
  - 65° on all sides

Any initial failure of the rock in the crown pillar would likely quickly propagate to surface within this zone but with time the failure zone would expand in the surface overburden to a slope of approximately 45° as shown as a second surface subsidence perimeter in Figure 1.

The preliminary remediation design includes backfilling (topping up) the voids at the top of the arsenic stopes to enhance crown pillar stability after saturation and freezing of the dust are complete. However it could take up to 10 years for this particular arsenic stope to be remediated under the current project schedule (though this is incomplete). Therefore given the results of the stability analyses and the potential evidence of movement of the crown pillar, Golder therefore recommends that some mitigation work is required to enhance the stability of this crown pillar prior to the start of the remediation work. The preliminary remediation designs will therefore include temporary enhancement of the stability of the crown pillar over arsenic stope B2-12/13/14 and various options are being assessed. Given the INAC risk ranking of ***HIGH*** for this crown pillar mitigation of it should be a priority, therefore planning and design to enhance the stability of this crown pillar should be started.

If the crown pillar has actually started to fail the mitigation and remediation plan would need to take this into account. Due to the evidence of possible crown pillar failure noted above and the uncertainties and limitations in the stability analyses, additional investigation is warranted to determine if any instability has occurred.

Monitoring cannot be used as a definitive tool to assess if and when mitigation is required because failure could occur quickly with little warning.

Golder recommended a crude monitoring program in the fall of 2010 for the areas above arsenic stope B2-12/13/14 and arsenic stope B2-08 to assist with interpretation of the nature of surface cracking observed near B1 pit. Prisms mounted on tripods were placed on surface and the prisms are currently being surveyed manually twice a week. The data is added to a spreadsheet and forwarded on to interested parties typically within 1 to 2 days.

Because the current monitoring system is subjected to freeze thaw effects and possible ice lens melting during the break-up period (early spring and late fall) the reliability of the system as an indicator of crown pillar stability is currently limited. Thus, Golder recommends that all vehicles stay off the area above B2-12/13/14 within the inner potential subsidence zone shown on Figure 1 until further notice. Foot access can be allowed if a procedure of thorough inspection for fresh and new cracking is carried out prior to access within this zone. Golder will provide further advice on access over the area outside the break-up period at a later date under but agrees with the current advice documented in INAC's Giant Mine Risk Registry item 5.2.2 which states that only light vehicles are allowed in B1 pit at all times so the care and maintenance contractor needs to be reminded of this.

Monitoring in addition to the current system is recommended to determine if the crown pillar is deforming, the extent of the deformation, and the movement mechanisms involved. This monitoring will be used to help plan the mitigation work and for assessment of both worker and public safety but as noted above it will not provide a fail-safe warning of impending failure. Golder can provide advice on additional geotechnical evaluation to help limit uncertainty in the predicted probability of failure of the crown pillar and a more sophisticated monitoring system if requested to do so.

Golder's preliminary stability assessments also suggest that similar exclusion zones, monitoring, and mitigative work may be required over arsenic stope B2-08. Further discussion on this topic will be provided in the future.

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Attachment: Figure 1

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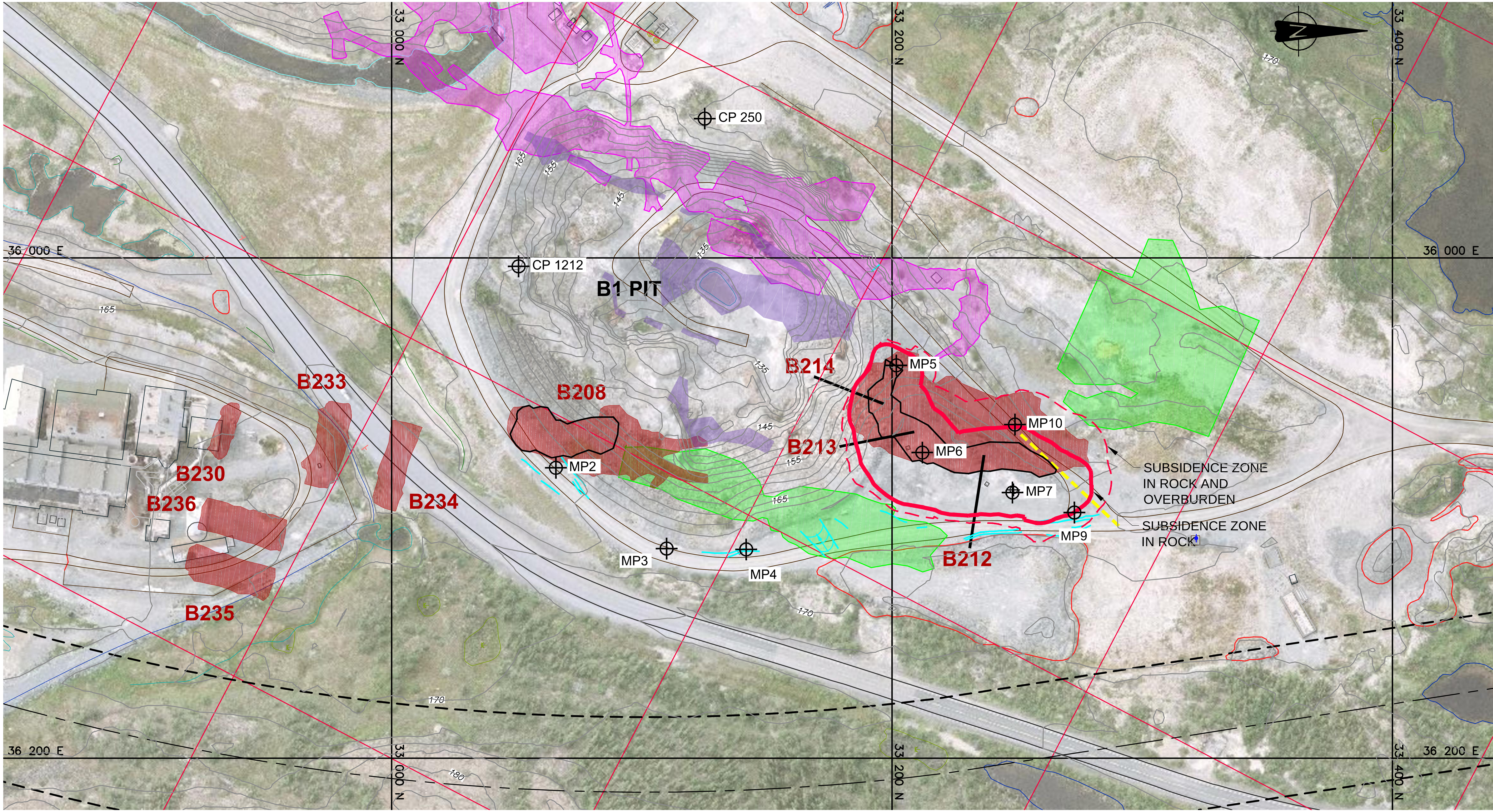

LEGEND

- ARSENIC CHAMBERS AND STOPES
- NEAR SURFACE NON-ARSENIC STOPES
- NON-ARSENIC STOPES ADJACENT TO AN ARSENIC STOPE
- UNDERGROUND STOPE BREAKTHROUGH TO OPEN-PIT, BACKFILLED WITH UNKNOWN FILL
- SURVEY MONITORING POINT
- CROWN PILLAR SUBSIDENCE ZONE IN ROCK AND OVERBURDEN
- CROWN PILLAR SUBSIDENCE ZONE IN ROCK
- TOP OF STOPE
- SURFACE CRACKING
- B1 PIT RAMP SAG

0 15 30 45 60 75
SCALE IN METRES (SCALE 1:1500)

PROJECT
GIANT MINE
REMEDIATION PROJECT
YELLOWKNIFE, N.W.T.

TITLE
POTENTIAL SURFACE SUBSIDENCE LIMITS AND PRISM MONITORING POINTS

Golder Associates

PROJECT No. 09-1427-0006			PHASE No. 6000/6200	
DESIGN	DTK	24-MAY-11	SCALE AS SHOWN	REV. 0
CADD	MP	24-MAY-11		
CHECK	DTK	25-MAY-11	FIGURE 1	
REVIEW	DTK	25-MAY-11		