# WOLVERINE PROJECT

# MINE DEVELOPMENT AND OPERATION PLAN

## VERSION 2010-02

## SECTION 5 ADDENDUM

## QML-0006

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Yukon Government

Department of Energy, Mines and Resources

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December 29th, 2010

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# 5 Ground Support Methods and Monitoring Instrumentation

Over the past several months an extensive underground rehabilitation program was implemented and will continue into 2011. A professional engineer with expertise in geotechnical evaluations was hired to inspect all excavations and recommend ground support regimes that would improve the stability of the openings and provide a viable method for future mining.

It is not the intent of this report to analyse the findings nor will it address past history. This Addendum is written for the purpose of updating Section 5 of the "Mine Development and Operation Plan Version 2010-02", dated July 8, 2010, for the purpose of securing permission from the Chief to commence mining operations at the Wolverine Mine Site.

## 5.1 Ground Support Methods

The present ground support system differs with the initial support network of split sets and rebar. These bolts have been replaced with longer water injected friction style Swellex bolts. The applications of these bolts depend on the size of the opening and function of the excavation and are used in conjunction with shotcrete and mesh to form a secure environment. These applications have been grouped into five different Support Types and are summarized in the following tables. The types of bolts, amounts, and their locations are recorded daily and depending on the area either one or two percent of the installations are pull-tested to ensure proper installation. All test results are recorded in a Ground Control Log Book. A procedure has been developed to address any bolts that fail.

**Table 5-1: General Guidelines for Support Type 1.**

| Function | Opening | Support Type | Span m(ft) | Location Wall or Back | Support Type | Bolt Length m (ft) | Spacing m (ft) | Shotcrete mm (in) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| Access | Decline above 1230 level | 1a | 5.0 (16') | Wall | Swellex(12T) + (4"x4") #8 mesh | 2.4 (8') | 1.2 x 1.2 (4' x 4') | 50mm(2") Fibre reinforced 100mm(4') Regular | Spot bolt as required and mesh to 1.5m from sill. |
| | | | | Back | Swellex(24T) + (4"x4") #8 mesh | 3.7 (12') | 1.2 x 1.2 (4' x 4') | | |
| | Decline below 1230 level | 1b | 5.0 (16') | Wall | Swellex(12T) + (4"x4") #8 mesh | 3.0 (10') | 1.2 x 1.2 (4' x 4') | 50mm(2") Fibre reinforced 100mm(4') Regular | Spot bolt as required and mesh to 1.5m from sill. |
| | | | | Back | Swellex(24T) + (4"x4") #8 mesh | 3.7 (12') | 1.2 x 1.2 (4' x 4') | | |

**Table 5-2: General Guidelines for Support Type 2.**

| Function | Opening | Support Type | Span m(ft) | Location Wall or Back | Support Type | Bolt Length m (ft) | Spacing m (ft) | Shotcrete mm (in) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| Access | Stope Access above 1230 level | 2a | 5.0 (16') and Height <5.0 | Wall | Swellex(12T) + (4"x4") #8 mesh | 2.4 (8') | 1.2 x 1.2 (4' x 4') | 50mm(2") Fibre reinforced | Spot bolt as required and mesh to 1.5m from sill. |
| | | | | Back | Swellex(24T) + (4"x4") #8 mesh | 3.7 (12') | 1.2 x 1.2 (4' x 4') | 50mm(2') Regular | |
| | | | 5.0 (16') and Height >5.0 | Wall | Swellex(12T) + (4"x4") #8 mesh | 3.0 (10') | 1.2 x 1.2 (4' x 4') | 50mm(2") Fibre reinforced | Spot bolt as required and mesh to 1.5m from sill. |
| | | | | Back | Swellex(24T) + (4"x4") #8 mesh | 3.7 (12') | 1.2 x 1.2 (4' x 4') | 50mm(2') Regular | |
| | Stope Access below 1230 level | 2b | 5.0 (16') and All Heights | Wall | Swellex(12T) + (4"x4") #8 mesh | 3.0 (10') | 1.2 x 1.2 (4' x 4') | 50mm(2") Fibre reinforced | Spot bolt as required and mesh to 1.5m from sill. |
| | | | | Back | Swellex(24T) + (4"x4") #8 mesh | 3.7 (12') | 1.2 x 1.2 (4' x 4') | 50mm(2') Regular | |

**Table 5-3: General Guidelines for Support Type 3.**

| Function | Opening | Support Type | Span m(ft) | Location Wall or Back | Support Type | Bolt Length m (ft) | Spacing m (ft) | Shotcrete mm (in) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| Stope Drift | Footwall Drift above 1230 level | 3a | 4.25(13.9') | Wall | Swellex(12T) + (4"x4") #6 mesh | 1 -3.0 (10') 2 -2.4(8') per wall | 1.0 x 1.0 (3' x 3') | None Required | Spot bolt as required and mesh to 1.5m from sill. Shotcrete if required. |
| | | | | Back | Swellex(24T) + (4"x4") #6 mesh | 3.7 (12') | 1.0 x 1.0 (3' x 3') | None Required | |
| | Footwall Drift below 1230 level | 3b | 4.25(13.9') | Wall | Swellex(12T) + (4"x4") #6 mesh | 3.0 (10') | 1.0 x 1.0 (3' x 3') | None Required | Spot bolt as required and mesh to 1.5m from sill. Shotcrete if required. |
| | | | | Back | Swellex(24T) + (4"x4") #6 mesh | 3.7 (12') | 1.0 x 1.0 (3' x 3') | None Required | |

**Table 5-4: General Guidelines for Support Type 4.**

| Function | Opening | Support Type | Span m(ft) | Location Wall or Back | Support Type | Bolt Length m (ft) | Spacing m (ft) | Shotcrete mm (in) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| Raises | Fresh Air Raises | 4 | 3.6(12') | Wall | Swellex(12T) + (4"x4") #6 mesh | 2.4 (8') | 1.2 x 1.2 (4' x 4') | 75mm(3") Fibre reinforced | Spot bolt as required and mesh to 1.0m from sill. Shotcrete if required. |
| | | | | Back | Swellex(12T) + (4"x4") #8 mesh | 2.4 (8') | 1.2 x 1.2 (4' x 4') | 75mm(3") Regular | |

**Table 5-5: General Guidelines for Support Type 5.**

| Function | Opening | Support Type | Span m(ft) | Location Wall or Back | Support Type | Bolt Length m (ft) | Spacing m (ft) | Shotcrete mm (in) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| Intersections | In Decline above 1230 level | 5 | >7.2 (16’) | Back | Swellex(24T) + (4”x4”) #8 mesh | 3.7 (12’) | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Regular | Spot bolt as required. Support must extend 6m before and beyond the intersection |
| | | | | Wall Ht<5m | Swellex(12T) + (4”x4”) #8 mesh | 2.4 (8’) | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Fibre reinforced | Spot bolt as required. Support must extend 6m before and beyond the intersection |
| | | | | Wall Ht>5m | Swellex(12T) + (4”x4”) #8 mesh | 3.0 (10’) | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Regular | Spot bolt as required. Support must extend 6m before and beyond the intersection |
| | | 5a | 7.2-12 (16’-39') | Back | Swellex(24T) + (4”x4”) #8 mesh | 3.7 (12’) | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Regular | Spot bolt as required. Support must extend 6m before and beyond the intersection |
| | | | | Wall Ht<5m | Swellex(12T) + (4”x4”) #8 mesh | 2.4 (8’) | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Fibre reinforced | Spot bolt as required. Support must extend 6m before and beyond the intersection |
| | | | | Wall Ht>5m | Swellex(12T) + (4”x4”) #8 mesh | 3.0 (10’) | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Regular | Spot bolt as required. Support must extend 6m before and beyond the intersection |
| Intersections | In Decline above 1230 level | 5c | >7.2 (16’) | Back | Swellex(24T) + (4”x4”) #8 mesh | 3.7 (12’) | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Regular | Spot bolt as required. Support must extend 6m before and beyond the intersection |
| | | | | Wall Ht<5m | Swellex(12T) + (4”x4”) #8 mesh | 3.0 (10’) | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Fibre reinforced | Spot bolt as required. Support must extend 6m before and beyond the intersection |
| | | | | Wall Ht>5m | Swellex(12T) + (4”x4”) #8 mesh | 3.0 (10’) | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Regular | Spot bolt as required. Support must extend 6m before and beyond the intersection |
| | | 5d | 7.2-12 (16’-39') | Back | Swellex(24T) + (4”x4”) #8 mesh | 5.5(18') | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Regular | Spot bolt as required. Support must extend 6m before and beyond the intersection |
| | | | | Wall Ht<5m | Swellex(12T) + (4”x4”) #8 mesh | 3.0 (10’) | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Fibre reinforced | Spot bolt as required. Support must extend 6m before and beyond the intersection |
| | | | | Wall Ht>5m | Swellex(12T) + (4”x4”) #8 mesh | 3.0 (10’) | 1.2 x 1.2 (4’ x 4’) | 100mm(4”) Regular | Spot bolt as required. Support must extend 6m before and beyond the intersection |

## 5.2 Instrumentation

Figure 5-1 shows the location of the instrumentation used to monitor ground movement. Currently at Wolverine we have installed nine extensometers and nine tilt metres on the main ramp. Eight additional extensometers are on order and will be installed when they arrive. There are no plans for installing new tilt meters at this time. To date no movement has been detected. Along with weekly instrumentation readings, a monthly geodetic survey of the steel sets in the Portal area is completed. This survey also shows no movement. A daily log kept in the Mine Office records the results of daily inspections of walls, backs, and structures throughout the mine.

## 5.3 Ground Control Management Plan

A Ground Control Management Plan (GCMP) for the Wolverine Mine is in the process of being finalized utilizing the recommendations of our geotechnical consultant. The main objectives of this plan are to:

1) Reduce the risk of ground failure by providing standardized rock support systems dependent on different size headings, geological structures, and rock types.
2) Achieve a safe working environment.
3) Contribute to efficient extraction of the ore reserve.

The Support Types previously described are being incorporated into the GCMP, complete with diagrams and a list of support elements and Instructions.

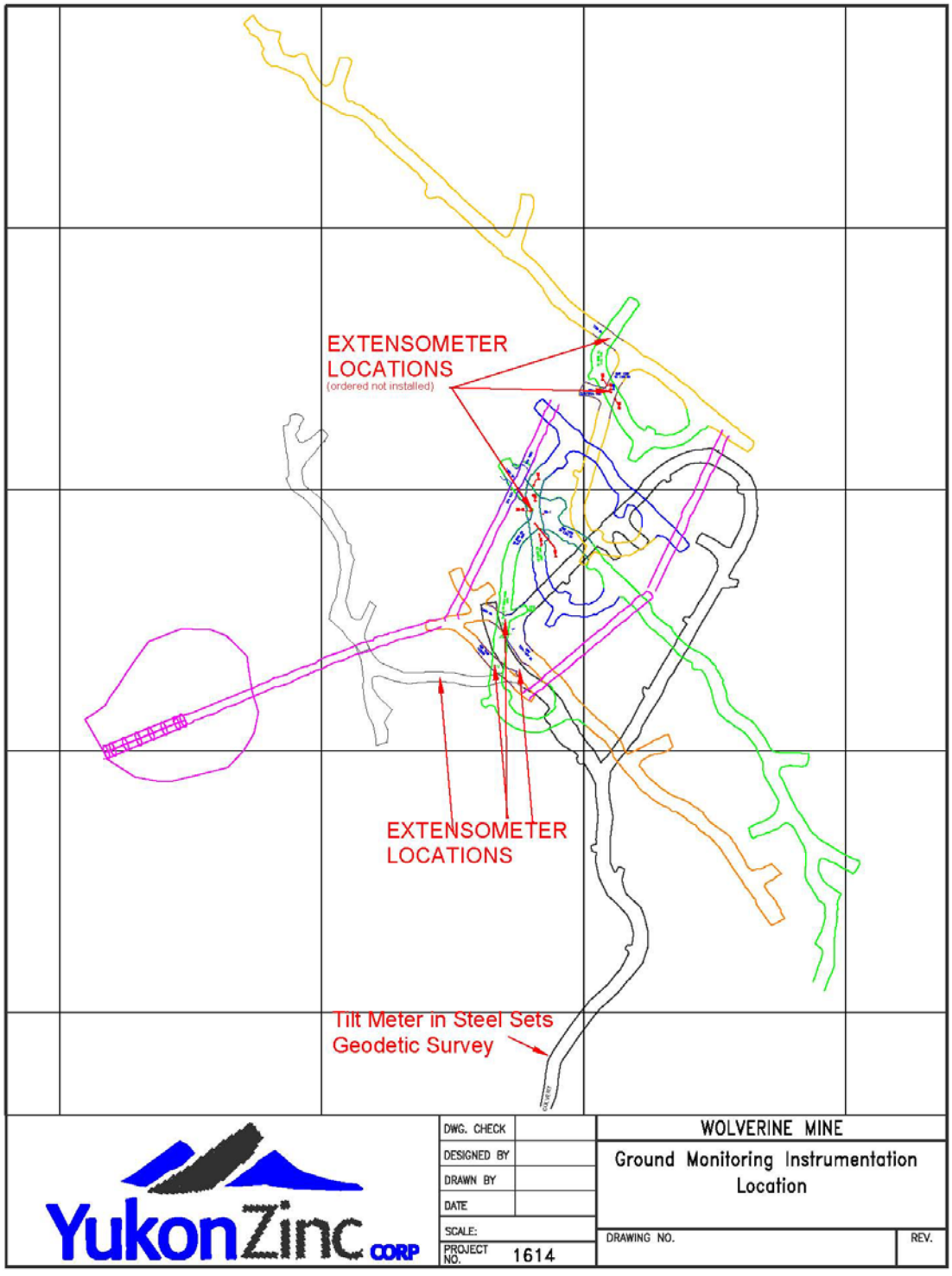


**Figure 5-1: Ground Monitoring Instrumentation Locations**