# Geotechnical considerations open pit audit Site: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Date conducted:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| 1 Mine planning and design |
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| **Point** | **Standard** | **Standard met** | **Comments** |
| 1.1 | Senior mine management has demonstrated a clear understanding and commitment to address the geotechnical issues in open pit mining using sound geotechnical engineering practice |  |  |
| 1.2 | The geometry and design life of each open pit excavation and associated waste dumps has been determined and formally documented |  |  |
| 1.3 | The mine has utilized geotechnical input in the mine design process |  |  |
| 1.4 | The positioning of open pit walls and waste dumps have taken into consideration the tenement boundaries, the locations of major surface facilities and the geotechnical parameters that can affect the integrity of these facilities |  |  |
| 1.5 | A multi-disciplinary, mine design and planning process exists and is formally implemented |  |  |
| 1.6 | A set of development planning and design criteria have been drawn up to provide general guidance in mine planning and design for open pits, waste dumps, ROM pads and major haul routes. e.g. stockpiles and waste dumps have been designed to take into account the full range of foundation materials, stockpile/dump materials and ground/surface water conditions |  |  |
| 1.7 | Geotechnical domains are used to divide the rock mass into volumes of similar expected ground behaviour in three dimensions |  |  |
| 1.8 | The mine has developed a ground control management plan (GCMP) relevant to the local ground conditions and mining strategies |  |  |
| 1.9 | The mine has both short and long term production schedules that take into account the likely geotechnical impacts which may have an adverse affect on safety |  |  |
| 1.10 | An assessment has taken place to determine whether all boreholes need to be fully grouted to prevent contact with water bearing bodies and those requiring grouting are sealed |  |  |
| 1.11 | The boundaries of water filled hazards have been accurately determined and a safe working distance specified according to the ground conditions and the mine plan |  |  |
| 1.12 | The interaction of near-by underground mine voids has been taken into consideration for the mine design and excavation sequencing to minimize the potential for adverse stability conditions on pit walls |  |  |
| 1.13 | Water diversion and storage structures are designed according to acceptable engineering standards |  |  |
| 1.14 | Internal water drainage strategies exist for open pits, waste dumps and haul roads |  |  |
| 1.15 | A justifiable design criteria exists for mining in close proximity to surface water drainage paths and open pit sumps where underground workings exist |  |  |
| 1.16 | The mine has a formalised plan for closure of the open pit |  |  |
| 1.17 | The closure plan considers issues such as drainage, visibility (dusting & road bends), abandonment bunding and erosion materials spreading onto sensitive land |  |  |
| 1.18 | The design of final pit walls takes into account time-dependent effects on rock strength, the degree of inherent uncertainty, and reflects the associated need for conservative slope design criteria |  |  |
| 1.19 | The closure plan has been approved by the relevant regulatory bodies and nearby land owners |  |  |

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| 2 General operational issues |
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| **Point** | **Standard** | **Standard met** | **Comments** |
| 2.1 | The mine has implemented the ground control management plan (GCMP) for pit walls, stockpiles and waste dumps |  |  |
| 2.2 | The GCMP has a review period and is signed off by relevant management bodies each time a modification is made to that document |  |  |
| 2.3 | All relevant personnel understand their roles within this site GCMP |  |  |
| 2.4 | The mine has a suitably qualified person(s) to oversee geotechnical issues or has appropriate visitation by contracted geotechnical experts with backup from appropriate site personnel |  |  |
| 2.5 | The site has formalised procedures for geotechnical mapping commensurate with the rate of mining and the specific site safety risks for those undertaking mapping |  |  |
| 2.6 | Geotechnical mapping is being carried out on a regular basis consistent with the rate of mining and areas requiring additional geotechnical information |  |  |
| 2.7 | The as-mined pit wall/dump conditions and geotechnical model are used to make risk assessments for each mining area |  |  |
| 2.8 | Safety/catch berms are maintained such that sufficient catch volume remains to halt the movement of rock down the slope |  |  |
| 2.9 | For situations where berms are not in a suitable condition, formalised procedures are in place and implemented to prevent rock from toppling down onto the working areas |  |  |
| 2.10 | The mine has a system for house-keeping loose material after each wall blast and if blocks of loose rock come to rest at the crest of berms |  |  |
| 2.11 | Where underground workings or natural voids exist, the mine has developed formal safe working practices for mining through voids that are formally approved and implemented |  |  |
| 2.12 | The mining through voids document complies with the departmental guidelines on open pit mining through underground workings as a minimum standard |  |  |
| 2.13 | Appropriate bunding strategies have been developed and implemented to limit access to "drop-offs" from levels above (general traffic ramps and dump tip heads) |  |  |
| 2.14 | Waste dump procedures have been developed to take into account the full range of excavation materials being dumped and ground/surface water conditions in all areas |  |  |
| 2.15 | Waste dump management includes policies for drainage at the top and bottom of dumps, tip head design and management, foundation stability, and dust, where it is an issue |  |  |
| 2.16 | Where areas of significant hazard are identified (e.g. undertaking cutbacks, areas with high rates of deformation), suitable safe working practices are developed and implemented to protect personnel that may work below the level of the cut-back |  |  |
| 2.17 | Emergency action plans or protocols exist in the event of a potential high risk ground movement event |  |  |
| 2.18 | The mine conducts regular, on-going, checks of pit walls to determine the need for scaling over time for various types of work (e.g. installation of reinforcement or monitoring installation) and documents any rehabilitation work carried out |  |  |
| 2.19 | Records are kept of scaling work undertaken |  |  |
| 2.20 | The mine has a standard specification for scaling equipment and these specifications can satisfy the full extent of operating conditions |  |  |
| 2.21 | The mine enforces a standard work procedure for scaling |  |  |

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| 3 Drill and blast |
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| **Point** | **Standard** | **Standard met** | **Comments** |
| 3.1 | A standard drilling and blasting pattern exists, and is always used, for each geotechnical domain, and influence of groundwater |  |  |
| 3.2 | SWP’s are available for drilling and blasting operations |  |  |
| 3.3 | Suitable subgrade drilling and blasting is undertaken to allow for safe trafficking conditions without damaging batter crests |  |  |
| 3.4 | All final wall drilling equipment is fitted with automatic hole parallelism and angle controls that are maintained in good working order |  |  |
| 3.5 | Overbreak/underbreak at the excavation perimeters is monitored |  |  |
| 3.6 | A system exists to correct mining techniques where excess overbreak or burden at the toe is encountered |  |  |
| 3.7 | Where applicable, the impact of blasting on nearby structures e.g. tailings storage facilities or water diversion structures has been adequately assessed and taken into consideration when designing all forms of blast |  |  |

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| 4 Rock reinforcement |
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| **Point** | **Standard** | **Standard met** | **Comments** |
| 4.1 | The mine has determined ground support strategies for each type of support/reinforcement, geotechnical domain and dimension of excavation |  |  |
| 4.2 | A recognised rock support and reinforcement design method has been used to design the required rock support and reinforcement system |  |  |
| 4.3 | A technical specification exists for all the rock support and reinforcement systems in use |  |  |
| 4.4 | The mining cycle has been adapted to the ground conditions to suit any delays in installing the ground support |  |  |
| 4.5 | Written standard work procedures have been developed for the installation of the various types of rock support and reinforcement in use at the mine |  |  |
| 4.6 | The installation procedures provided by the supplier(s) of the rock support and reinforcement elements are being followed |  |  |
| 4.7 | The storage and handling of rock support and reinforcement elements are such that deterioration with time is minimized |  |  |

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| 5 Quality control and monitoring |
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| **Point** | **Standard** | **Standard met** | **Comments** |
| 5.1 | Regular geotechnical inspections are made on foot by suitably experienced personnel to detect change in ground stability of the walls and berms and to document the performance of pit walls with time |  |  |
| 5.2 | Strategies for pit wall monitoring are appropriately matched to the mode and scale of potential failures and can provide suitable information with adequate forewarning |  |  |
| 5.3 | The mine has established tolerance limits for various modes of failure which are used to determine the appropriate levels of action |  |  |
| 5.4 | Where appropriate, a seismic monitoring system is installed in a mine where seismic activity causes damage to the pit walls and/or the rock support and reinforcement systems in the mine |  |  |
| 5.5 | Geotechnical hazards and monitoring results are effectively and regularly communicated to the workforce (including management) |  |  |
| 5.6 | The mine has developed and implemented quality control requirements for each type of rock reinforcement and support element used at the mine |  |  |
| 5.7 | Groundwater samples are routinely collected and chemically analysed to determine the potential for corrosion of the rock support and reinforcement system |  |  |
| 5.8 | Variations to the recommended installation procedures have been discussed according to the formal design strategy and agreed with the supplier prior to their implementation |  |  |
| 5.9 | The mine has an action plan that is implemented when it is found that quality control results (e.g. the load capacity of the installed rock support and reinforcement system) do not meet the required standard |  |  |

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| 6 Design confirmation/back analysis |
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| **Point** | **Standard** | **Standard met** | **Comments** |
| 6.1 | An on-going record of geotechnical monitoring, with written notes of observations, is maintained, regularly updated and current. A procedure exists where changes in the geotechnical model are identified, or change in pit wall performance noted and relevant changes made to the mine design and GCMP(Ground Control Management Plan) |  |  |
| 6.2 | The pit wall performance documentation is current |  |  |
| 6.3 | The as-mined pit wall geometry is known and ratified against initial wall designs |  |  |
| 6.4 | Accurate plans are used to show “as-is” void and pillar geometry of nearby underground mines to confirm design strategies |  |  |
| 6.5 | The mine has developed a process whereby any slope failures are back analysed to re-evaluate initial designs |  |  |

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| 7 Training and competency |
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| **Point** | **Standard** | **Standard met** | **Comments** |
| 7.1 | The workforce receives on the job training and assessment covering the recognition of geotechnical hazards |  |  |
| 7.2 | The workforce receives on the job training and assessment covering general ground awareness when working near drop-offs, e.g. pit bench edges, ore stockpiles |  |  |
| 7.3 | The workforce receives on the job training and assessment covering general ground awareness when working near pit walls |  |  |
| 7.4 | The workforce receives on the job training and assessment covering general ground awareness when working where underground voids might exist |  |  |
| 7.5 | The workforce receives on the job training and assessment covering general ground awareness when working on waste dumps |  |  |
| 7.6 | The workforce receives on the job training and assessment covering the importance of the correct drilling and blasting work procedures |  |  |
| 7.7 | The workforce receives on the job training and assessment covering general ground awareness with respect to assessing scaling requirements and safe scaling practices |  |  |
| 7.8 | The workforce receives on the job training and assessment covering the importance of the correct rock reinforcement installation procedures |  |  |
| 7.9 | Mine management have procedures for assessing the ongoing competence and performance of relevant mining personnel in : recognising geotechnical hazards, working near drop-offs, working near pit walls, working where underground voids might exist, working on waste dumps, the correct drilling and blasting work procedures, assessing scaling requirements and safe scaling practices and the correct rock reinforcement installation procedures |  |  |

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