Condiciones de seguridad e higiene que prevalecen en la Mina 8 Unidad Pasta de Conchos

Informe

Del estudio realizado por el Panel Internacional de Expertos en Seguridad en Minas del Foro Consultivo Científico y Tecnológico, A.C.

Octubre 5, 2007

Reconocimientos

El Foro Consultivo Científico y Tecnológico y los miembros de su Panel Internacional de Expertos en Seguridad en Minas (PE), desean hacer patente su reconocimiento a Don Francisco Javier Rivera y Don Gilberto Ríos Ramírez, representantes de los familiares de los mineros fallecidos, por su apoyo y colaboración durante las dos visitas a la mina siniestrada.

OBJETO DEL ESTUDIO

El 25 de junio de 2007, la Secretaría del Trabajo y Previsión social y el Foro Consultivo Científico y Tecnológico firmaron el contrato RF-071-2007, mediante el cual la Secretaría encomendó al Foro la elaboración de un dictamen técnico sobre las condiciones de seguridad y salud que prevalecen en la mina Pasta de Conchos, ubicada en Coahuila.

A tal efecto, el Foro Consultivo convocó a un panel internacional de expertos (PE) en seguridad en minas que realizó los análisis correspondientes y preparó un informe que fue revisado por un grupo multidisciplinario de académicos constituidos como Consejo Consultivo Minero. Sus puntos de vista y observaciones fueron tomados en cuenta en la preparación del presente Dictamen.

Es importante señalar que en las dos visitas que se realizaron a la mina colaboraron con el PE dos mineros designados por los familiares de los mineros fallecidos, los cuales participaron en las discusiones y en el trabajo de campo. Un tercer invitado, el Sr. Manuel Royo, cuya participación también fue sugerida por los familiares y que de manera verbal aceptó incorporarse al trabajo del PE, finalmente no participó. Sus motivos son desconocidos para el Foro Consultivo y su PE.

Finalmente, se hace notar que la fecha inicial de entrega del Dictamen quedó estipulada para el 19 de septiembre de 2007. Sin embargo, la información recabada en la segunda visita a la mina siniestrada obligó a los expertos a reevaluar toda la información recabada hasta esa fecha, haciendo necesario solicitar la prórroga prevista en el contrato para su entrega, término que concluye el día de hoy.

EL FORO CONSULTIVO CIENTÍFICO Y TECNOLÓGICO

El Foro Consultivo Científico y Tecnológico, A.C. (Foro) se crea el 5 de junio de 2002, a partir de la publicación de la Ley de Ciencia y Tecnología en el Diario Oficial de la Federación. En el artículo 36 de dicha Ley se establece que el Foro Consultivo se constituye como órgano autónomo y permanente de consulta del Poder Ejecutivo, del Consejo General de Investigación Científica y Desarrollo Tecnológico (presidido por el presidente de la República e integrado por los secretarios de Estado, entre otros) y de la Junta de Gobierno del CONACYT, así como de los poderes Legislativo y Judicial federales a través de los convenios firmados con ellos.

El Foro Consultivo Científico y Tecnológico es una organización de la sociedad civil, con autonomía operativa del Gobierno Federal. Su función primordial es la de proporcionar consejo experto en los temas de ciencia y tecnología al Ejecutivo Federal y a los otros poderes de la Unión. Aunque el Foro es una institución comparativamente joven, ha llegado de manera creciente a ocupar un espacio en el debate nacional en temas relacionados con la creación y apropiación del conocimiento en colaboración con las instituciones que lo integran y gobiernan.

La mayor parte de los trabajos del Foro consiste en estudios y monografías de algún aspecto de la vida intelectual o productiva del país. Estos estudios son desarrollados por especialistas nacionales quienes, de manera casuística, se apoyan en colaboradores y expertos de otros países contribuyendo, en combinación con una o más de las instituciones que lo gobiernan, a un número muy superior de productos. Éstos incluyen la celebración de reuniones temáticas, la gestión de leyes, normas y reglamentos, y el fomento de la construcción de un marco regulatorio sólido para el fomento a la ciencia y a la tecnología en México en todas las áreas del conocimiento.

Asimismo, el Foro promueve la expresión de la comunidad científica, académica, tecnológica y del sector productivo para la formulación de propuestas en materia de política y programas de investigación científica y tecnológica, para presentarla al Consejo General.

Las funciones del Foro Consultivo se señalan en el artículo 37 de la citada Ley, siendo éstas:

1. Proponer y opinar sobre las políticas nacionales y programas sectoriales y especiales de apoyo a la investigación científica y al desarrollo tecnológico.
2. Proponer áreas y acciones prioritarias y de gasto que demanden atención y apoyo especiales en materia de investigación científica, desarrollo tecnológico, formación de investigadores, difusión del conocimiento científico y tecnológico y cooperación técnica internacional.
3. Analizar, opinar, proponer y difundir las disposiciones legales, las reformas o adiciones a las mismas, necesarias para impulsar la investigación científica y el desarrollo y la innovación tecnológica del país.

4. Formular sugerencias tendentes a vincular la modernización, la innovación y el desarrollo tecnológico en el sector productivo, así como la vinculación entre la investigación científica y la educación conforme a los lineamientos que la Ley de Ciencia y Tecnología y otros ordenamientos establecen.
5. Opinar y valorar la eficacia y el impacto del Programa Especial y de los programas anuales prioritarios y de atención especial, así como formular propuestas para su mejor cumplimiento.
6. Rendir opiniones y formular sugerencias específicas que le solicite el Ejecutivo Federal o el Consejo General.

Según lo señalado en el artículo 36 fracciones II y III, el Foro Consultivo está integrado por científicos, tecnólogos, empresarios y por representantes de las organizaciones e instituciones de carácter nacional, regional, local, públicas y privadas, reconocidas por sus tareas permanentes en la investigación científica y desarrollo e innovación tecnológicas, quienes participarán de manera voluntaria y honorífica. La selección de participantes se hace con base en los criterios de pluralidad, renovación y representatividad marcadas en la Ley de Ciencia y Tecnología.

La Mesa Directiva está formada por los titulares de catorce instituciones y por tres investigadores electos por los miembros del Sistema Nacional de Investigadores a través de una convocatoria conjunta entre el CONACYT y el Foro Consultivo. Las instituciones miembros de la Mesa Directiva son:

1. Academia Mexicana de Ciencias, A. C. (AMC)
2. Asociación Nacional de Universidades de Educación Superior, A. C. (ANUIES)
3. Asociación Mexicana de Directores de la Investigación Aplicada y Desarrollo Tecnológico, A. C. (ADIAT)
4. Confederación de Cámaras Industriales de los Estados Unidos Mexicanos (CONCAMIN)
5. Academia de Ingeniería, A. C. (AI)
6. Universidad Nacional Autónoma de México (UNAM)
7. Academia Nacional de Medicina, A. C.
8. Consejo Nacional Agropecuario
9. Centro de Investigaciones y Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV)
10. Instituto Politécnico Nacional (IPN)
11. Red Nacional de Consejos y Organismos Estatales de Ciencia y Tecnología, A.C. (REDNACECYT)
12. Academia Mexicana de la Lengua
13. Consejo Mexicano de Ciencias Sociales (COMECSO)
14. Academia Mexicana de la Historia

Los temas centrales que ocupan y orientan las labores del Foro pueden agruparse de la siguiente manera:

1. Evaluación al Sistema Nacional de Innovación
2. Análisis de los programas de apoyo a la ciencia y a la tecnología, en particular al sistema de Fondos Sectoriales y Mixtos del CONACYT.
3. Construcción de un Acuerdo Nacional para Fomentar el Desarrollo, la Innovación y la Competitividad de México con base en el Conocimiento.
4. Estudio de prospectiva para la ciencia y la tecnología en México al 2030.
5. Propuesta de programas y reformas para la federación de la ciencia y la tecnología en México
6. Identificación y propuesta de las bases para una política de estado en ciencia, tecnología e innovación.
7. Identificación de mecanismos de inversión en conocimiento para el desarrollo y bienestar de México.
8. Identificación de los mecanismos de la sociedad, para la apropiación del conocimiento.

Además de los anteriores, el Foro ha abordado, a petición de las comunidades que representa, los siguientes temas específicos:

9. Clonación, células troncales y genoma humano
10. Competitividad con base en el conocimiento
11. Nueva Ley para los Inmigrantes
12. Bioseguridad de los Organismos Genéticamente Modificados
13. Propiedad industrial
14. Propuesta de modificaciones a la Ley de Ciencia y Tecnología
15. Propuesta de modificaciones a la Ley General de Salud.
16. Captación de recursos para incrementar el presupuesto de egresos de la federación para ciencia y tecnología
17. Creación de la Agencia Espacial Mexicana
18. Ley para el Fomento a la Innovación y al Desarrollo de Empresas y Actividades de Base Tecnológica
19. Legislación y Política en Ciencia Tecnología y Educación Superior
20. Sismos y Tsunamis en México y en el Mundo
21. Protección Civil y Desastres Naturales
22. Análisis de los programas y esquemas de financiamiento de la ciencia, la tecnología y la innovación.
23. Situación de la Ciencia y la Tecnología en las Universidades Públicas de los Estados
24. Mecanismos para la Apropiación y Explotación del Conocimiento de Científicos e Investigadores de México
25. Análisis de las Políticas de Ciencia, Tecnología e Innovación en México
26. Análisis del presupuesto ejercido en ciencia y tecnología (2004, 2005 y 2006)
27. Análisis de las Finanzas Públicas en México
28. Proyecto de captación de recursos federales adicionales para ciencia y tecnología
29. Presupuesto Federal de Egresos. Propuesta para 2005 “Inversión para impulsar la Investigación Científica y el Desarrollo Tecnológico en México”
30. Cadena agroalimentaria del maíz y la tortilla

31. Acceso a la justicia ambiental y creación de tribunales ambientales, entre otros.

La información recabada a través de las anteriores actividades, la interlocución lograda entre los diversos actores y el conocimiento adquirido de los diversos esquemas estatales, regionales y federal en cuanto al estado de la ciencia, la tecnología y la innovación, su financiamiento y su impacto en la educación, el empleo y el bienestar social, hacen posible que el Foro Consultivo Científico y Tecnológico se encuentre plenamente validado para ofrecer opinión experta a los poderes de la Unión en los temas de su competencia e identifique sistemas, programas y propuestas de estímulos que hagan posible la articulación real entre el sector productivo, el académico y la sociedad. Además, ha favorecido desde su creación el diálogo horizontal entre los legisladores, el ejecutivo estatal y federal, las comunidades académica y empresarial del país y la sociedad.

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Executive Summary

Introduction

On February 19, 2006 an underground explosion occurred at the Pasta de Conchos Mine #8 owned by Industrial Minera Mexico (IMMSA). Activities were immediately implemented to rescue 65 trapped miners.

After five days of rescue efforts, it was concluded that there was no possibility for the miners to be alive. At that point efforts transitioned from being a rescue operation to being a recovery operation.

In April 2007, IMSSA decided to suspend further recovery efforts due to concerns about the structural stability of the mine, critical concentration of gasses, and possible presence of pathogenic organisms inside the mine. Out of the 65 bodies, only two were recovered.

Families of the deceased miners did not agree with the halting of the recovery efforts. The Mexican Government through the Secretaria del Trabajo y Previsión Social (STPS) decided that an independent investigation should be conducted to assess current conditions at the mine and to decide whether or not to resume recovery efforts.

In June 2007, Mexico's Foro Consultivo de Ciencia y Tecnología (FCCT) was commissioned by the STPS to form a Panel of International Experts in Mining (PE) to conduct an investigation in order to assess the current conditions at Pasta de Conchos Mine #8.

On July 11th 2007, the PE visited the mine site to collect technical and engineering data. During this first visit, uncertainty of the current mine conditions did not allow access to the underground workings. The PE suggested the possibility to perform underground video logging using pre-drilled boreholes.

In the evening of August 15th, the PE performed downhole video analysis and completed the recording of the scenes in fifteen boreholes. This analysis of the current conditions of the Pasta de Conchos mine is based on interviews, information and reports provided by IMMSA, and the STPS, and borehole video surveys.

This report represents the considered opinions of experts working with the best available information. The provided information was sometimes incomplete or inconsistent. As a result, assumptions, inference and educated guesses had to be made during the analysis.

The analysis consists contained in this report of eight sections addressing ground control and roof support, mine ventilation, water in the mine, mine electrical power, material handling, accident records, norm-23 related comments, and findings.

Conditions at the mine that impact health and safety risks

Roof control and support: It can be expected that the roof and the support system conditions, in the area beyond cross cut 17, will be similar to those experienced during the rehabilitation of the restored area. It can also be expected that conditions within the whole mine will deteriorate with time in the absence of regular maintenance.

Ventilation: Currently it is not possible to demonstrate that the ventilation system is capable of removing methane from all areas of the mine. It is likely that critical concentrations of methane will be present due to rock fall obstructions and caved roofs. The risks associated with the present ventilation system are greater than during regular operations.

Water: The hazard associated with water conditions in the mine, once dewatering and monitoring is resumed, are comparable to those faced in typical mining operations. Water contaminants would not involve significant risks of disease due to microorganisms from decaying human bodies.

Mine power distribution: The Electrical Power Distribution at Pasta de Conchos Mine does not present any significant risk to health and safety. The surface power supply and distribution are operational. The underground power supply and distribution system is operational in the excavated and recovered areas up to cross-cut 17.

Material handling equipment: The risks posed by material handling operations during recovery activities are higher than for normal operations but are substantially lower than they were during the rescue operations. The surface material handling system is operational. The underground material handling system is operational in the excavated and recovered areas up to cross-cut 17. The underground material handling system beyond cross-cut 17 is destroyed and will need to be repaired or replaced as further excavation and recovery proceeds. The risks posed by material handling operations beyond cross-cut 17 will be present higher than the normal operation.

Accident Records: The lack of comparable incident rate data from the Mexican mining industry prevents the team from fully evaluating the level of increased safety risk associated with the recovery operations between February 2006 and April 2007. The limited analysis that was possible, shows a safety incident rate during recovery to be approximately five times the average incident rate during normal operations at the mine during 2005. This shows a much higher than normal risk associated with the recovery operations.

Findings

A total of fifteen boreholes were observed: **DG-5, DG-7, M-7, C-5, C-6, C-23, C-15, M-8, DG-10, DG-11, C-24, C-26, C-11, C-20, T-3.** Five bore holes were collapsed C-6, C-23, DG-10, C-26, T-3. Out of the ten holes, which the camera could reach the bottom of the borehole and the top of the voids, only C-20 showed timber posts still standing and has the least debris. The rest of the boreholes show extensive caved up materials and major damages to the support system. Two holes C-15 and C-11 show that the water level is rising and accumulating in the south area of the mine.

- The supports were still standing in one of the boreholes C-20. The supports had rocks and rubble around them. The rest of the boreholes showed broken material and damage to the support system

- The images show the different types of damages that the support system has. Most of these images show serious deficiencies in the support system and indicate the instability of the floor and roof

- The videos showed that the main roof consists of low structural strength, poor quality mudstone and siltstone material. This can explain why practically all the intersections have rock falls.

- The roof in the rehabilitated intersections are elevated due to the caving height. This condition can cause a serious problem for the areas already restored.

- The underground conditions in the video images show that in general the conditions inside the mine are unstable.

- In the C-11 borehole the water level is at 145m. The video shows Methane being liberated. The presence of water suggests a connection between C-15 and C-11 and that there are no temporary obstructions.

- Water level will continue rising and will fill the cavities and boreholes; it is important to continue observing water levels. If the water level varies in contiguous boreholes, it may suggest that there are barriers caused by rubble and debris. Any sudden increase of the water levels would be a significant safety concern.

- The presence of water in the south area of the mine represents an important concern since mine conditions can rapidly deteriorate.

- During the operation of restoration and recovery carried out from February 2006 to April 2007, safety records indicate a high frequency of incidents and accidents. Safety records show accidents involved with material handling and heavy lifting are directly related to the restoration of the support systems and debris cleaning activities.

- Available information demonstrated the difficulty and the unsafe conditions present during the restoration of the roof support for the recovery activities.

1 Introduction

On February 19, 2006 an underground explosion occurred at the Pasta de Conchos Mine #8 in the State of Coahuilla in Northern Mexico. Activities were immediately implemented to rescue the 65 trapped miners.

After five days of rescue efforts, Industrial Minera Mexico (IMMSA) reached the conclusion that there was no possibility for the miners to be alive. At that point the response transitioned from being a rescue operation to being a recovery operation. The recovery continued focusing on systematic explorations.

In April 2007, IMSSA decided to suspend further recovery efforts due to concerns about the structural stability of the mine, critical concentration of gasses, and possible presence of pathogenic organisms inside the mine. At the time the recovery operations were stopped the clearing and recovery efforts had progressed from the mine entry to cross-cut 17 (see Figure 1.1). The rehabilitation and recovery activities included:

- Airlocks installed between cross-cut 5 and diagonal 6
- Boreholes were drilled to inject sealing foam between Diagonals 17 and 18 occurred
- Construction of three ventilation shafts

According to company reports submitted to the Secretaria del Trabajo y Prevision Social (STPS) Table 1.1 describes the level of effort that was undertaken up to April 3rd 2007 when recovery efforts were halted due to safety concerns. Figure 1.1 shows the areas that were re-habilitated during the recovery efforts in 2006-2007.

Table 1.1- Review of Recovery Level of Effort

Description of actions	Quantity
Debris removed (tons)	67,417
Rock Fall recovered	39
Meters crossed	5,888
Meters drilled (various diameters)	19,057
Hours Man	1,092,000
Turns	1,083
Days	380

Out of the 65 bodies, only two were recovered before recovery operations were halted in April 2007. Figure 1.2 shows the areas of the mine where the miners were thought to be assigned the day of the accident.

Families of the deceased miners did not agree with the halting of the recovery efforts since, they considered, it was a unilateral decision based on an internal report from the mining company. The STPS decided that an independent investigation should be conducted to assess current conditions at the mine and to decide whether or not to resume recovery efforts.

In June 2007, Mexico's Foro Consultivo de Ciencia y Tecnología (FCCT) was commissioned by the STPS to form a Panel of International Experts in Mining (PE) to conduct an investigation of the current conditions at Pasta de Conchos Mine #8.

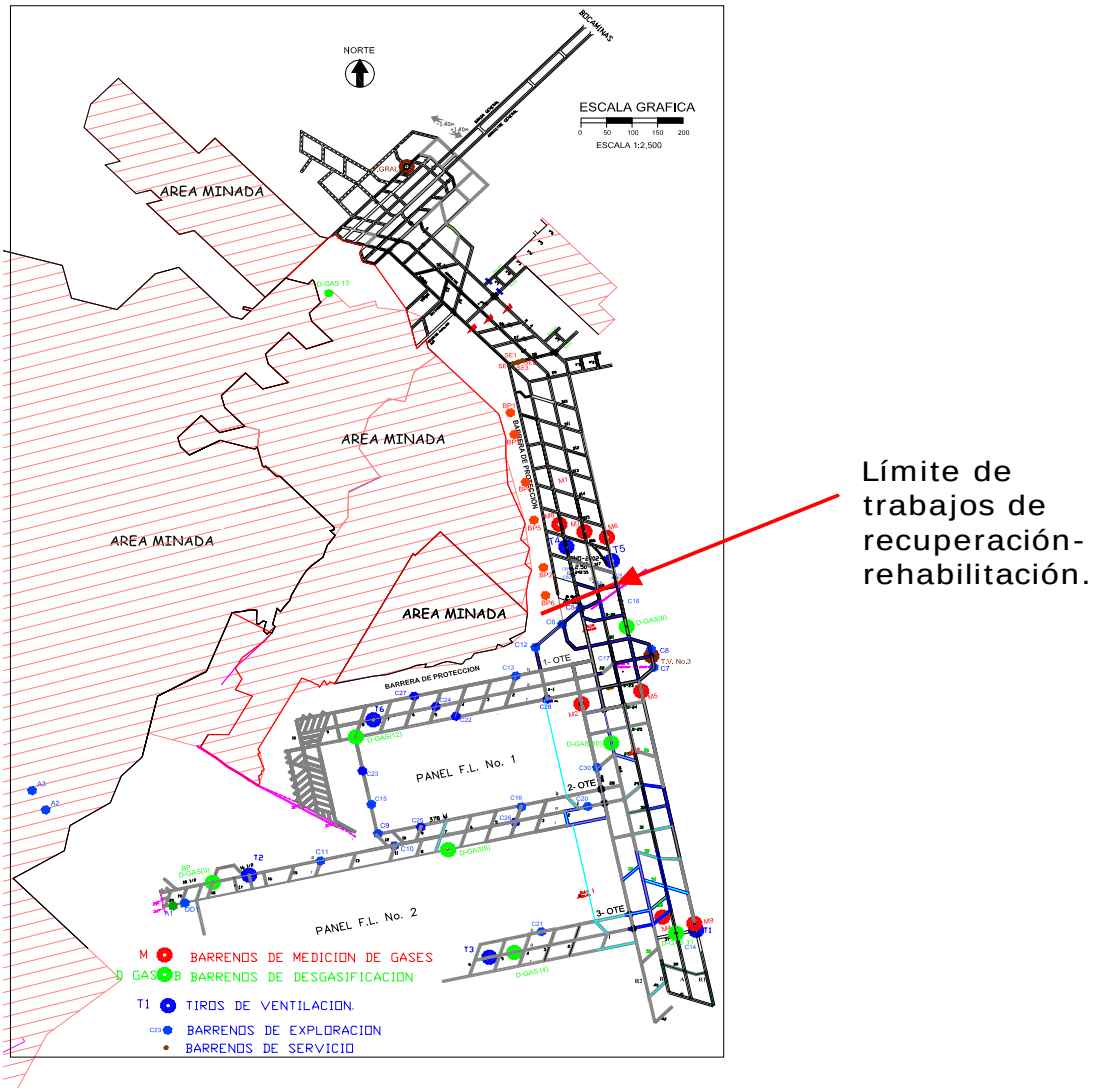


Figure 1.1: General Plan of the mine showing the areas where recovery efforts stopped

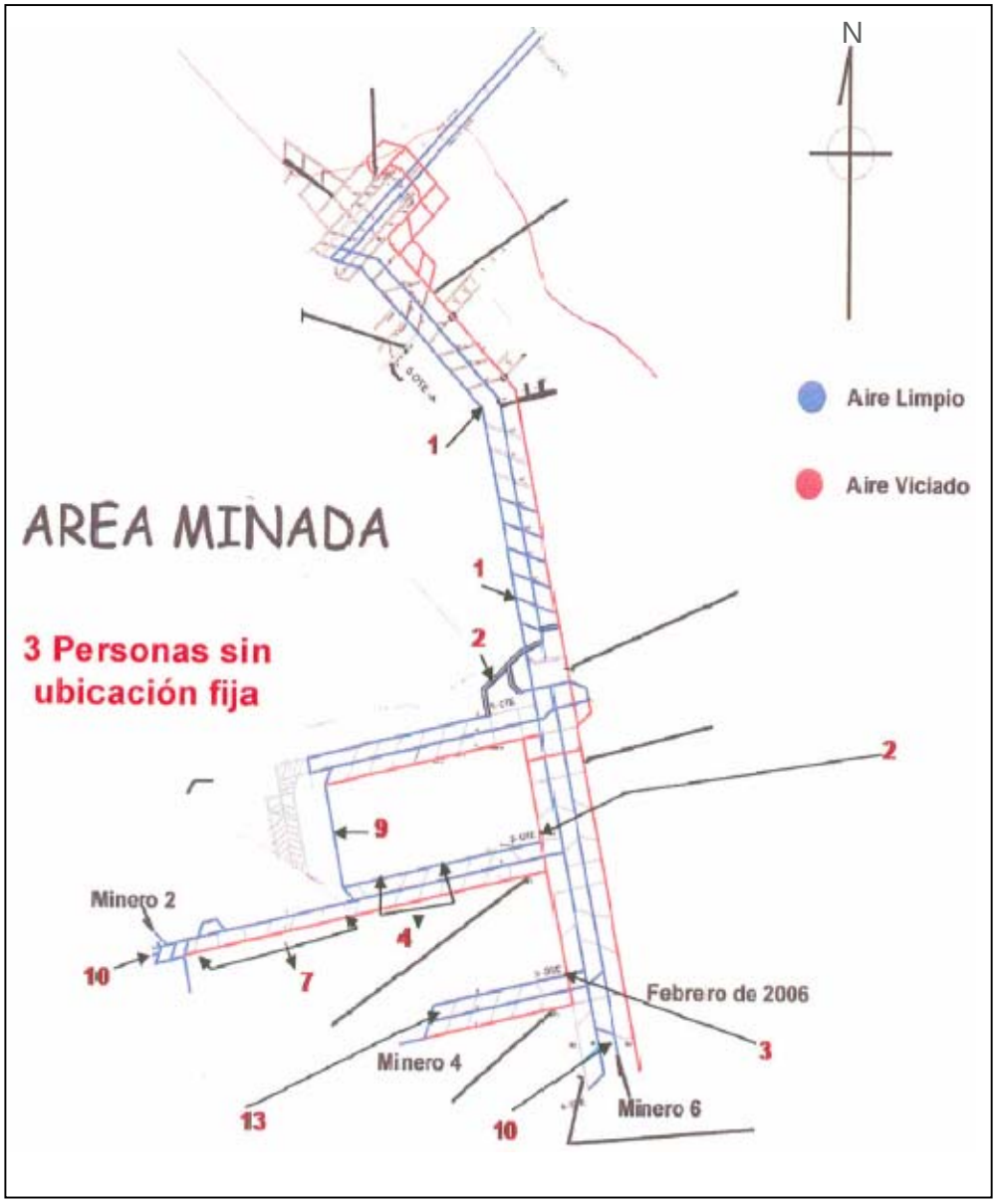


Figure 1.2: Hypothetical locations of workers and numbers of workers at each location on the day of the accident

Commissioned by the FCCT, on July 11th 2007, the PE visited the mine site to collect technical and engineering data. During this first visit, uncertainty of the current mine conditions did not allow access to the underground workings. The PE suggested to the FCCT the possibility to schedule a second visit to perform underground video logging using pre-drilled boreholes. These boreholes had been previously drilled from the surface to the mine voids by the mining company.

In the evening of August 15th, The PE performed downhole video analysis and completed the recording of the scenes in and around fifteen boreholes. The fifteen videos logged in the course of the video analysis were recorded onto individually numbered compact DVDs now under FCCT custody.

This analysis of the current conditions of the Pasta de Conchos mine is based on interviews, information and reports provided by IMMSA, by the STPS, and borehole video surveys. This report represents the considered opinions of experts working with the best available information. The provided information was sometimes incomplete or inconsistent. As a result, assumptions, inference and educated guesses had to be made during the analysis.

The analysis consists of eight sections addressing ground control and roof support, mine ventilation, water in the mine, mine electrical power, material handling, accident records, norm 23 related comments, and findings.

2 Ground Control and Roof Support

Summary

This section analyzes the geology, mining sequence and ground support system at the Pasta de Conchos underground coal mine to evaluate conditions that impact health and safety risks. The analysis is based on the information and documents provided by Industrial Minera Mexico, discussions with company officials, representatives and miners and observations of 15 downhole video recordings. Since the information provided by the company was incomplete and at times conflicting in nature, assumptions, inferences and educated guesses had to be made during the analysis process. It can be expected that the roof and the support system conditions, in the area beyond cross-cut 17, will be similar to those experienced during the rehabilitation of the restored area. It can also be expected that conditions within the whole mine to deteriorate with time in the absence of regular maintenance.

Background

The Pasta de Conchos mine operates a coal seam with an average thickness of 2.35 m (with a range of 1.8-2.4 m from core logs). Entries are 5.20 m wide and 2.40 m high. The coal seam is underlain by sandstone. Fine grained siltstone, mudstone and sandstone form the immediate roof. Table 2.1 summarizes the available corehole log information. Figure 2.1 indicates the location of the core holes with respect to the mine workings.

Table 2-1 Corehole logs summary

Hole Number and Elevation (m)	Immediate Roof and thickness (m)	Coal thickness and depth interval (m)	Floor
DF'-15 384.655	Siltstone with sandstone (0.80 above)	1.90 (136.70-137.60)	Sandstone
DF-15 384.940	Siltstone	2.18 (140.00-142.18)	Sandstone
DF'-15-1	Mudstone with sandstone (1.55) above	2.19 (134.05-136.24)	Sandstone
DD'-14' 381.920	Siltstone with sandstone (9.82) above	2.40 (157.85-160.22)	Mudstone
DE-15 382.6	Siltstone	2.40 (157.56-159.96)	Sandstone
DE'-15' 384.368	Mudstone and coal with (1.10) sandstone above	2.05 (147.64-149.70)	Sandstone
DF-16 Bis 385.271	Mudstone with siltstone (1.95) above	1.81 (144.80-146.61)	Sandstone

DE'-16 382.985	2.78 m of interbedded siltstone, sandstone and mudstone with sandstone above	1.89 (150.62-152.52)	Sandstone
DE-16 382.239	Mudstone	1.90 (158.70-160.60)	Sandstone
DE'-16' 383.531	Sandstone	2.08 (153.07-155.15)	Sandstone

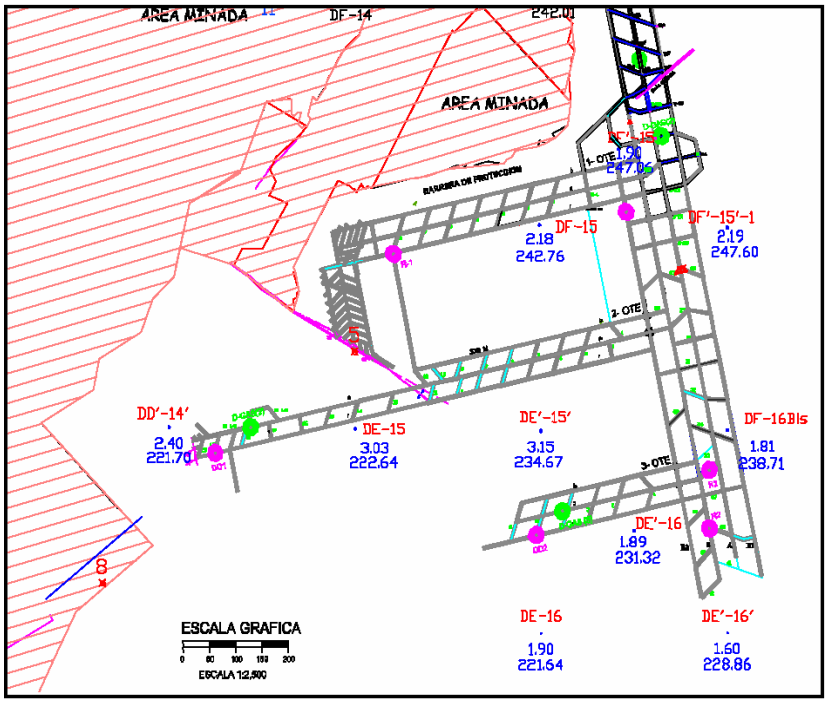


Figure 2.1 Corehole locations

The quality of the mudstone, siltstone and sandstone at the roof was determined using the rock mass rating (RMR) and the coal mine roof rating (CMRR) systems (Rodolfo Nava, 2007). Values for RMR and CMRR are given in Tables 2.2 and 2.3.

Table 2-2 RMR Rating for the roof rocks.

Rock Type	RMR Values	Rating
Mudstone	20-30	Poor
Siltstones	30-50	Poor to Fair
Sandstone	50-80	Fair to Good

Table 2-3 CMRR Rating for the roof rocks.

Rock Type	CMRR Values	Rating
Mudstone	20-30	Poor
Siltstones	30-50	Poor to Fair
Sandstone	50-80	Fair to Good

At the Pasta de Conchos mine the 5.2 m wide by 2.4 m high entries are developed with a continuous miner that takes 12 alternating 2.5 m wide and 0.5 m deep cuts to advance 3 m before roof supports are installed. A combination of timber-steel set and steel set are used for roof support. Figure 2.2 depicts the various roof support configurations that are used at the mine. The selection of support system is based on the roof rock conditions. Steel beams of 5.5 m length are used to bridge the intersection at cross-cuts; there is no information whether additional vertical supports is used at the four corners of the intersection. In areas with very poor roof condition, 0.25 m of coal is left as an immediate roof to allow for a timely roof support installation. In normal conditions the timber-steel sets are spaced 0.7 m apart.

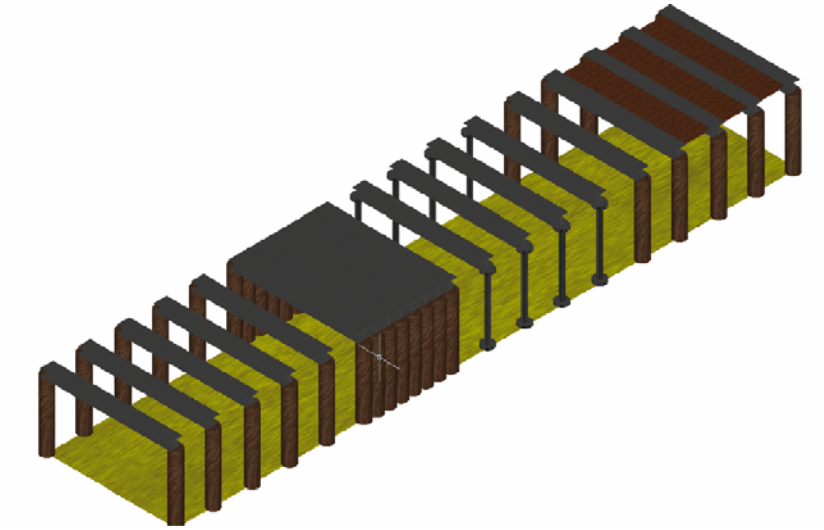


Figure 2.2 Support system used at the Pasta de Conchos mine

During the rescue and recovery process, 39 major roof falls at intersections, (Figure 2.3) with some of them extending into the entries and the cross-cuts had to be cleared and rehabilitated using manual labor.

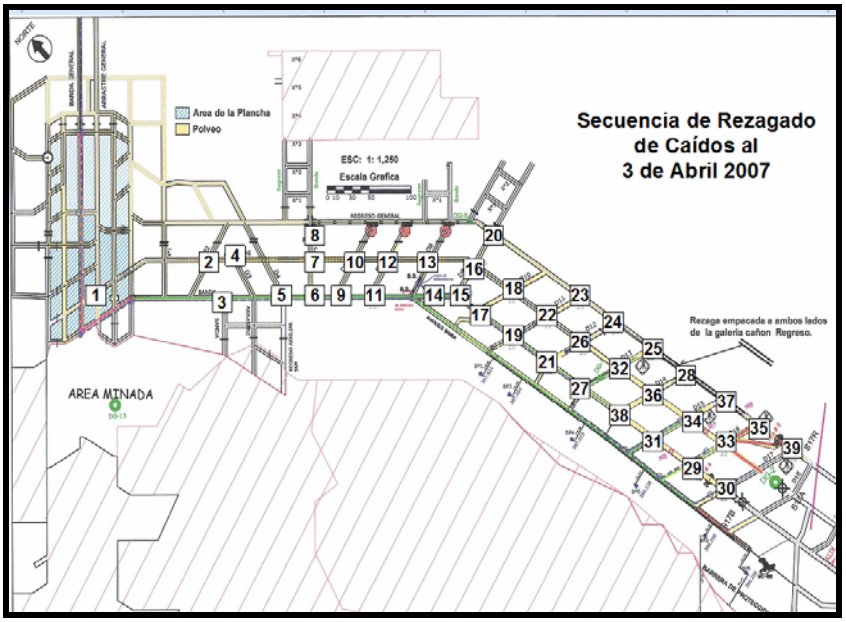


Figure 2.3 Locations of major roof falls.

At cross-cut intersections, cavings as great as 13 m high and 15 m wide have been reported (Figure 2.4). The caved areas were rehabilitated with the use of cribbing above timber-steel sets (Figure 2.5). Cribs are designed to support vertical loads, but can collapse when lateral loads are applied. The height of the cribbing used to rehabilitate the caved areas would be extremely unstable in the presence of lateral ground movements (Figure 2.6).

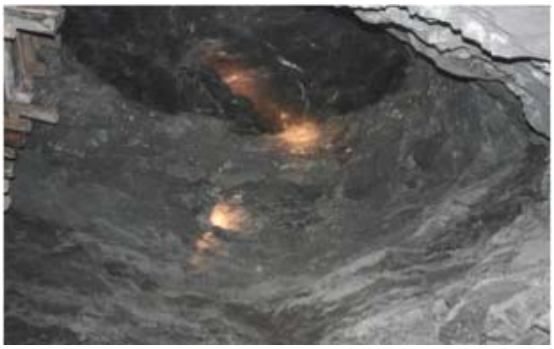


Figure 2.4 Caving at cross-cut 7.

Figure 2.5 Cribbing to support caved area.

Figure 2.6 Collapsed cribbing at cross-cut 13.

Using the background information, general ground control principles as they apply to the Pasta de Conchos mine are addressed in the following section.

Analysis

As the coal seam is excavated, the vertical stresses above it are redistributed. The vertical stress supported by the excavated material will shift to the adjacent pillars leaving a distressed region immediately above the excavation (Figure 2.7).

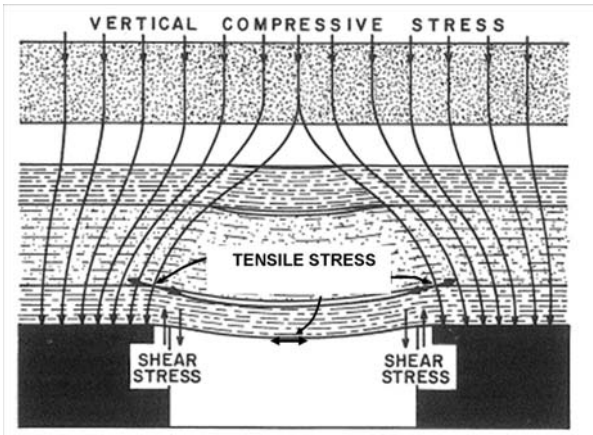


Figure 2.7 Stress redistribution due to excavation (after Stefanco, 1983).

The height of the distressed zone h_r (Figure 2.8) can be estimated using an empirical equation relating the height h_r to the RMR and the roof span B as follows (Bieniawski, 1989):

$$h_r = \frac{100 - RMR}{100} B$$

At the Pasta de Conchos mine the RMR value for the roof rock is in the range of 20 to 50. For the 5.2 m wide entries and cross-cuts, the height h_r for the distressed zone will be in the range of 2.60-4.16 m. At intersections where the span is 7.25 m the height h_r becomes 3.6-5.76 m.

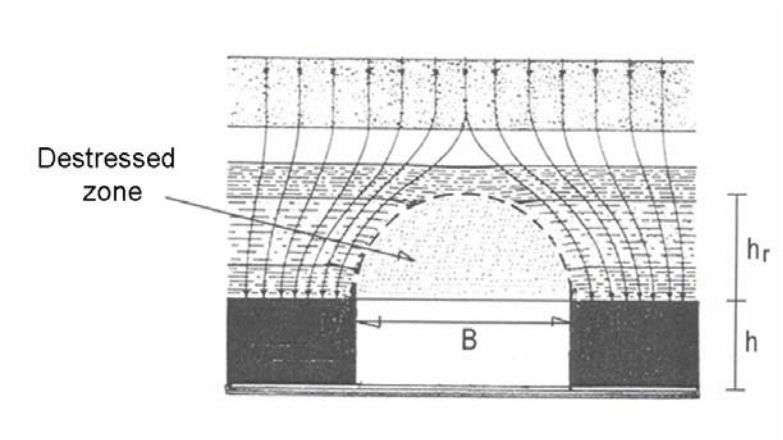


Figure 2.8 Distressed zone height

Gravity causes the overlying layers to sag and separate, developing tensile and shear stresses that can lead to the failure of the immediate roof. The extent of sagging and bed separation will depend on the type and properties of the roof rock and the time between the excavation and roof support installation.

At the Pasta de Conchos mine, because the immediate roof consists of mudstone and siltstone with an RMR ranging from 20 to 50, bed sagging and separation can be expected to develop very rapidly. The distressed zone would fully develop and the total weight of the distressed material would be bearing on the roof support system.

The support load can be estimated from RMR as proposed by Unal (1983):

$$P = \frac{100 - RMR}{100} \gamma B^2$$

Where P = support load per unit length of entry
B = entry width
γ = rock density

The relationship can be rewritten as:

$$P = h_r \gamma B$$

Where h_r = height of distressed zone (use 0.8 h_r for equivalent height)

The load on the supports at the Pasta de Conchos mine can be estimated using the above equation. The support loads at the 5.2 m wide entries and cross-cuts are estimated to be in the range of 26-42 ton/m of entry. This is for a roof rock with an RMR range of 20-50 and an assumed rock density of 2.4 ton/m^3. The support capacity of the timber currently used was given as 19.5 ton (Rodolfo Nava, 2007). The maximum timber-steel set spacing of 0.7 m used at the mine is adequate to support the estimated vertical minimum load.

At the intersections (Figure 2.9) the shape of the caving can be assumed to be ellipsoid with a diameter of 7.25 m and a height ranging from 3.6 to 5.76 m. The load on the roof support is estimated to be in the range of 297 to 476 ton. This load would be distributed to the vertical support members at the four corners of the intersection.

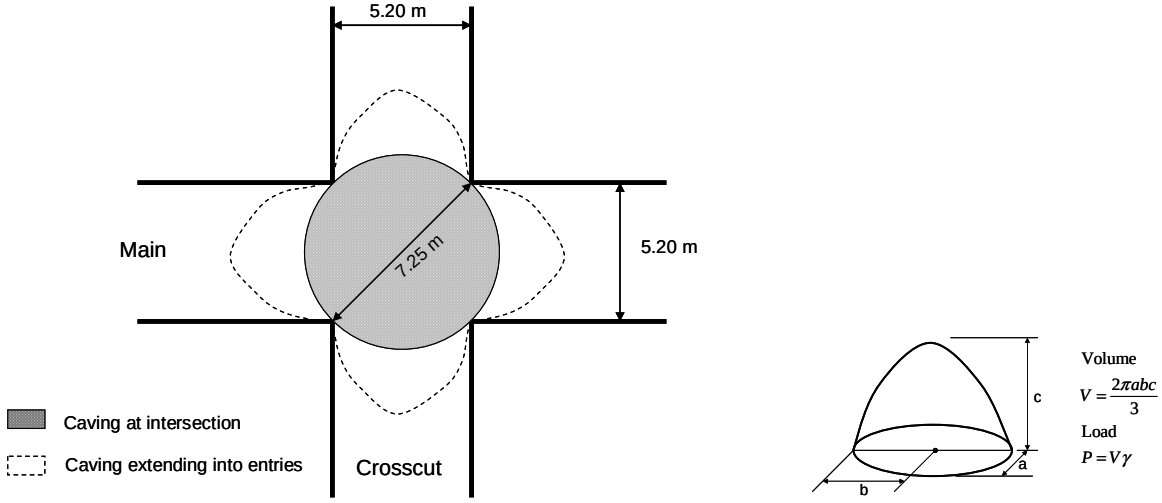


Figure 2.9 Geometry of caving at intersection.

Information on the type of vertical support used at the four corners of the intersection is not available to assess its performance.

The roof support systems used at the mine (timber-steel and steel sets) are designed to support vertical loads. They are not designed to withstand lateral pressure similar to a mine explosion. In the event of an explosion, the timber and steel post without lateral bracing would be knocked down by the force of the explosion allowing the roof to cave.

After the initial failure of the immediate roof, caving will continue to propagate upward unless it is arrested by the formation of a new, stable, self supported linear arch, by a more competent roof layer (Figure 2.10), by a vault that has achieved a stable geometry with respect to the stress conditions, or by bulking (swelling) of the roof debris (Figure 2.11) (Karfakis,1987). The failure of the roof toward the surface will be intermittent and progressive. The picture in Figure 2.4 taken at cross-cut 7 shows a caving arrested by a more competent layer.

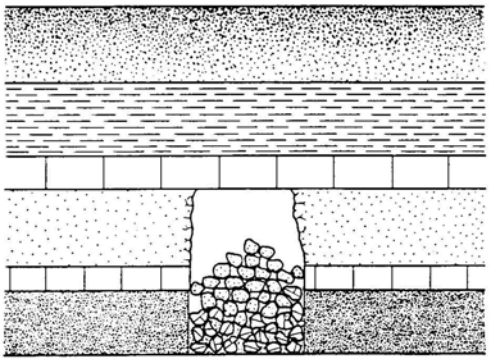


Figure 2.10 Caving arrested by competent layer

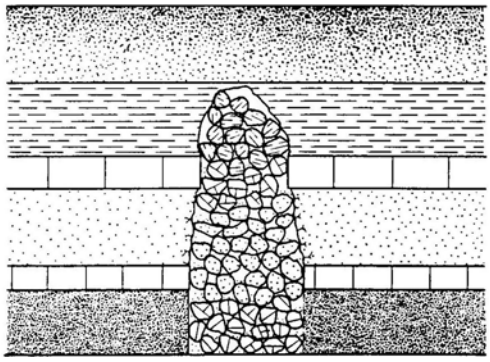


Figure 2.11 Caving arrested by bulking

If competent layer and stable pressure arch considerations are removed from the caving height prediction model, the concept of harmless height, based on bulking is developed (Piggott and Eynan, 1977). In this approach, simple relationships are developed between the height of collapse, the thickness of the extracted material, and the bulking characteristics of the roof material, in order to predict the height of the caving, with a given geometry, to be choked with rubble (Figure 2.12).

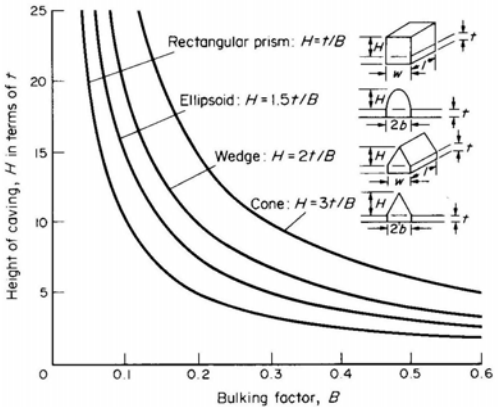


Figure 2.12 Maximum height of roof caving (after Piggott and Eynan, 1977).

The relationship used for maximum caving height determination assumes idealized geometries, constant bulking, and no lateral movement of the rubble. It is impossible to predict, a priori, the exact geometry of the impending cave-ins.

Based on observations at the Pasta de Conchos mine, it can be assumed that the shape of the cave-ins is an ellipsoid. Using Figure 2.13 (Karfakis, 1987) the maximum expected height of collapse is estimated to be 18 m, with a given mining height of 2.40 m and an assumed overburden bulking factor of 20%.

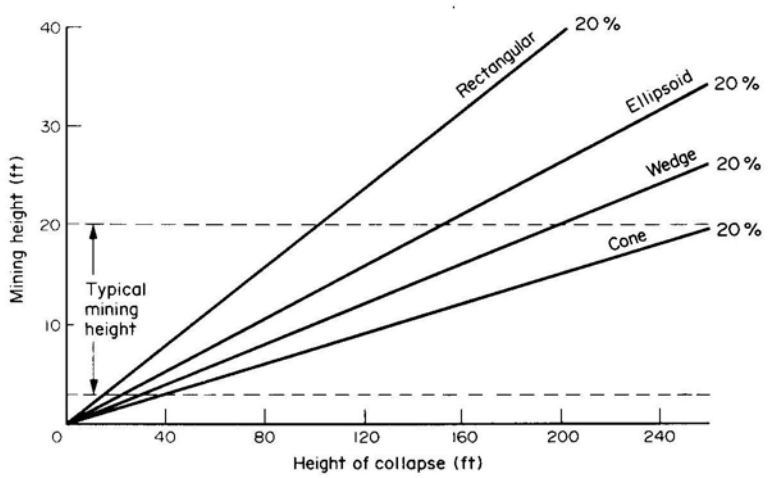


Figure 2.13 Estimated collapse heights for various caving geometries and mining heights

Observations from Borehole Video Recordings

A video camera was lowered into 15 boreholes of which 2 were in the rehabilitated area of the mine. Five of the 13 boreholes in the unexplored section of the mine were collapsed and one was filled with water. In 7 boreholes the camera was able to reach the bottom. Out of the 7 holes only hole C-20 showed roof support standing with some rubble (Figure 2.14).

Figure 2.14: Snapshot from borehole C-20

Borehole C-24 showed all timber down with some rubble on the floor and a relatively clean roof line (Figure 2.15).

Figure 2.15 Snapshot from borehole C-24

The rest of the holes showed no standing timber and had various degrees of caving and rubble at the bottom (Figure 2.16). The extent of the caving could not be assessed since the mine survey map was not provided. The mine floor elevation at the borehole location is needed to determine the vertical extent of the roof caving.

Figure 2.16 Snapshot from borehole C-5.

Expected Hazardous Conditions

The following is a list of conditions that can be present at the mine and that should be a major safety concern to miners.

- It is expected that all vertical timber support in direct line with the mine explosion shock wave to be knocked down.
- In areas of the mine with mudstone and siltstone immediate roof, with roof support down, severe roof falls would be expected.
- In the area beyond cross-cut 17 caving heights of up to 18 m are possible, especially at intersections.
- Caved areas throughout the mine are high points that can trap methane at critical concentration.
- Rubble and debris from caving can form a dam holding back mine water.
- Rubble and debris from caving would block air flow making ventilation difficult.
- Cribbing of the caved areas in the rehabilitated region of the mine can still present hazardous conditions in the presence of lateral ground movements.

3 Mine Ventilation

Summary

Currently it is not possible to demonstrate that the ventilation system is capable of removing methane from all areas of the mine. It is likely that critical concentrations of methane will be present due to rock fall obstructions and caved roofs. The risks associated with the present ventilation system are greater than during regular operations.

Ventilation system experience during recovery and restoration:

The management and miner's representatives have not reported any ignitions throughout the recovery effort. From the accident reports it appears that the company has managed the ventilation well under the circumstances. However, past performance does not guarantee that future operations would be incident-free. Just one ignition could result in a multiple-fatality incident. Measuring and controlling the ventilation inby is almost impossible due to roof falls and current uncertainty about the stability of the mine.

The observed mine conditions indicates low-oxygen levels or explosive methane concentrations. Measurements at the boreholes can show the composition in the nearby area being monitored, but information of the overall mine workings will be critical and difficult to asses. Occasional interruptions to mine power could suddenly reverse the direction of the airflow in the ventilation system creating hazardous conditions.

The interference of the ventilation system due to the roof cavings could make inby areas inaccessible. This condition also creates a very high risk where air and gas levels could become uncontrollable under certain circumstances leading to a potential serious accident. It is believed that this situation has risks that are much higher than would be acceptable during normal mining operations at Pasta de Conchos.

Background

The surface fan appeared to be installed properly as well as the ventilation circuit as depicted in a report by Meza's (2007), a mining consultant from the Ministry of Economy. IMSSA conducted a simulation of the ventilation circuit based on conditions before the accident as well as a circuit simulation based on their understanding of the current situation. In this type of simulation the results for the inby at the rehabilitated area can only balance the intake air holes with the return air holes. One must speculate about the direction the air is taking. The potential for local recirculation areas and no-movement areas is very high because of the post accident conditions in the mine.

Ing. Raul Meza offers a report on the possible causes of the accident and the operating parameters of the mine three months prior to the accident. This report describes the ventilation system in effect prior to the accident.

Conversations with the mining company and miners representatives indicate that the explosion did not exit the slopes completely to the surface. If this is the case, then the explosion in the mine may have been primarily a methane explosion and a somewhat limited one because it did not raise enough coal dust to propagate the explosion all the way out of the slope. The explosion was powerful enough to knock down the entire roof support system in a consistent fashion.

Description of Ventilation Conditions

The following is a description of what could be expected from the ventilation system following an underground explosion:

It is conservative to assume that all ventilation controls that have not been inspected and verified are damaged and no longer function. Based on this assumption, it would be expected that different areas of the mine will predictably have various levels of methane build-up. Air samples taken in monitoring holes will detect high levels of methane. Methane in the concentration of 5%-15% is explosive.

Any area where the concentration exceeds 15% will have some regions where an explosive concentration is present. Very high concentrations of methane can be assumed to be inert when enough oxygen has been replaced by the methane. Nevertheless, there will be some areas of the mine where high concentration is diluted to explosive ranges.

When dewatering systems are lost, over time, the water can build-up until it interferes with ventilation and may close off the bleeder. This condition has been observed at Pasta de Conchos at the T-2 bleeder.

Presently, at Pasta de Conchos, the numerous roof falls have a significant impact on the mine ventilation. The roof falls destroy ventilation controls (curtains, stoppings, and overcasts), allowing the air to mix between the intake and return airways. This mixing creates trapped pockets of poor quality air and methane concentrations. The methane will form in pockets on top of the fall cavities in poorly ventilated areas. This creates potential explosion hazards in the presence of ignition sources.

The mine operates an exhaust ventilation fan that, according to the company reports, generates roughly 130,000 cfm at the fan. The mine generates roughly 1,000,000 cubic feet of methane per day. Gas generation (most likely Methane) was observed bubbling through the water in the borehole video at the C-11 hole.

The bleeder borehole with fan is shown in Figure 3.1 and 3.2 The methane levels at this fan exceeded the explosive range (5%-15%) and the discharge airflow had to be diluted at the fan by opening the discharge pipe on the side to allow fresh air to dilute the gas prior to discharge to the atmosphere. The fan appeared to be properly grounded and the workmanship of the installation was good. In addition to the bleeder boreholes there are holes drilled for monitoring gasses underground like the one shown in Figure 3.3. De-gas hole #4 shown in Figures 3.4 and 3.5 was capped when the panel visited the site.

Figure 3.1 Bleeder borehole fan.

Figure 3.2 Bleeder borehole fan.

Figure 3.3 Monitoring drill hole.

Figure 3.4 De-gas hole 4

Figure 3.5 De-gas hole 4

Given that there are additional ventilation holes at T1, T2 (presently under water), T3, T4, T5, DG3, 4, 6, 8,10,11, 12, M-2, M-4, M-5, M-6, M-7, M-8, and M-9 the opportunity to get control of and monitor the ventilation is better now than when the mine was in operation prior to the accident. The breakdown in ventilation controls beyond cross-cut 17 and reversals of air flow during fan outages make gas build-up to explosive limits a real possibility..

Expected Ventilation Conditions

The following is a list of conditions related to ventilation that can be present at the mine and that should be a major safety concern to miners.

- All ventilation controls that have not been seen and verified should be considered damaged or blown out to a point where they no longer function.
- This will lead to areas of the mine where various levels of methane build-up should be expected.
- From the air samples taken in monitoring holes, high levels of methane have been detected.
- Methane in the concentration of 5%-15% is explosive, and any area where the concentration exceeds 15% will have a part of the mine where this explosive concentration is present.
- At very high concentrations of methane it can be assumed to be inert if enough oxygen has been replaced by the methane. Nevertheless there will be some areas of the mine where concentration is diluted and it will pass through the explosive range before being rendered safe under 5%.
- Without dewatering the mine and with the passing of time the water build-up in the mine will close off bleeder and evaluation boreholes needed to ventilate and monitor. The water has already closed off the T-2 Bleeder.

- The numerous roof falls will have a significant impact on the ventilation. Roof cavings will destroy ventilation controls (curtains, stoppings, and overcasts), allowing the air to mix between the intake and return airways. It will create trapped pockets of poor quality air and methane concentrations. The methane will form in pockets on top of the fall cavities in poorly ventilated areas as the methane, being lighter than air, will rise and concentrate in poorly ventilated areas.

4 Water in the Mine

Summary

The hazard associated with water conditions in the mine, once dewatering and monitoring is resumed, are comparable to those faced in typical mining operations. Water contaminants would not involve significant risks of disease due to microorganisms from decaying human bodies.

Existing Water Conditions in the Mine

Marshall Miller & Associates, video-logged 15 holes and this information provided some insight regarding the mining water conditions. Boreholes with wet conditions are indicated in blue in Figure 4.2, only boreholes C-11 and C-15 show flooded mine conditions as noted in Table 4.1.

The bore hole C-15 at the longwall panel face area indicated the water level at approximately 145 m which is about half the height of the opening. The bore hole c-11 located at the tail gate indicated the water is in the bore hole at depth of approximately 145m based on the topography elevation inferred from core logs (Figure 4.1) and clearly shown the gas liberation (most likely Methane). One positive conclusion is the water level demonstrated that there is communication between the two holes and there is no temporary dams existing which may cause additional safety concerns. Snapshots of the borehole video logging for water analysis purposes are given in Appendix E.

Table 4-1 Summary of Video Survey

Borehole ID	Video Casing	Top Mine Void1	Top Video2 Void	Video Total Depth	Void Height	Comments
DG-5	115.7	135	136	137.4	1.4	Dry open entry Hole offset
DG-7	138.6	138.6	138.6	141	2.4	Dry open mine conveyor belt
C-6	119.4	136		124.5		Hole collapsed Condensation
C-5	126.8	135	136	138.5	2.5	Open void – dry Debris – rock
M-7	6	138		86		Chased rock downhole, then bridged off. Wet
C-23	131.5	144		134		Collapsed hole. Muddy casing.
C-15	**136.2**	**145**	**145**	**146.5**	**1.5**	**Flooded. Rock debris. No gas bubbles**
M-8	6	138.8	136.3	142.2	5.9	Mine void intact. Wet. Inside crib. Then into entry. Floor submerged.
C-10	105	133	138.6	120		Collapsed borehole. Dripping water. Horizontal stress.
DG-11	128.9	139	138.6	140	1.4	Void area. No visible supports. Dry.
C-24	124.1	140.9	141.1	144	2.9	Open dry entry. Dark, debris. Fallen timbers.
C-26	130.7	138.8		137.6		Collapsed borehole.
C-11		**154**		**144**		**Water level check 145'. Gas bubbles. (no VHS recording)**
C-20	124	140	139.8	142.2	2.4	Mine void. Wet. Rubble. Timbers upright.
T-3	128.4	152.1	148.5	149.5	1	30-inch casing torn inwards twice. Collapsed. Wet. No timbers.

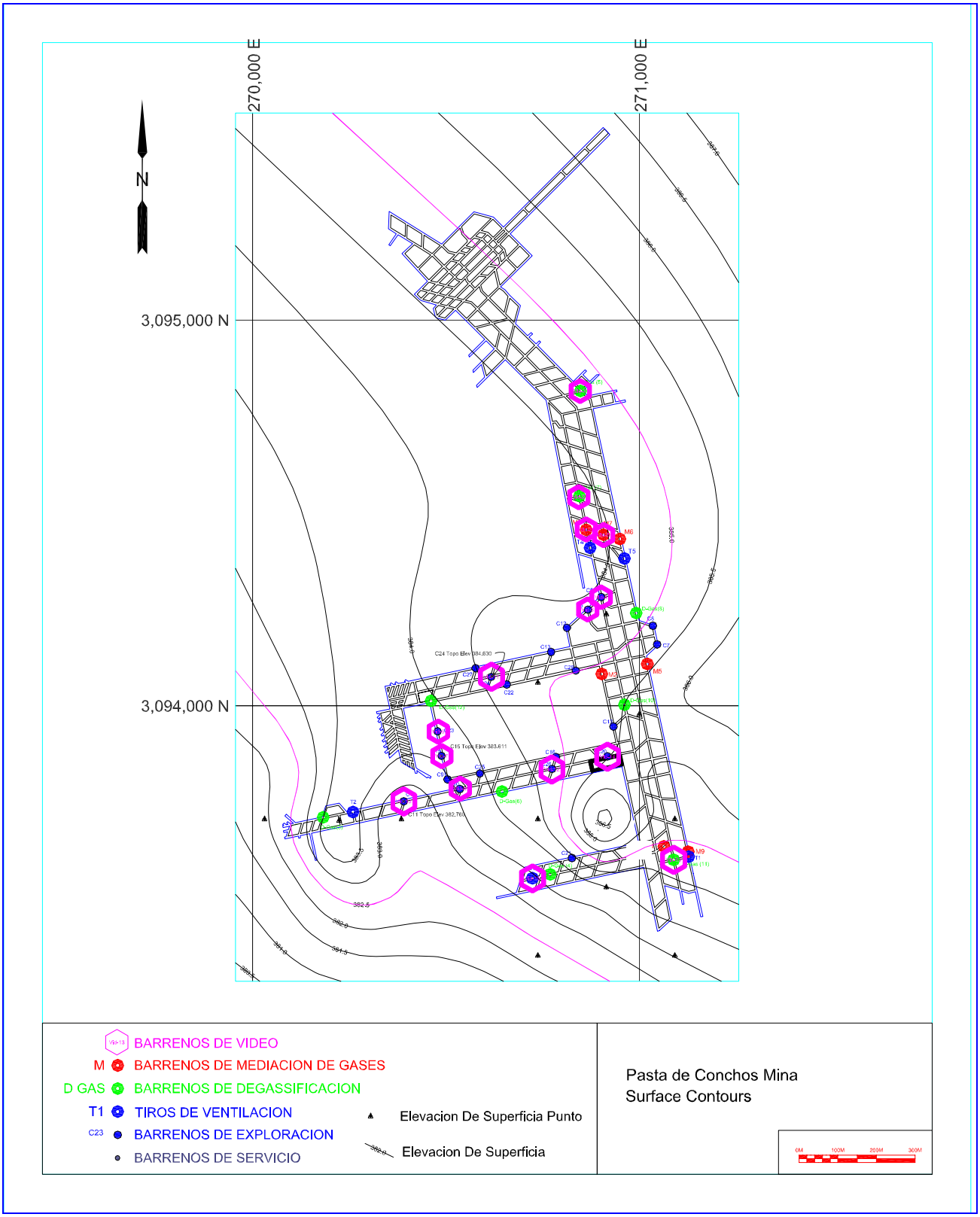


Figure 4.1 Borehole video locations and survey topography.

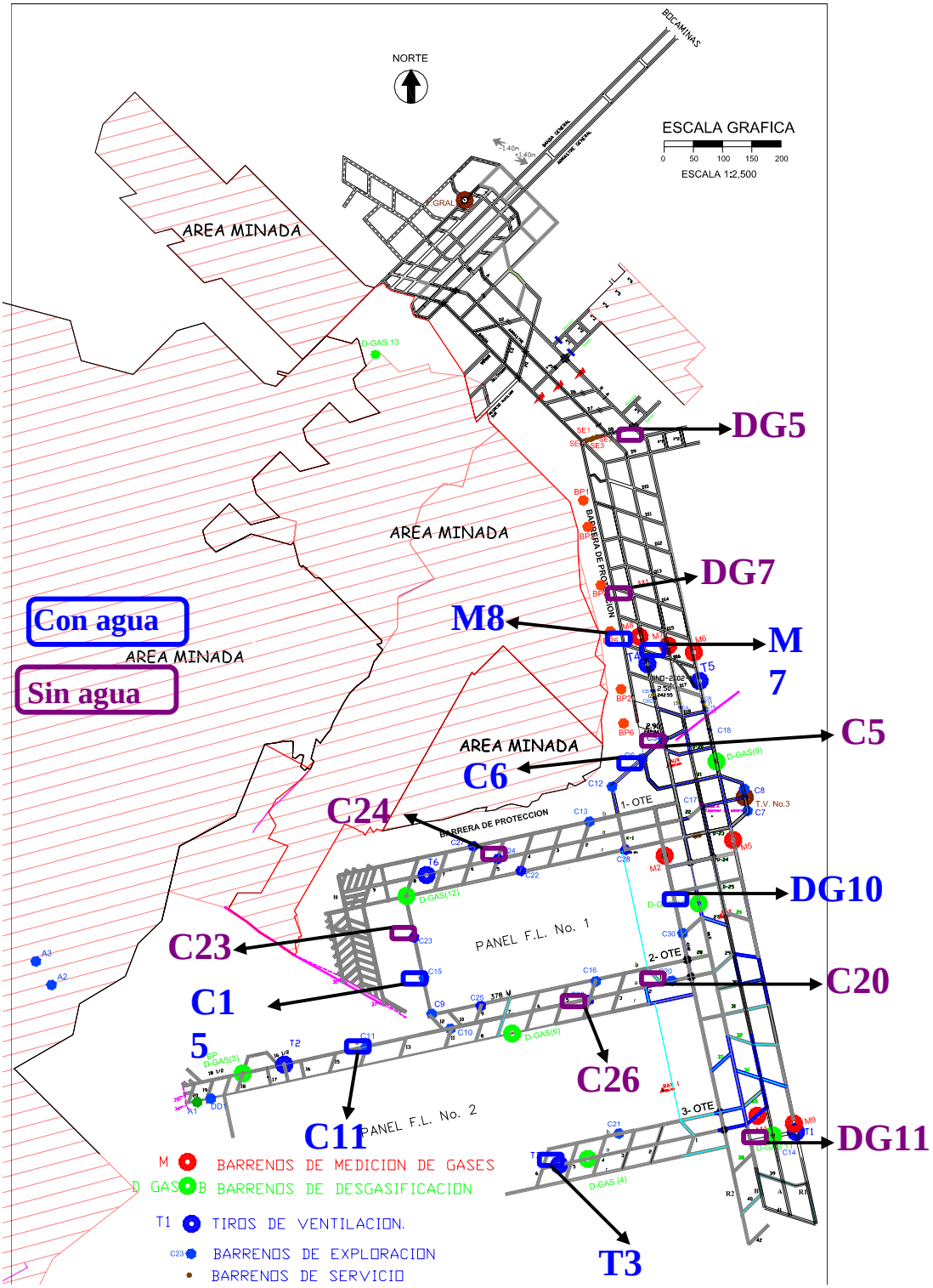


Figure 4.2 Borehole video locations

Analysis

Surface elevation data from the core logs were used to create a limited model of the surface and the coal seam elevation to assist in estimating void volumes.

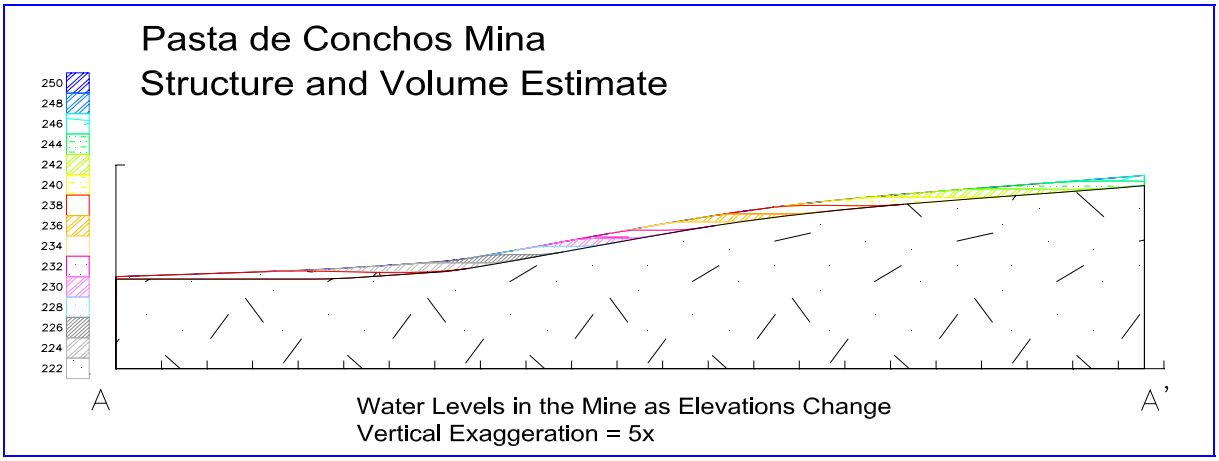


Figure 4.3 Structure and Volume Estimate

Figure 4.3 contains a fence diagram showing the way the estimate was calculated using gridded surfaces. A surface was created for each water level at 2-meter increments. The mine outline and pillar works were then used to cut across the surfaces. The results are shown (Figure 4.4) in the form of a stage-storage curve based on water elevations. This is a high-side estimate that can be pro-rated when the total amount of mined volume is known. Water volume by elevation is listed in Table 4.2. The quantities indicated were derived from Carlson Software's volumetric routines.

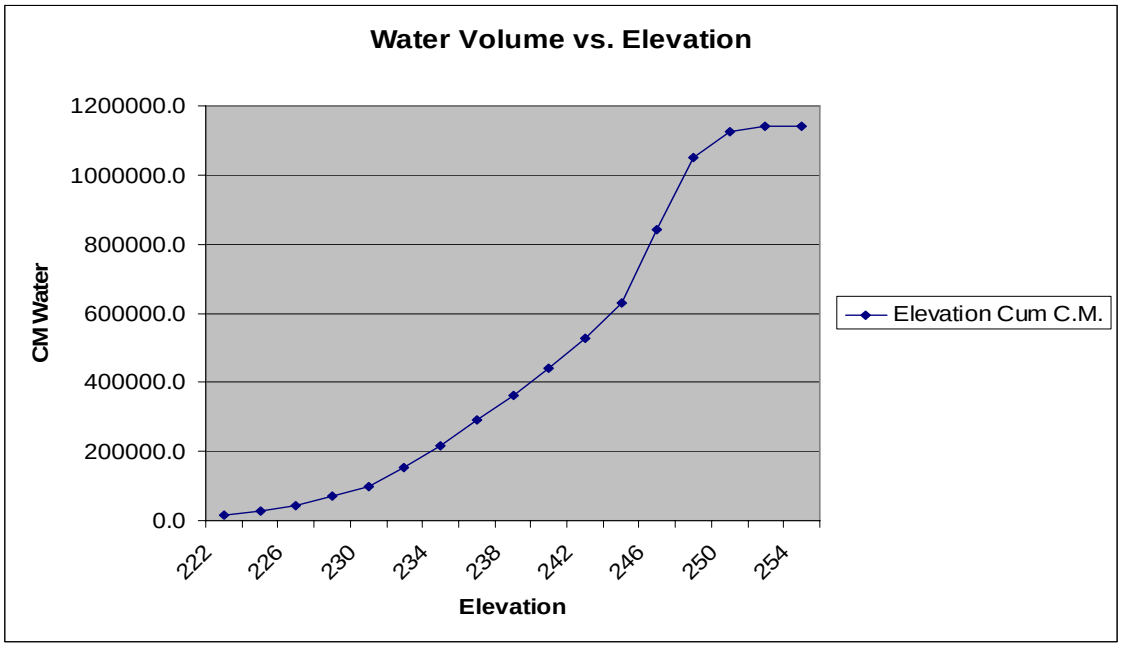


Figure 4.4 Water volume (m^3) versus Mine Elevation (meters)

Table 4-2 Water Volume by Elevation

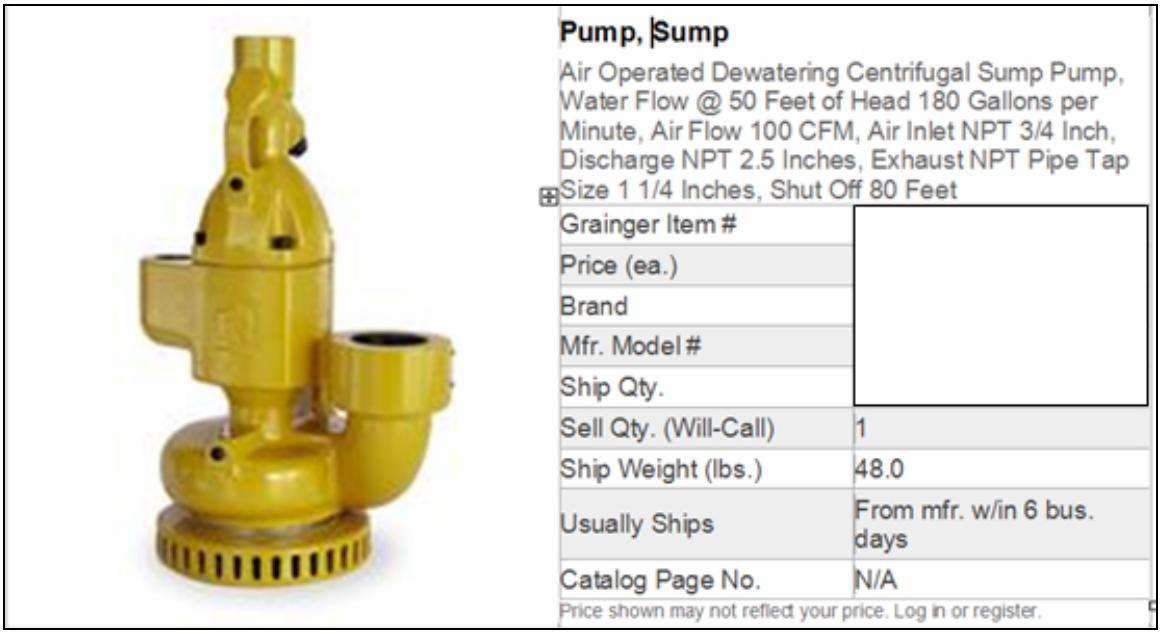
Elevation	Cubic Meters	Cum Cubic Meters
222	14458.2	14458.2
224	11548.6	26006.8
226	18599.6	44606.4
228	25796.9	70403.3
230	28386.7	98790.0
232	55683.6	154473.6
234	63355.5	217829.0
236	74789.1	292618.1
238	69972.7	362590.8
240	76664.1	439254.8
242	86529.3	525784.1
244	102128.9	627913.0
246	212164.1	840077.1
248	208791.0	1048868.1
250	76437.4	1125305.5
252	13993.7	1139299.2
254	69.6	1139368.9
	1139368.9	**1139368.9**

Based on this model, the cumulative total volume number should exceed the actual total volume of the mine.
Assuming the use of an air pump discharging into a line with a diameter of roughly 3" with characteristics to those of the pump illustrated in Figure 4.5 we could expect the following:

117 days x 24 hrs/day x 60 minutes/hr x 180 gallons/hr x .003785 gallons/CM =

114,800 CM at 24 hrs/day
57,400 CM at 12 hrs/day
37,883 CM at 8 hrs per day

The water build-up since the pumps were shut down will be a function of the elevation of the water at the beginning of the shut-down period. As can be seen in the stage-storage curve the capacity changes dramatically with the elevation in the mine. With good flow and open areas there would be little build-up if the water was already at the 232 elevation for example. This is where piezometer readings would be essential in determining the extent of the drainage volume.



Pump, Sump

Air Operated Dewatering Centrifugal Sump Pump, Water Flow @ 50 Feet of Head 180 Gallons per Minute, Air Flow 100 CFM, Air Inlet NPT 3/4 Inch, Discharge NPT 2.5 Inches, Exhaust NPT Pipe Tap Size 1 1/4 Inches, Shut Off 80 Feet

Grainger Item #	
Price (ea.)	
Brand	
Mfr. Model #	
Ship Qty.	
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	48.0
Usually Ships	From mfr. w/in 6 bus. days
Catalog Page No.	N/A

Price shown may not reflect your price. Log in or register.

Figure 4.5 Typical Air Operated Dewatering Pump

Figure 4.6 and Figure 4.7 are coal contour and mine layout maps used to reference video logging locations used for the water study.

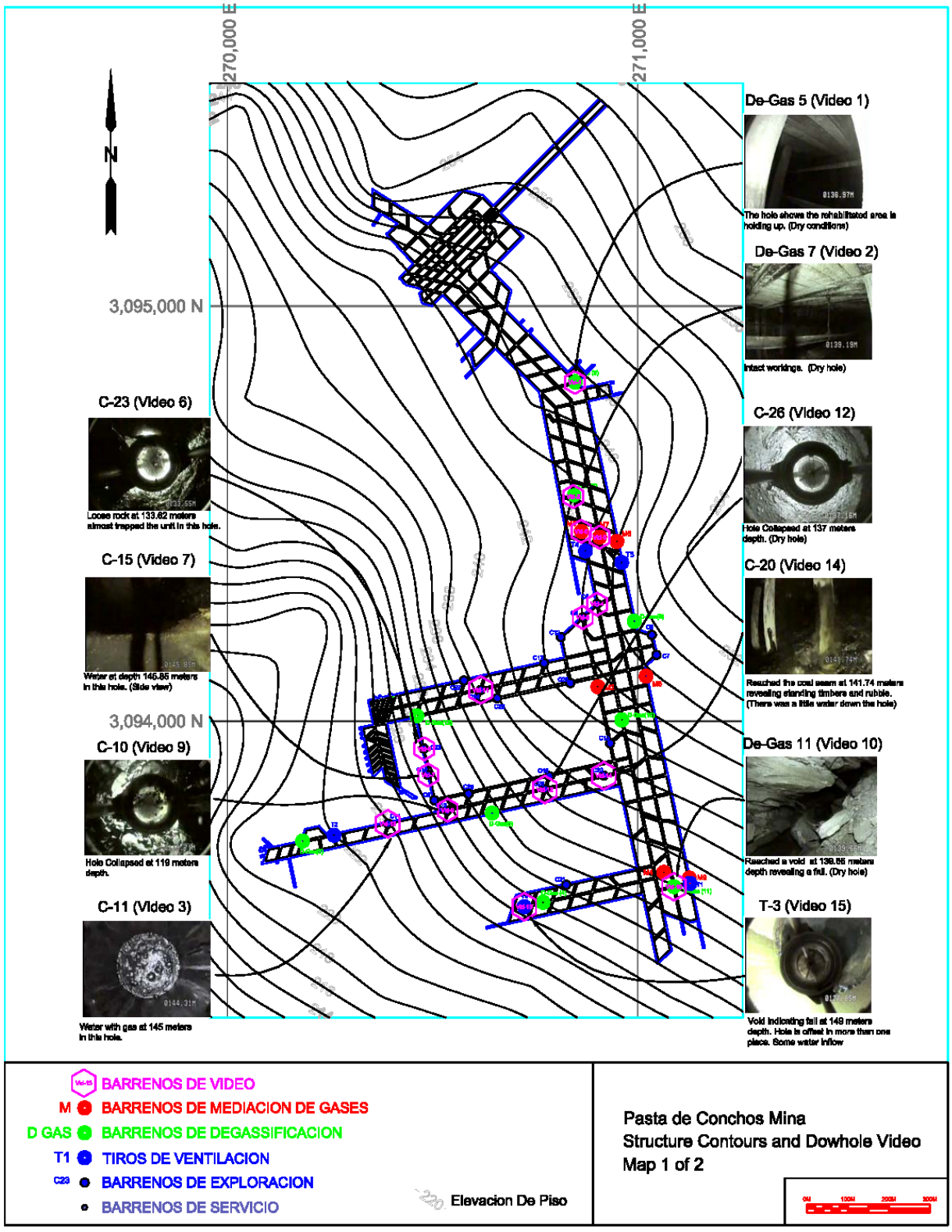


Figure 4.6: Contour Map showing video logs location and correspondent video snapshots.

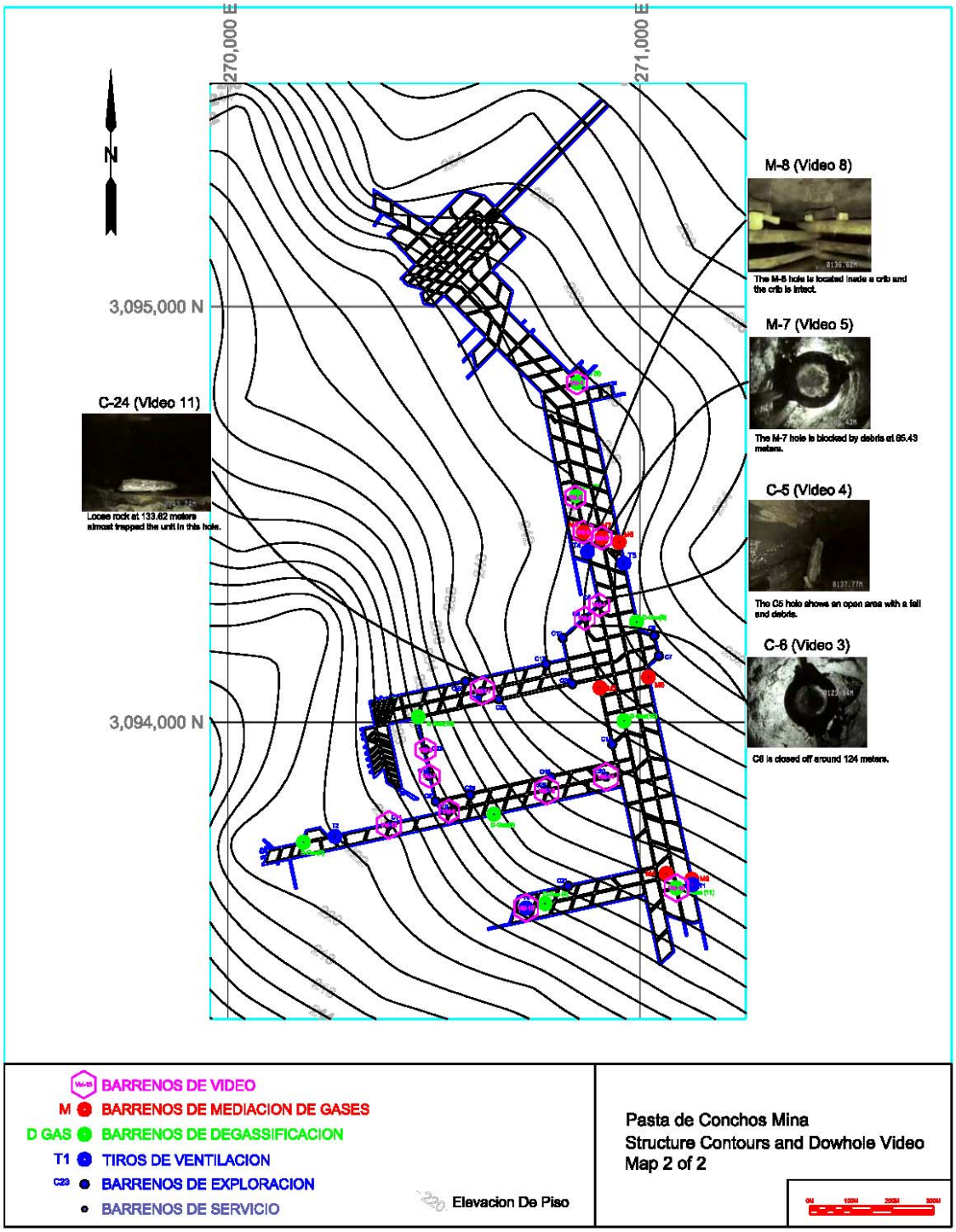


Figure 4.7 Contour Map showing video logs location and correspondent video snapshots.

Microbiological Potential Risks

There will be local ponds of water under normal circumstances where local dips and fault offsets occur in addition to the falls which can back up the water. This will exposed workers to contact with water on a regular basis even if the water has been pumped down from inby areas of the mine. Exposure to water-born pathogens will be a function of the disease's ability to survive, the worker's immune system, and open areas of the skin. Other exposure possibilities include water in the eyes or mouth as possibilities during the heavy manual labor of recovery.

IMSSA internal reports concluded that a renewed recovery effort would involve significant risks of disease due to microorganisms for decaying human bodies. The Pan American Health Organization (http://www.paho.org/English/dd/ped/ DeadBodiesBook.pdf) publication concerning recovery of dead bodies during emergencies confirms that company consultants' conclusion can not be supported by medical evidence. Among other things, although the microbial analysis provided to the FCCT by IMMSA generally showed higher rates of coliform contamination than permissible by water quality standards, all but one of the analyses show "non-detects" for fecal coliforms, which would be expected if contamination from decaying bodies were a real issue. More generally, microorganisms adapted for survival in a living human body are unlikely to survive long after death, although some viruses might remain infectious.

Coal mines at the depth of Pasta de Conchos will have their own microbial ecological niche, but those organisms are not likely to be adapted to life as a human commensual or pathogen. At any rate, those natural coal mine microbes would be part of the normal environment of underground mining and not a part that is normally of health concern for miners. Figure 4.8 shows locations of microbiological testing within the Mine. The results of testing are provided in Figure 4.9.

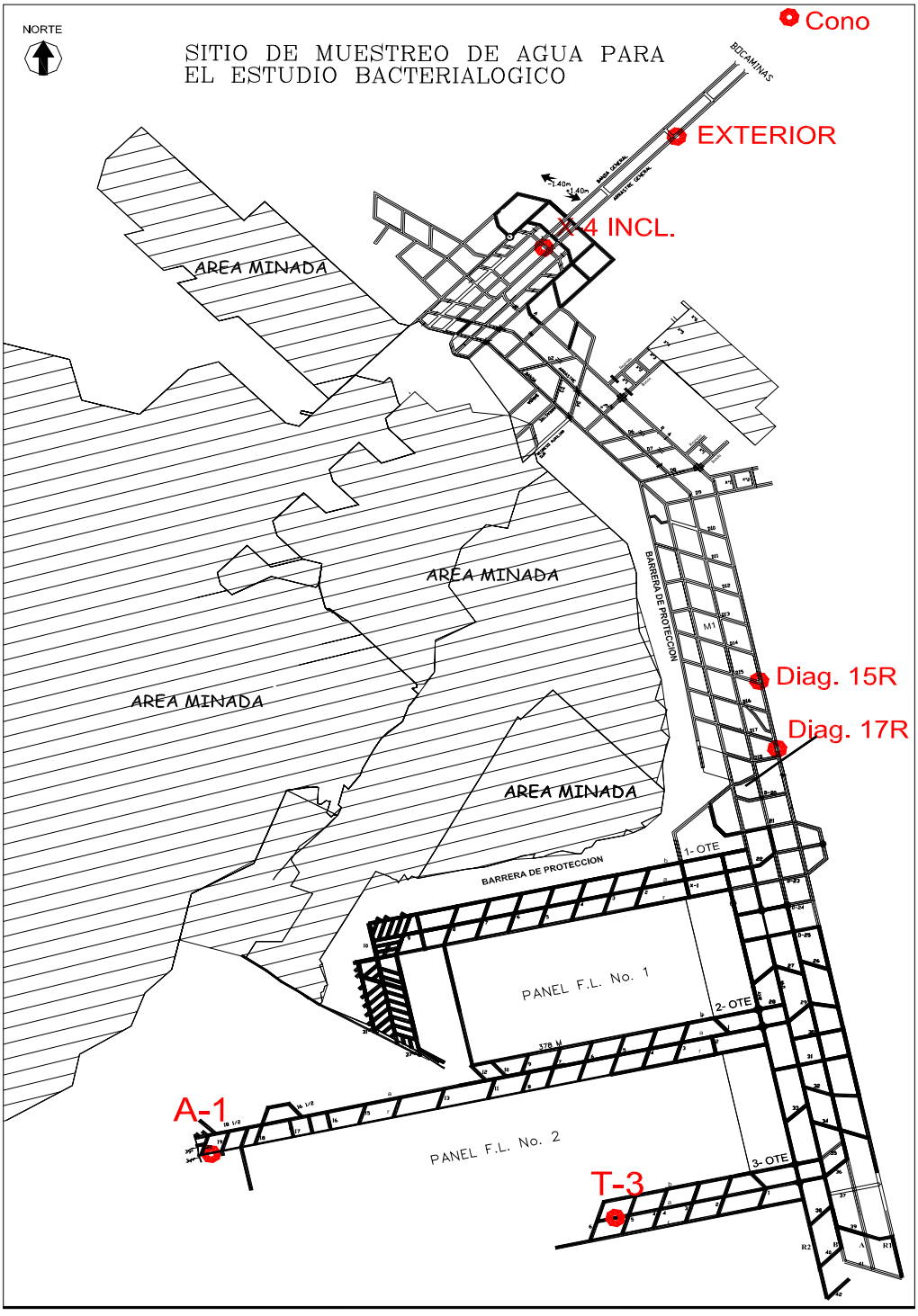


Figure 4.8 Microbiological Sampling Locations.

INDUSTRIAL MINERA MEXICO, S.A. DE C.V.
UNIDAD PASTA DE CONCHOS

RESULTADO DE MUESTREO DE ESTUDIO BACTERIOLOGICO DE AGUA

Fecha	Lugar	Mesofilicos	Coliformes	Coliformes Fecales
05 junio 2007	A-1	298,000 ufc/ml	500 NMP/100 ml	Negativo
26 abril 2007	Cono	13,400 ufc/ml	0	Negativo
9 abril 2007	T-3	1,500,000 ufc/ml	Menor 1 NMP/100 ml	Negativo
9 abril 2007	Diag. 17R	220,000 ufc/ml	80,000 NMP/100 ml	240 NMP/100 ml.
26 Febrero 2007	A-1	730,000 ufc/ml	2,600 NMP/100 ml	Negativo
26 Febrero 2007	A-1	710,000 ufc/ml	11,000 NMP/100 ml	Negativo
26 Febrero 2007	A-1	680,000 ufc/ml	0	Negativo
1 Noviembre 2006	Diag. 15R	41,000 ufc/ml	0	Negativo
1 Noviembre 2006	X-4 Incl.	50,000 ufc/ml	10 NMP/100 ml	Negativo
1 Noviembre 2006	Exterior	216,000 ufc/ml	0	Negativo

ufc.= Unidades Formadoras de Colonias.
MP= Numero mas probable
ml= mililitros

PRUEBA	METODOLOGIA DE PRUEBA
ORGANISMOS MESOFILICOS AEROBIOS	NOM-092-SSA1-1994
ORGANISMOS COLIFORMES TOTALES	NOM-112-SSA1-1994
ORGANISMOS COLIFORMES FECALES	NOM-000-SSA1-1995

NORMA OFICIAL MEXICANA NOM-201-SSA1-2002

LIMITE MAXIMO SEGUN EL REGLAMENTO FEDERAL	
CONTEO TOTAL DE BACTERIAS MESOFILICOS AEROBIOS	100 ufc/ml
CONTEO TOTAL DE ORGANISMOS COLIFORMES TOTALES	< 1NMP/100 ml
CONTEO TOTAL DE ORGANISMOS COLIFORMES FECALES	NEGATIVO

Figure 4.9 Microbiological analysis results.

Expected Water Conditions

The following is a list of conditions related to water in the mine.

- C-11 and C-15 water levels are similar indicating that there could be communication between the two sections of the mine.
- The unexplored areas of the mine would require pumping down the water level and conducting testing to verify water conditions.
- The water conditions are correctable with dewatering pumps and opening of monitoring locations that are currently inaccessible.
- Currently, the inability to monitor water levels prevents identification of potential dams between various sections of the mine. This increases risk due to potential for sudden release of water. This risk is higher than would normally be present during routine mining operations. However, restoring monitoring holes and pumping the area could mitigate this apparent risk.
- Without further monitoring data and the ability to pump out the affected area it would not be possible to assure safety. Such a condition would not be an acceptable risk during normal operations.
- Water contaminants would not involve significant risks of disease due to microorganisms from decaying human bodies.

5 Mine Power Distribution

Summary

The Electrical Power Distribution at Pasta de Conchos Mine does not present any significant risk to health and safety. The surface power supply and distribution are operational. The underground power supply and distribution system is operational in the excavated and recovered areas up to cross-cut 17.

Current Safety status of the mine electrical system

Surface Electrical Power Supply and Distribution System: The safety status of the surface electrical Power Supply and Distribution System appears to be at least as good as it was before the explosion.

It was reported by one of the recovery miners during an interview that the mine fan, a Jeffrey Axivane 96-inch diameter exhaust fan, was running when the first responders arrived after the incident, also indicating the surface utility power supply was not damaged by the explosion.

Underground Power Supply and Distribution up to Cross-cut 17: The safety status of the underground power supply and distribution system out to cross-cut 17 was good at the time of the last entry into the mine (3 April 2007). It had been repaired as the recovery/excavation work was in progress. When the panel members were at the site one of the members conducted an inspected. Material removed during recovery operations was observed including a number of electrical motors and cables that had been removed. These items did not show evidence of burn damage that might have been caused by either the explosion or a fire. There was no physical evidence of short circuits that had not been protected by automatic disconnect devices. The assumption would be that damage to the underground electrical supply and distribution system came from the roof falls. During interviews with recovery personnel they said that all underground systems were “repaired to normal operating status” as they advanced to cross-cut 17.

Underground Power Supply and Distribution Beyond Cross-cut 17: The safety status of the underground mine electrical system beyond cross-cut 17 has been disconnected/isolated and is assumed to be extensively damaged or destroyed. It can also be assumed that it would need to be repaired if further recovery operations are undertaken.

Expected power distributions conditions

- The underground power supply beyond cross-cut 17 is destroyed and will need to be repaired or replaced.
- The risks associated with repair and replacement operations of the electrical power distribution system is slightly greater than the risk associated with normal mining operations due to the increased likelihood of human error during the installation of new services within the mine.
- These increased risks are present in any new installation and are successfully mitigated through visual inspections, pre-energizing verifications and other systems checks before the system is placed into service.
- The electrical power distribution system at Pasta de Conchos has not historically exhibited reliability or safety problems.

6 Material Handling

Summary

The risks posed by material handling operations during recovery activities are higher than for normal operations but are substantially lower than they were during the rescue operations. The surface material handling system is operational. The underground material handling system is operational in the excavated and recovered areas up to cross-cut 17. The underground material handling system beyond cross-cut 17 is destroyed and will need to be repaired or replaced as further excavation and recovery proceeds. The risks posed by material handling operations passed cross-cut 17 will be higher than the normal operation.

Current Conditions of the Material Handling System

Surface material handling: There was no visible evidence that the surface material handling system was damaged by the explosion. During the inspection of surface equipment the beltline, crusher, washer, and track systems all appeared normal. Safety of these systems is no less safe than before the explosion. The mine ventilation fan was not inspected but it was reported to be running at the time of the mine visit.

Material handling in the recovered area up to cross-cut 17: Assessment of the underground material handling system can only be done on the basis of interviews with personnel involved in recovery efforts. Two supervisors that were interviewed during the site visit said that the entries and the material handling equipment were restored to their normal working condition as material was removed and the entry was cleaned up. It was reported that the beltline and track systems have been repaired and were in useable condition before recovery efforts were halted on 3 April 2007.

Material handling beyond cross-cut 17: Because of the number and severity of roof falls encountered during the operations to excavate and repair the various mining systems up to cross-cut 17, it is assumed that the material handling system in the areas passed cross-cut 17 has been destroyed by roof falls and will need to be repaired or replace.
The narrow travel-way, due to the difficulties of cleaning and re-establishing the supports in newly restored sections of the mine can cause serious health and safety problems for the miners who must cross these areas while carrying heavy loads.

Expected material handling conditions

- The surface material handling system is operational.
- The underground material handling system is operational in the excavated and recovered areas up to cross-cut 17.
- The underground material handling system beyond cross-cut 17 is destroyed and will need to be repaired or replaced as further excavation and recovery proceeds.
- The risks posed by material handling operations passed cross-cut 17 will present higher than the normal operation than they were during the rescue operations.

7 Accident Records

Summary

The lack of comparable incident rate data from the Mexican mining industry prevents the team from fully evaluating the level of increased safety risk associated with the recovery operations between February 2006 and April 2007. The limited analysis that was possible, shows a safety incident rate during recovery to be approximately five times the average incident rate during normal operations at the mine during 2005. This shows a much higher than normal risk associated with the recovery operations.

Analysis of Available Accident Data

The Pasta de Conchos mine safety data that was provided to the team includes the graph shown in Figure 7.1. This graph shows the number of incidents per month that occurred between March 2006 and March 2007.

Table 7.1 summarizes the data depicted in Figure 7.1. This graph displays the average number of incidents per month during 2005. The graph also shows that the number of accidents occurring during the recovery averaged 24 incidents per month for the 13 months. This is almost five times the monthly number of accidents during the 2005 routine operations at the mine.

Table 7-1 Monthly Incidents During the Period of Recovery

Month	Number of Incidents
March 06	10
April 06	9
May 06	11
June 06	22
July 06	25
August 06	23
September 06	18
October 06	27
November 06	**117**
December 06	18
January 07	18
February 07	11
March 07	6
Total for Period	315
Average # per Month	24.23

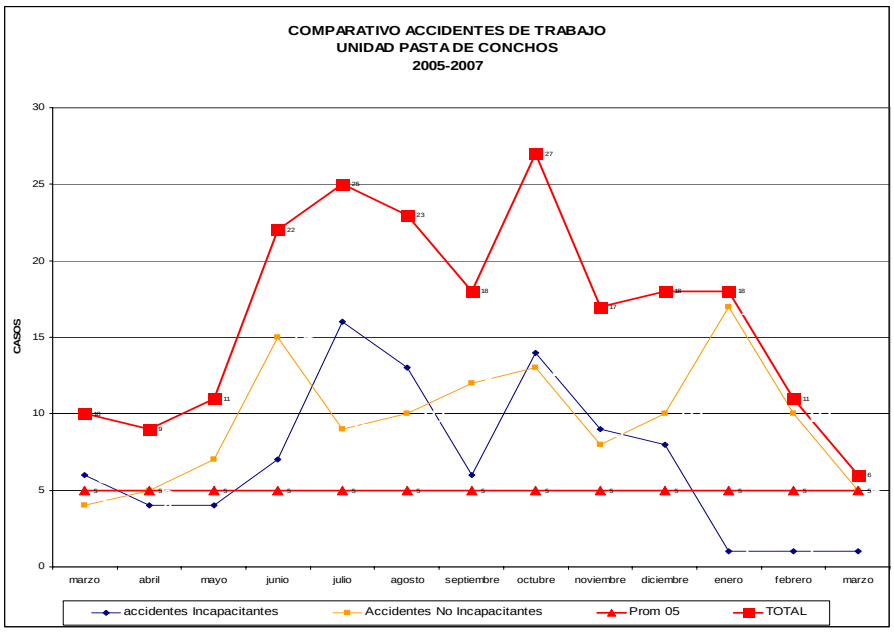


Figure 7.1: Comparison of the number of accidents per month to past year (2005) performance

Using the data that is available from IMSSA it is possible to calculate approximate accident incident rates for the mine during the recovery period. The incident rate data is normally reported as the number of incidents per 100 man-years of work. To calculate an incident rate one needs to know the total number of incidents and the total number of hours work.

In the March 2006 to March 2007 period of recovery operations the total number of incidents was 315. An approximate total number of hours worked can be derived by assuming the 1,092,000 hours worked during the recovery were evenly distributed between February 2006 through March 2007. With this assumption the average monthly hours worked was:

Average Hours Worked per Month = 1,092,000/14 = 78,000 hours per month

The following calculation is used to convert the actual incidents and hours worked into the incident rate.

(Number of incidents/Numbers of hours worked) x 200,000

Based on this the incident rate at Pasta De Conchos during the recovery period would be calculated as follows:

Incident rate = (24/78,000) x 200,000 = 62
This is the number of incidents per 100 man years of work

The team did not have access to Mexican coalmining incident rate data to compare Pasta de Conchos mine safety incident rates to the rest of Mexican coalmining industry. The team could not compare Pasta de Conchos mine's incident rates before the accident to those during recovery because the hours worked at the mine were not available. One cannot determine to what extent the increase in the average number of incidents per month was because there was more work being done or because there was higher risk work being done. However there

is reliable underground coalmining industry data available from the U.S. Mine Safety and Health Administration that can provide insight into the relative safety of recovery operations.

The Mine Safety and Health Administration the incident rates for US underground coalmines in 2005 was 7.8 incidents per 100 man years of work. The incident rate during the recovery period was nearly eight times this value. From this analysis it can be concluded that there is approximately 8 times the likelihood of an accident to occur during the recovery operations than is likely to occur during routine operations at a US underground coalmine in 2005.

This elevated risk occurs because of the conditions in the mine and the type of work being conducted.

The accident data for Pasta de Conchos shows an increase in accidents related to material handling and heavy lifting which are directly related to the re-construction of the supporting system and the debris cleaning. The detailed data available to the team was not sufficient to identify safety trends. This detailed information could be used to better characterize the type of events that are occurring. However, the increase in risk over normal operation is clearly evident.

The team was unable to find data that quantifies the Mexican mining industry level of risk during routine activities, recovery activities and rescue activities. This information is needed to make informed decisions. If this information is available and understood it can be used improve rescue operations and recovery operations decision making.

The documents available to the team during briefings and the photos taken by IMSSA and the team clearly demonstrated the difficulty and danger involved in the activities of cleaning and re-supporting the ground. The gas problems, the difficulties related to maintaining effective ventilation in the mine, the problem with support systems are all factors that increase the risk of serious accident during recovery operation.

The lack of comparable incident rate data from the Mexican mining industry prevents the team from evaluating the level of increased safety risk associated with the recovery operations between February 2006 and April 2007.

8 Regulatory NOM-23 Comments

Roof Support Regulatory Analysis

NOM-23-STPS-2003 The supporting system used in the mine is based on years of experience and common practices that have been widely used in the region. The support system is capable of sustaining the vertical loads but has been demonstrated to be insufficient to support horizontal loading created by a shock wave during the event of 19 February 2006.

NOM-23-STPS-2003, Work in Mines – Occupational health and safety conditions, provides broad guidance that does not clearly define the responsibilities of the operator and government inspector in the process of designing, reviewing, and approving the roof control and support systems.

NOM-23-STPS-2003, Work in Mines – Occupational health and safety conditions, does not provide guidance on assumed conditions that must be met by the design of roof control and support systems.

NOM-23-STPS-2003 defines the elements of roofing and support in sections 4.2. Support and 4.20 Fortification. In Appendix C, Safety Conditions, element C.1.3 broad guidance requiring preparation of design criteria and selection of the support and the materials to employ, that take into consideration the plans and studies.

Ventilation Regulatory Analysis:

The ventilation system at the mine looks compliant and adequate to meet the requirements of NOM-23.

High pressure degasification pumps are used intermittently to reduce methane concentrations close to 30% when concentrations rise above that level. Consistent with the requirements of NOM-023, Pumps shut down when concentrations drop below 30%.

Accident Records Regulatory Issues

There is a need to have reliable Mexican underground coalmining industry safety data available to the general public. This information would increase public accountability for those that are responsible for improving safe mining operations. It is also needed to better understand the probability and consequences of safety decisions.

9 Findings

Following are the results of the analysis based on the best available information provided and based on the video logs recorded during the second visit to the mine. A map showing the locations of the boreholes is provided in Figure 9.1. Detailed anaisis of video logs are contained in Appendix D.

A total of fifteen boreholes were observed: **DG-5, DG-7, M-7, C-5, C-6, C-23, C-15, M-8, DG-10, DG-11, C-24, C-26, C-11, C-20, T-3**. Five bore holes were collapsed C-6, C-23, DG-10, C-26, T-3. Out of the ten holes, which the camera could reach the bottom of the borehole and the top of the voids, only one borehole C-20 showed timber posts still standing and has the least debris. The rest of the boreholes show extensive caved materials and major damages to the support system. Two holes C-15 and C-11 show that the water level is rising and accumulating in the south area of the mine.

All the video images show different levels of damage to the support system. The majority are serious which indicates the instability of the ground. This clearly indicates that the supporting system is capable to stand vertical loads but it lacks to sustain horizontal loads.

The majority of the boreholes videos indicated that the main roof consists of poor quality mudstone and siltstone which may explain why all the intersections have major roof falls. All the intersections have the longest span, once the supporting system has failed, the main roof composed of poor quality mudstone and siltstone material will collapse too. The area beyond cross-cut 17 could be reasonably assumed to be under the same conditions. The efforts to reopen the area in order to clean and re-support the area would be very difficult and hazardous; it should be a major concern to the miner's safety.

The borehole C-15 at the longwall panel face area indicated the water level at approximately 145 m. The video in borehole C-11 located at the tail gate indicated the water level at a depth of approximately 145 m and clearly shows gas liberation (most likely Methane). The water level in both boreholes demonstrated that there is an opening between the two boreholes and no temporary dams exist between C-11 and C-15.

The water level will continue rising and fill the voids inside the mine, it will be important to continue monitoring the water level and give early warning if the condition changes. Water level variations in contiguous boreholes may indicate an underground water trap or dam caused by debris. Those dams will hold water back and any sudden release will be a major safety concern.

The accident report during recovery operations shows a relatively high frequency of accidents, which should be a concern. The report clearly indicates that accidents are related to material handling and heavy lifting which is directly related to the reconstruction of the supporting

system and cleaning the debris. It is important to note that during this reconditioning process miners were exposed to unsupported roof.

The underground conditions based on the video images reviewed in the field and then reviewed in detail can only be described as unstable. The available document during the briefing and the photos session clearly demonstrated the difficulty and danger involved in the activities of cleaning and re-supporting the ground.

The methane gas problem and the re-establishment of the ventilation system can be a major concern since the opening can not be kept under constant dimensions. Its impact on the miner's safety can be a serious problem due to:

- **Roof control and support:** It can be expected that the roof and the support system conditions, in the area beyond cross-cut 17, will be similar to those experienced during the rehabilitation of the restored area. It can also be expected that conditions within the whole mine will deteriorate with time in the absence of regular maintenance.

- **Ventilation:** Currently it is not possible to demonstrate that the ventilation system is capable of removing methane from all areas of the mine. It is likely that critical concentrations of methane will be present due to rock fall obstructions and caved roofs. Existing monitoring cannot properly characterize the methane concentrations throughout the working areas. The risks associated with the present ventilation system are greater than during regular operations.

- **Water:** The hazard associated with water conditions in the mine, once dewatering and monitoring is resumed, are comparable to those faced in typical mining operations. It is not possible to assure that there cannot be a sudden release of water into areas where recovery and restoration activities need to take place

- **Mine power distribution:** The Electrical Power Distribution at Pasta de Conchos Mine does not present any significant risk to health and safety. The surface power supply and distribution are operational. The underground power supply and distribution system is operational in the excavated and recovered areas up to cross-cut 17.

- **Material handling equipment:** The risks posed by material handling operations during recovery activities are higher than for normal operations but are substantially lower than they were during the rescue operations. The surface material handling system is operational. The underground material handling system is operational in the excavated and recovered areas up to cross-cut 17. The underground material handling system beyond cross-cut 17 is destroyed and will need to be repaired or replaced as further excavation and recovery proceeds. The risks posed by material handling operations beyond cross-cut 17 will present higher than the normal operation than they were during the rescue operations.

- **Accident Records:** The lack of comparable incident rate data from the Mexican mining industry prevents the team from fully evaluating the level of increased safety risk associated with the recovery operations between February 2006 and April 2007. The limited analysis that was possible shows a safety incident rate during recovery to be approximately five times the average incident rate during normal operations at the mine during 2005. This shows a much higher than normal risk associated with the recovery operations.

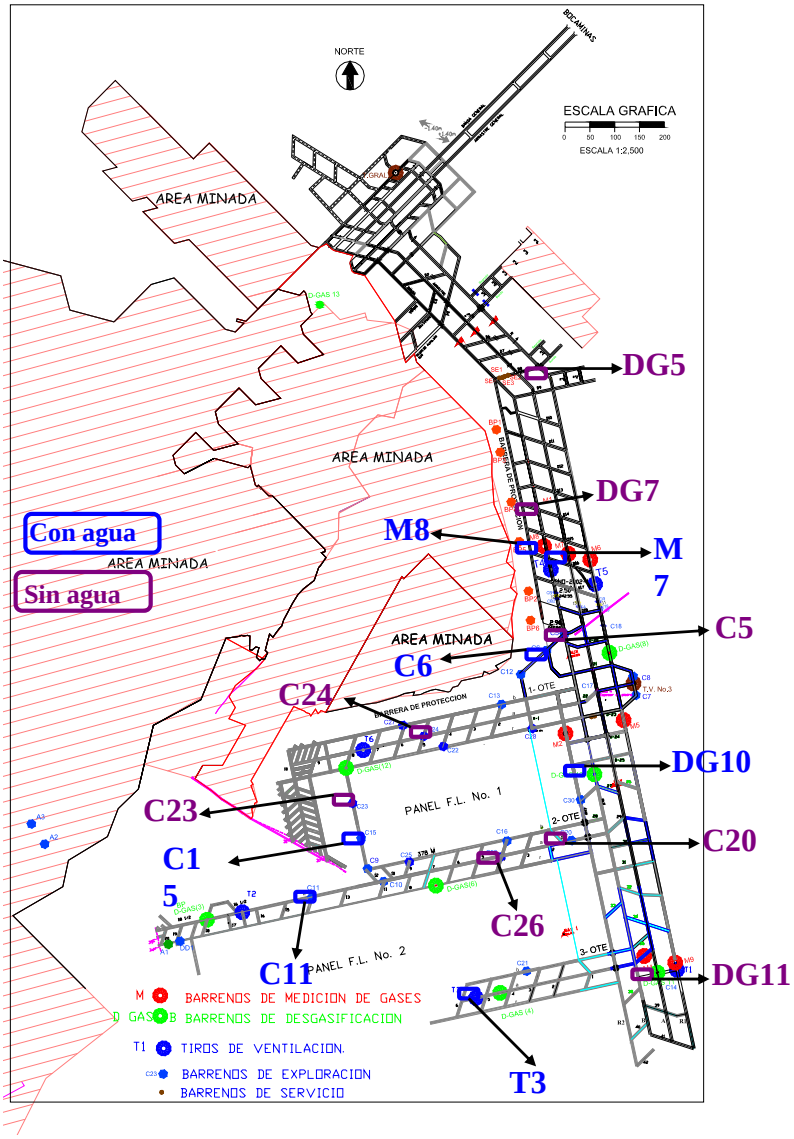


Figure 9.1 General plan view of the mine showing borehole locations.

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Mine Safety Regulatory Recommendations

Pasta de Conchos Mine, lessons learned can improve mine safety

It is important to differentiate between avoiding an accident and avoiding a possible tragedy. We submit that a tragedy would not be caused if there is an integrated and rigorous system of maintenance and monitoring, a system of efficient ventilation, a better technology for supporting roof were possibly implemented and there was a government policy promoting degasification of methane.

In the hypothetical case of an accident in which some miners could have survived inside the mine, it is critical to be able to respond as rapidly as possible to send rescue groups to the interior on the mine. In the case of an accident, the rescue group must always adopt a strategy of caution that is focused on the protection of the rescue personnel. Nevertheless, the rescue procedures are usually slow and diminish the chance to a great extent to rescue to the miners alive.

If, after an accident, one concludes that the miners are likely to be alive, it is vital to determine as rapidly and accurately as possible the location of the trapped miners. Seismic monitoring equipment must be available on or near the site before hand to listen for signs the miners are still alive.

In any case, time is always the enemy that must be fought to rescue the miners who are still alive, but time is also needed to make and carry out the correct decisions to protect the members of the rescue groups in order to avoid a second tragedy that leads to a catastrophe.

The failures described throughout the Pasta de Conchos report are, almost in all the cases, system failures: safety, maintenance systems, management controls, emergency preparedness systems, and emergency response systems. One of the questions that we need to ask in any tragic event is; Could this happen again? Could the monitoring systems have detected the sudden change of gas accumulation? Could the roof and support system have been better designed to withstand the explosion.

We need to ensure the rescue group responds quickly. That it has preplanned responses for providing assistance within a few hours after an accident. The rescue plan must adequately protect the rescuers so that a tragic event does not become catastrophic as happened in Utah where 3 rescuers perished and 6 were injured in vain during the attempt to rescue 6 miners trapped inside the mine.

When the rescue team has better information to work with, including up to date plan drawings of the mine, gas sensor networks, communication signals and the location of the miners, the possibilities of successful rescue increase, and the risk for the rescuers is diminished.

It is for that reason that it is urgent to learn from this very lamentable and tragic event at Pasta de Conchos and to carry out the remedial actions as rapidly as possible. But it is equally important to understand what occurred so that we can design and implement better laws and mining standards, in terms of safety, training, and engineering for the mines and the miners of Mexico.

A call to improve safety in mining

It is suggested, that the governor, the state, and federal legislature introduce legislation that will strengthen the safety and health requirements and its implementation and also should promote degasification of coal mines when it becomes feasible, and will introduce ways for rapid notification of and response to mine emergencies, and installation of improved mine communication and tracking systems in order to be able to locate and maintain contact with miners in emergency situations.

It is also suggested that the Coahuila State University and CINVESTAV-Coahuila could host an International Mining Health and Safety Symposium in 2007(2008?) to help stimulate adoption of improved technologies and equipment in Mexico's mines. The federal government could issue an emergency rule on methane detection, improved gas standards, communication, and other mine safety improvements. The federal government through the *Foro Consultivo de Ciencia y Tecnología* could appoint a scientific and labor management task force to assess the availability of new laws and technologies covered by the new rules.

At the national level, Senators and Representatives of Mexico could propose new laws to enhance coal mine safety and health, and urging lawmakers to strengthen oversight and enforcement of the current Mexican federal mine safety & health law, and define new norms that will require improvements in coal degasification, mine safety equipment technology, training, and will also improve mine rescue response strategies and management.

The Department of Labor (STPS) could be allowed to halt production at mines whose owners ignore outstanding violations.

A brief history of the development of mine safety regulations

Review current state rules and federal standards based on what we have learned from the Pasta de Conchos tragedy and other unfortunate disasters around the world. For example, when comparing the Pasta de Conchos tragedy with other unfortunate mining disasters (see www.msha.gov), a tragic coincidence emerges with the Consol No. 9 catastrophe that occurred in 1968 killing 78 miners in West Virginia, USA. This tragedy trigged in the United States the new Federal Coal Mine Health and Safety Act of 1969, generally referred to as the Coal Act. The 1969 act was a comprehensive and stringent act if compared to any previous Federal legislation governing the mining industry. The Coal Act included surface as well as underground coal mines within its scope, required two annual inspections of every surface coal mine and four at every underground coal mine, and dramatically increased federal

enforcement powers in coal mines. The safety standards for all coal mines were strengthened, and health standards were adopted. The Coal Act included specific procedures for the development of improved mandatory health and safety standards.

“In 1973, the U.S. Secretary of the Interior, through administrative action, created the Mining Enforcement and Safety Administration (MESA) as a new departmental agency separate from the Bureau of Mines. MESA assumed the safety and health enforcement functions formerly carried out by the Bureau to avoid any appearance of a conflict of interest between the enforcement of mine safety and health standards and the Bureau's responsibilities for mineral resource development.

In 1977 the U.S. Congress passed the Federal Mine Safety and Health Act (Mine Act). The Mine Act amended the 1969 Coal Act in a number of significant ways, and consolidated all federal health and safety regulations of the mining industry, coal as well as non-coal mining, under a single statutory scheme. Mining fatalities dropped sharply under the Mine Act from 272 in 1977 to 86 in 2000. The Mine Act also transferred responsibility for carrying out its mandates from the Department of the Interior to the Department of Labor, and named the new agency the Mine Safety and Health Administration (MSHA) previously known as MESA. Additionally, the Mine Act established the independent Federal Mine Safety and Health Review Commission to provide for independent review of the majority of MSHA's enforcement actions.

The Mine Improvement and New Emergency Response Act of 2006, also known as the MINER Act, was signed by President George W. Bush on June 15, 2006. This legislation, the most significant mine safety legislation in 30 years, amends the Mine Safety and Health Act of 1977 and contains a number of provisions to improve safety and health in America's mines.

The Mine Improvement and New Emergency Response Act of 2006 requires operators of underground coal mines to improve accident preparedness. The legislation requires mining companies to develop an emergency response plan specific to each mine they operate, and requires that every mine have at least two rescue teams located within one hour. The act increases both civil and criminal penalties for violations of federal mining safety standards and gives the Mine Safety and Health Administration (MSHA) the ability to temporarily close a mine that fails to pay the penalties or fines. In addition, the act calls for several studies into ways to enhance mine safety, as well as the establishment of a new office within the National Institute for Occupational Safety and Health (NIOSH) devoted to improving mine safety. Finally, the legislation establishes new scholarship and grant programs devoted to training individuals with respect to mine safety.”

Recommendations

All accidents are preventable; the Mexican mining industry has the capability to improve engineering, safety, training, and maintenance methods to reduce the number and severity of mining accidents.

Many factors contributed to the tragic loss of 65 miners in Pasta de Conchos. If we focus on the future and implement changes in regulations, mine safety trainings and practices, safety equipment, and response capability we will have taken major strides toward preventing such tragedies in the future.

The state and federal leaders and the leaders in the Mexican mining community have it within their power to prioritize and act on the recommendations offered. The keys to making dramatic progress are commitment, cooperation, and a willingness to make common sense changes to improve mine safety and to help the industry evolve and improve existing safety technology and the strategies to meet the challenge of Pasta de Conchos.

We believe in a constructive and collaborative approach, to help focus on what should be learned and done to address the largely systemic failures that contributed to the tragic loss of life at the Pasta de Conchos mine. We envision the possible need for additional state and/or federal legislation at some point in the near future, this report does call for new and improved mining laws.

It is suggested that the Engineering and Scientific Institutions in Mexico such as Coahuila State University, Guanajuato University, CINVESTAV, CONACYT, etc. could host an International Mining Health and Safety Symposium in 2008 to help stimulate adoption of improved technologies and equipment in Mexico's mines. The federal government could issue an emergency rule on methane detection, improved gas standards, communication, and other mine safety improvements. The federal government through the *Foro Consultivo de Ciencia y Tecnología* could appoint a scientific and labor management task force to assess the availability of new laws and technologies covered by the new rules.

At the national level, Senators and Representatives of Mexico could propose new laws to enhance coal mine safety and health, and urging lawmakers to strengthen oversight and enforcement of the current Mexican federal mine safety & health law, and define new norms that will require improvements in mine safety and equipment technology. The Department of Labor (STPS) could be allowed to halt production at mines whose owners ignore outstanding violations. The coal mine health and safety agencies in Coahuila State could establish and equip state-run mine rescue teams to enhance company-based systems.

Following are regulatory recommendations:

1. **Propose new coal mining law to improve safety and health, consistent with national expectations.**

   Suggested actions:

   The federal government
   - Publish an emergency norm on:
     - Methane detection,
     - Improved to the methodology for gas handling, and mine communications.

   Legislators at the national level
   - Propose new law to improve the safety in the coalmines
     - Provide underground coalminers with adequate self contained self rescuers SCSR adequate to the miners as well as additional SCSR stored in escape routes.
     - Require that computerized plans of the mine be updated constantly.
     - Require the formation of rescue teams that are near the mines.
     - Provide STPS with the authority to suspend the production of mines whose owners do not meet mine safety regulations.
   - Urgently reinforce the need to craft legislation that pursues safer mining practices in Mexico through better safety and hygiene
   - Define new norms that require improvements as far as the coal degassing, the technology of mine safety equipment
   - Improve mine rescue strategies as well as the ability to response capability.

   The organizations of the state of Coahuila related to the safety and hygiene in the Coalmines
   - Ask for a regulation to establish state rescue groups to provide a regional rapid response capability for mine rescue operations to augment the coalmining companies' response capabilities.
   - Pursue the establishment of mine safety training and qualification for miners
   - Pursue the design of emergency refuge shelters for use in underground coal mines, similar to those used in other coalmining countries.

   The federal and state governments:
   - Introduce legislation to improve degasification of coalmines
   - Promote and help form fast response capabilities for mine emergencies
   - Help foster the development of more reliable communications systems inside and outside the mines
   - Develop a reliable tracking systems to help locate miners in emergency situations

   All organizations
   - It is in the best interests for all to act cooperative and aggressively to prevent future tragedies like Pasta de Conchos. It is too late to prevent the Pasta de Conchos tragedy. There is enough information to see the need to improve many aspects of the mine safety and regulations and inspection.

- All organizations can find ways to better fulfill their responsibilities for mine safety.
- The roll of the mining industry, the Secretary of Labor, The Secretary of Economy, STPS, and the involved agencies of the state of Coahuila should be to correct the conditions within their areas of responsibility that failed to prevent such a disastrous event.

2. Urgent call to start developing the foundation of Mexico's national mine research institute

Suggested actions:

Government Agencies

- Direct the Scientific and Technological Consultative Forum to sponsor a scientific, technical and labor team to evaluate and provide advice on new laws, norms and technologies to improve mine safety.

- Formulate, a proposal to develop the foundation of Mexico's national mine research institute. The envisioned Institute will develop the know-how and state-of-the-art technologies to improve safety and health in the mining industry. It will also emphasize competitiveness, quality control, and safety through research, science and technology.

  - The institute will be dedicated to develop and investigate protocols and criteria to support and define rules and norms in the mining industry.
  - The Institute will be aimed to significantly improve safety and health in the mining industry worthy of Mexico.
  - The institute will research new methods and products coming from the mining industry, and will promote through the whole nation of Mexico, Science, Technology and Education in the Earth Science and Engineering sector such as, Mining Engineering, Metallurgy, Engineering Geology, Materials Science, Physics, etc.

3.- **Urgent call to improve safety technology through science and technology**

Suggested actions:

The Independent University of Coahuila and the Advanced Study and Research Center of the IPN, Unit Forecastle,

- Host an international symposium on the health and the safety of the mines in the 2007-2008, with the objective to stimulate the adoption of new technologies and safety equipment in the mines of Mexico.

- Improve safety technology through Mexico's state and federal government collaboration and support. This point calls as well for a full commitment from the mining industry to sustain this effort.

  - Improving mine degasification technology
  - Safety and Health training for the miners
  - Updating mine support methods
  - Strengthening underground gas sensors and warning systems
  - Engineering of Ventilation and power systems
  - Emergency communications and tracking
  - Sustainable mining activities in Mexico

APPENDIX A
Document and Photo List

Original File Name	Type of Document	Description
2.- seccion falla.ppt	Diagram	Topographical profile of section fails
3_seccion_falla.ppt	Diagram	Topographical profile of section fails
6.- PLANO GENERAL.ppt	Diagram	General diagram of the mine
7_plano_general.ppt	Diagram	General diagram of the mine
ENG Mesa Casual Analsys Results - translation.doc	Document	Translation of ENG Mesa Casual Analysis Results
Conchos Mine Prel.Hipot.-Template.doc	Documents	Conchos Mine Preliminary Recommendations by Dr. Antonio Nieto & Assoc
Fotos_NR_11jan2007.xls	Documents	Description of photos
NOM-023-STPS-2003 ver ingles.doc	Documents	Official Mexican Standard - Work in Mines - Occupational Health and Safety Conditions
Notes from Mondays meeting July 9 with Grupo Mexico.doc	Documents	Notes from Mondays meeting July 9 with Grupo Mexico.
review of week of 9 july2007 meetings.DOC	Documents	Jame Dukelow's notes from week of July 9, 2007
Scope of Foro Team Efforts.doc	Documents	Scope of forum team efforts
Structure of Expert Write.doc	Documents	Structure of Write-Up to determine if recovery efforts should continue.
Structure of Expert Write1.doc	Documents	Structure of Write-Up to determine current safety level
Value Mapping Exercise with Foro Team.xls	Documents	Value Mapping Exercise with Foro Team by Dukelow and Walters
10.- INCIDENTES DURANTE EL PERIODO DE RESCATE.ppt	Graph	Incidents During the Period of Rescue
11_incidentes_durante_el_periodo_de_rescate.ppt	Graph	Incidents During the Period of Rescue
LAB1.jpg	Lab Report	ROCA Lab - Bacteria analysis report - June 8, 2007
LAB1.jpg	Lab Report	ROCA Lab - Bacteria analysis report - June 8, 2007
LAB2.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - November 7, 2006
LAB2.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - November 7, 2006

LAB3.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - November 7, 2006
LAB3.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - November 7, 2006
LAB4.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - November 7, 2006
LAB4.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - November 7, 2006
LAB5.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - February 26, 2007
LAB5.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - February 26, 2007
LAB6.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - February 26, 2007
LAB6.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - February 26, 2007
LAB7.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - February 26, 2007
LAB7.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - February 26, 2007
LAB8.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - April 9, 2007
LAB8.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - April 9, 2007
LAB9.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - April 9, 2007
LAB9.jpg	Lab Report	LAANCICO Lab - Bacteria analysis report - April 9, 2007
Document.pdf	Letters	3/30/07 Letter from D.G Wooton to Senor Arturo Bermea Castro and attached evaluation report.
13.-COAL CONTOUR MAP.ppt	Maps	Mine Contour Map by Grupo Mexico / Structural Plane Area
1389_G14-A13_GM(NvaRosita).pdf	Maps	Geological map with legend-Nueva Rosita
1389_G14-A13_GM(NvaRosita).pdf	Maps	Geological map with legend-Nueva Rosita
14_coal_contour_map.ppt	Maps	Mine Contour Map by Grupo Mexico / Structural Plane Area
5.- Geologia Subcuenca de Sabinas.ppt	Maps	Geological maps and description of Subriver Basin of Sabinas
5.-Geolagia Subcuenca de Sabinas.ppt	Maps	Geological maps and description of Subriver Basin of Sabinas
COAL CONTOUR MAP.ppt	Maps	Mine Contour Map by Grupo Mexico / Structural Plane Area

G14-A12_GM-muzquiz.pdf	Maps	Geological map with legend-Melchor Muzquiz
G14-A12_GM-muzquiz.pdf	Maps	Geological map with legend-Melchor Muzquiz
Structure Contours and Video 2 of 2.png	Maps	Structure Contours and Downhole Videos
Sturcture Contours and Video 1 of 2.png	Maps	Structure Contours and Downhole Videos
DSCN0020.jpg	Photos	Hwy Photo taken from inside car w/ mountains in distance
DSCN0021.jpg	Photos	Roadside photo of field and hillside
DSCN0022.jpg	Photos	Roadside photo of field and hillside #2
DSCN0023.jpg	Photos	Mine Plant photo - Grupo Mexico logo on outside
DSCN0024.jpg	Photos	Mining site photo - Industrial buildings - taken across parking lot.
DSCN0025.jpg	Photos	Eagle or hawk soaring in sky
DSCN0026.jpg	Photos	Several fenced areas in field - pumps and ventilator incl. DG-2
DSCN0027.jpg	Photos	Pumping station DG-8
DSCN0028.jpg	Photos	Security Sign
DSCN0029.jpg	Photos	Pump Station DG-11
DSCN0030.jpg	Photos	Ventilator N-1(?)
DSCN0031.jpg	Photos	Fenced area with Extinguisher & Single Authorized Personnel signs posted
DSCN0032.jpg	Photos	Pump Station DG-4
DSCN0033.jpg	Photos	Ventilator T-3
DSCN0034.jpg	Photos	Ventilator with four 'Prohibited' signs posted
DSCN0035.jpg	Photos	Ventilator N-(?)
DSCN0036.jpg	Photos	Pump Station with structure in background
DSCN0037.jpg	Photos	Lady in vehicle wearing hard hat
DSCN0038.jpg	Photos	Stacked white bags in concrete building
DSCN0039.jpg	Photos	Conveyor belt going underground
DSCN0040.jpg	Photos	Rail tracks going underground
DSCN0041.jpg	Photos	Rail tracks above ground
DSCN0042.jpg	Photos	Mine shaft
DSCN0043.jpg	Photos	Motor for conveyor belt
DSCN0044.jpg	Photos	Close-up of conveyor belt
DSCN0045.jpg	Photos	Hotel pool
DSCN0046.jpg	Photos	Cactus in field
DSCN0047.jpg	Photos	Pump Station DG-11
DSCN0048.jpg	Photos	4 men meeting near white pickup
DSCN0049.jpg	Photos	Four 'Prohibited' signs on fence
DSCN0050.jpg	Photos	Group of people meeting on-site
DSCN0051.jpg	Photos	Metal roof on Ventilator N-1

DSCN0052.jpg	Photos	Ventilator T-3 (from end angle)
DSCN0053.jpg	Photos	Ventilator T-3 (from side angle)
DSCN0054.jpg	Photos	Pump Station DG-4 (from back)
DSCN0055.jpg	Photos	Pump Station DG-4 (from front)
DSCN0056.jpg	Photos	Security Sign on Pump Station
DSCN0057.jpg	Photos	Photo of 7/12/07 document on computer screen
DSCN0058.jpg	Photos	People in meeting room
1.- Plan Ventilacion.ppt	Plans	Simulation 2 Ventilators extracting T-1 like entrance
1_plan_ventilacion.ppt	Plans	Simulation 2 Ventilators extracting T-1 like entrance
4.- plan de emergencia.doc	Plans	Pasta de Conchos Emergency Plan
5_plan_de_emergencia.doc	Plans	Pasta de Conchos Emergency Plan
7.- SCAN LOGGS.ppt	Plans	Mine plans dated in the 1970's and 1980's
10_secuencia_de_actividades_de_rescate.xls	Plans/Table	Sequence of Activities for Rescue
9.- SECUENCIA DE ACTIVIDADES DE RESCATE.xls	Plans/Table	Sequence of Activities for Rescue
- ¡ MINEROS DEL MUNDO UNIOS ! -p.htm	Reference Articles	Internet article on the families anguish over the Pasta de Conchos accident.
A cien años de cananea.doc	Reference Articles	100 Years of Mining in Cananea
BBC Mundo Internacional Polonia operación de rescate en mina.htm	Reference Articles	Internet article on Polish Mine Accident
BBC Mundo Internacional Rusia rescate en las minas.htm	Reference Articles	Internet article on Russian Mine Accident
Cumplen 100 horas labores de rescate en mina - El Universal Online - Los Estados.htm	Reference Articles	Internet article on Pasta de Conchos Accident
DESLIZAMIENTO DEL CERRO EL TORO.doc	Reference Articles	Internet article on environmental contamination due to artisan (informal) mining practices
Diario EL PAIS - Montevideo - Uruguay.htm	Reference Articles	Internet article on Beijing, China mine accident
Dräger Safety Rescate en mina a cielo abierto.htm	Reference Articles	Dräger Safety site - mining rescue company.
Dräger Safety Rescate subterráneo.htm	Reference Articles	Dräger Safety site - Photos of mining safety equipment.
EL DERECHO DE VIGENCIA Y LA PENALIDAD.doc	Reference Articles	Investigation Blog - Right of Use - Annual concession payment
Federacion Venezolana de Rescate.htm	Reference Articles	Course rescue operation in mines
Porqué y cómo mata el capital.doc	Reference Articles	Article on methane in Russian mines
Reinician labores de rescate en mina México esmas.htm	Reference Articles	Article on reinstated work to recover corpses in Pasta de Conchos mine

11.- REPORTE DE INCIDENTES ESTRUCTURA	Reports	Reports of uncertain conditions of instability of the structure found in daily inspection in inner mine Conchos Pasta
12_reporte_de incidentes_estructura.xls	Reports	Reports of uncertain conditions of instability of the structure found in daily inspection in inner mine Conchos Pasta
2.- Estabilidad Mina Pasta de Conchos, 12 de Julio de 2007.ppt	Reports	General evaluation of the stability of rock, ceiling, and floors of the Pasta de Conchos mine
2_estabilidad_mina_pasta_de_ conchos_12_julio_2007.ppt	Reports	General evaluation of the stability of rock, ceiling, and floors of the Pasta de Conchos mine
3.- Muestreo de aire.xls	Reports	Air Sample test results
4_muestreo_de_aire.xls	Reports	Air sample test results
8.- Record de ventilacion.xls	Reports	Ventilation test results
9_record_de_ventilacion.xls	Reports	Ventilation test results
Dana Engineering Inc - James S Dukelow Report - 23aug2007rev.doc	Reports	Report of Current Safety Status of Pasta de Conchos Mine #8 by James Dukelow
Dana Engineering Inc - James S Dukelow Report.doc	Reports	Report of Current Safety Status of Pasta de Conchos Mine #8 by James Dukelow
Dana Engineering Inc - James S Dukelow Report.doc	Reports	Report of Current Safety Status of Pasta de Conchos Mine #8 by James Dukelow
Dana Engineering Inc - Stanley Duncan Report.doc	Reports	Report of Current Safety Status of Pasta de Conchos Mine #8 by Stanley Duncan
Dana Engineering Inc - Stanley Duncan Report.doc	Reports	Report of Current Safety Status of Pasta de Conchos Mine #8 by Stanley Duncan
Dante- REPORTE (INTERNO) DE LAS CONDICIONES DE LA MINA 8 DE PASTA DE CONCHOS.doc	Reports	Report on Internal conditions of mine 8 after site visit by Guillermo Dante Ramirez Rodriguez, Ph.D
Document.pdf	Reports	Report of Conditions and Risks at Pasta De Conchos Mine by Donald McBride
Kelvin Wu - First trip Report.doc	Reports	Report on Roof Control & Support, Water in the Mine, and Accident Records
Mario PdeC Report-2.doc	Reports	Ground Control and Structural Integrity Considerations - Includes some photos
Pasta de Conchos MMA Video Summary Report 8-23-07.pdf	Reports	Summary Report of Downhole Video Recording Services Performed at Conchos mine by Marshall Miller & Associates
SAR Water Comments from the First Trip 9-6-2007.doc	Reports	Report from Steven Richards to Antonio Nieto - comments on underground water after first trip July 8-15, 2007

SAR Water Comments from the Second Trip 9-6-2007.doc	Reports	Report from Steven Richards to Antonio Nieto - Water conditions Addendum after second trip Auguest 12-15, 2007
SD Memo,7.12.07.doc	Reports	Report from Stan Duncan to Antonio Neito regarding the mine inspection on July 11, 2007
Text by email Dr. Kelvin Wu.doc	Reports	Memo from Kelvin Wu to Antonio Neito regarding bore hole videos and conditions of the mine
Ventilation Comments 9-6-2007 Compressed - SAR.doc	Reports	Ventilation Review by Steven Richards 9-6-07
14.- MUESTREOAGUA.ppt	Reports/Diagram/Table	site of water sampling for the bacterialogico study / result of sampling of bacteriologico water study

APPENDIX B
Panel Participants

	Full Name	Organization/Company
1	Antonio Nieto	Virginia Tech,
2	Kelvin Wu,	Penn State Univ. former MSHA chief executive
3	Mario Karfakis	Virginia Tech, Mining& Minerals Eng. Department
4	Dennis Walters	Dana Eng.
5	James S. Dukelow	Dana Eng.
6	Stanley Duncan	Dana Engineering.
7	Dante Ramírez	Colorado School of Mines
8	María Esther Sánchez Castro	Centro de Investigación y Estudios Avanzados del IPN
9	Steve Richards	Carlson

TECHNICAL SUPPORT (MONITORS AND CAMERAS)

10	David Graf	American Mining Research (AMR)
11	Robert Saxton	American Mining Research (AMR)
12	Philip Waters	Marshall Miller & Associates, Inc.

REPRESENTATIVES OF THE MINERS

13	Francisco Javier Rivera	Mina 8 Unidad Pasta de Conchos
14	Gilberto Ríos Ramírez	Mina 8 Unidad Pasta de Conchos

FORO CONSULTIVO STAFF MEMBERS

15	José Luis Fernández Zayas	Coordinador General del Foro Consultivo Científico y Tecnológico
16	Patricia Zúñiga	Secretaria Técnica del Foro Consultivo Científico y Tecnológico
17	Daniel Lira Castro	Enlace

APPENDIX C
NOM–023–STPS-2003

LABOR AND SOCIAL WELFARE

OFFICIAL Mexican Standard NOM-023-STPS-2003, Work in mines – Occupational health and safety conditions.

At the margin a seal with the Mexican National emblem reading: United Mexican States. Secretary of Labor and Social Welfare.

CARLOS MARIA ABASCAL CARRANZA, Secretary of Labor and Social Welfare, based on Articles 16 and 40, Section I and XI of the Federal Organic Law of Public Administration; 512, 523 – Section I, 524, and 527 last paragraph of the Federal Labor Law; Art. 3 – Section XI, 38 – Section II, 40 – Section VII, 41, 43 – 47, and 52 of the Federal Law on Metrology and Standardization; 28 and 33 of the Regulation of the Federal Law on Metrology and Standardization; Art. 3, 4, 16, 150 to 154 Section VI of the Federal Regulation of Safety, Health, and Job Environment; 3, and 22 – Sections III, and XVII of the Internal Regulation of the Secretary of Labor and Social Welfare, and

CONSIDERING

That on the 21st of July of 1997, the Official Mexican Standard NOM-121-STPS-1996, Health and Safety for work performed in mines, was published in the **Official Daily of the Federation**;

That this Department under my responsibility based on the Fourth Transitional Article, first paragraph of the Federal Regulation of Safety, Health and Occupational Environment, published in the **Official Daily of the Federation** on the 21st of January of 1997, has considered it necessary to perform various modifications to the referred to Official Mexican Standard, for the purpose of bringing it into conformity with the provisions established in the aforementioned regulatory ordinance;

That on the 25th of June of 2002, in compliance to that detailed in Article 46, Section I of the Federal Law on Metrology and Standardization, the Secretary of Labor and Social Welfare presented before the National consultative Committee of Standardization of Safety, Health, and Work Environment, the Pre-project of Modification of the Official Mexican Standard NOM-121-STPS-1996, Health and Safety FOR WORK performed in mines, to remain as PROY-NOM-023-STPS-2003, Work in Mines – Occupational Health and Safety Conditions, and that on the 30th of July of the same year the aforementioned Committee considered it correct and granted that it be published as a Project in the **Official Daily of the Federation**;

That for the purpose of complying with the provision in Articles 69-E and 69-H of the Federal Law on Administrative Procedure, the corresponding pre-project was submitted to the consideration of the Federal Commission of Regulatory Improvement, which issued a favorable opinion on the same;

That within the review process of Official Mexican Standards in matters of safety, health, and work environment that the Secretary of Labor and Social Welfare performs, some of the Standards have been unified for their better comprehension because they contain related elements, that by reducing their number, the code numbers corresponding to the Standards that are cancelled become available to be assigned to other new Standards or revisions of existing Standards, by which in order to maintain the continuity of the code numbers of the Official Mexican Standards in this material, the code for this Standard becomes NOM-023-STPS-2003;

That on the 19th of February of 2003, in compliance with the Agreement of the Committee and of the provision in Article 47 Section I of the Federal Law on Metrology and Standardization, the Project of Modification of this Official Mexican Standard was published in the **Official Daily of the Federation**, so that within the 50 calendar days following the aforementioned publication, the interested parties might present their comments to the National Committee of Standardization of Occupational Health and Safety;

That after having received comments from one party to this Project of the Official Mexican Standard, the National Consultative Committee of Standardization of Occupational Safety and Health, in compliance to that detailed in Article 47, Section III of the Federal Law on Metrology and Standardization, proceeded to study and issue the respective responses which were published in the **Official Daily of the Federation** on the 11th of July of 2003.

That in attention to the latter considerations and once the National Committee of Standardization of Occupational Health and Safety granted approval, the following is issued:

OFFICIAL MEXICAN STANDARD NOM-023-STPS-2003, WORK IN MINES – OCCUPATIONAL HEALTH AND SAFETY CONDITIONS

INDEX

1. Objective

This Official Mexican Standard has the objective of establishing the minimum occupational health and safety requirements for preventing risks to workers that perform activities in mines and damages to the installations in the workplace.

2. Field of application

2.1 This Official Mexican Standard regulates in all the national territory and applies in all the workplaces in which activities related to exploration, exploration, exploitation, and extraction of materials located in veins, strata,

gaseous masses, or beds, whether underground or on the surface, independently of the type and scale of the workplace in question.

2.2 The workplaces in which activities are performed related to the exploration and exploitation are exempted from compliance to this Standard, for obtaining principal products such as:

a) petroleum;

b) natural gas as a main product;

c) radioactive minerals;

d) substances contained in suspension or dissolution in subterranean waters or injected into the subsoil.

3. References

For the correct application of this Standard, the following Official Mexican Standards must be consulted:

NOM-001-SEDE-1999, Electrical installations (utilization).

NOM-001-STPS-1999, Buildings, locales, installations, and areas in the workplace – Health and Safety conditions.

NOM-002-STPS-2000, Safety conditions - Prevention, protection and fighting of fires in the workplace.

NOM-004-STPS-1999, Systems of protection and devices of safety in the machinery and equipment that is utilized in the workplace.

NOM-006-STPS-2000, Handling and storage of materials – Conditions and safety procedures.

NOM-010-STPS-1999, Health and Safety conditions in the workplaces where chemical substances capable of generating contamination in the work environment are handled, transported, processed, or stored.

NOM-011-STPS-2001, Health and Safety conditions in the workplaces where noise is generated.

NOM-017-STPS-2001, Personal protective equipment – Selection, use, and handling in the workplace.

NOM-019-STPS-1993, Constitution and operation of the Health and Safety commissions in the workplace.

NOM-020-STPS-2002, Containers subject to pressure and boilers – Operation – Safety conditions.

NOM-021-STPS-1993, Related to the requirements and characteristics of the reports of occupational accidents that occur, in order to integrate the statistics.

NOM-022-STPS-1999, Static electricity in the workplace – Health and safety conditions.

NOM-025-STPS-1999, Conditions of illumination in the workplace.

NOM-026-STPS-1998, Health and safety colors and signs, and identification of risks from fluids conducted in pipelines.

NOM-027-STPS-2000, Welding and cutting – Health and safety conditions.

4. Definitions

For the purposes of this Standard the following definitions are established:

4.1 Hazardous activities: are all those tasks derived from the work processes that generate unsafe conditions and overexposure of the workers to physical, chemical, or biological agents capable of causing damage to health or the workplace.

4.2 Support: is the type of roof and wall support of a gallery or other mining operation through any system of support or anchoring.

4.3 Probe: is the action of probing the walls, roof, and facing to knock down rocks or pieces of coal that are not well adhered with an iron bar and that can represent a risk to personnel.

4.4 Angle of repose of material: is the angle that permits the stability of the strata or piles of material.

4.5 Cofferdam; watertight enclosure: is a conduit for conducting water.

4.6 Work bank: is the stratum or cap of great thickness of mineral delimited above and below by different materials.

4.7 Borehole: are the perforations where charges of explosives are placed for the dislodging of material.

4.8 Pocketed borehole: are the explosive charges that after a detonation did not cause the dislodging of material and only caused a small cavity in the interior of the borehole.

4.9 Unexploded boreholes: are the charges of explosives not activated after a blast.

4.10 Beneficiation: are the tasks for the preparation, selection, treatment, refining, or first smelting of the materials extracted from the mines, for the purpose of separating them or raising their concentration or purity.

4.11 Lift; cage: is an elevator that serves for the vertical transport of workers and materials.

4.12 Emergency case: is the possible occurrence of fires, explosions, spills, floods, intoxications, and collapses.

4.13 Ceiling of the gallery: is the upper part of the gallery of a mine.

4.14 Discharge; blast: is the effect of the activation o fan explosive charge.

4.15 Cable ladder; steps: are two parallel cables with metal or wooden separators, utilized as steps.

4.16 Slag heap: is the dumping place for the materials product of the excavation in a mine.

4.17 Exploration: are the works and tasks performed for identifying deposits of materials and quantifying and evaluating their contents.

4.18 Explosives permissible for coal mines: are those explosive whose characteristic is the generation of a short flame.

4.19 Exploitation: are the Works and tasks designated for the preparation, development, detaching, and extraction of materials in a mine.

4.20 Fortification: is the reinforcement of roof, floor, and walls of a mining work through any system of structural support.

4.21 Heading: is the exposed wall of the gallery on which the loosening of the mineral is performed.

4.22 Long Heading: is the exposed FACE of variable length on which is performed the loosening of material that is delimited by two adjacent Works or galleries.

4.23 Gallery: is a path that is made in the underground mines for the extraction of minerals, ventilation, communication, or removal of water.

4.24 Grade: is a step or rung.

4.25 Winch: is equipment that using one or several steel cables permits the movement of pails, carts, and calashes for transporting materials, equipment, and workers.

4.26 Mine: is an excavation performed by jeans of wells and galleries or an open pit for extracting minerals.

4.27 Blaster; Borer: is the worker qualified and authorized by the employer for the use of explosives.

4.28 Occupationally exposed workers: are the workers that because of their occupational activities are found in a work environment in which a risk of major impact is present or that work in a hazardous activity.

4.29 Powdering: is the action of aspersing inert powder in roof, walls, and floor for neutralizing the coal dust.

4.30 Scrap pit: engineering work for the storage or final disposition of scrap material, whose construction and operation occur simultaneously.

4.31 Safety procedures: are the written instructions for performing a series of activities with the least risk for the workers and the workplace.

4.32 Undercut: is a subterranean mining excavation whether above or below the level of a gallery.

4.33 Lifesaving respirator: is a personal protective respiratory equipment, that consists of an air supply tank and complete face mask, designed for escaping from unbreakable atmospheres, to places with safe environments for health.

4.34 Major impact risks: are those related to the instability and the deformations of the wells, galleries, and headings of exploitation, taluses, and platforms of open cut mines, and slag heaps; the work of probing; the movement and use of explosives; the asphyxiating, toxic, flammable, and explosive gases and powders; the

floods; those derived from the operation of motorized winches, locomotives, and extraction and loading machinery, and the activities of welding and cutting.

4.35 Preventive Services of Occupational Health and Safety: is a multidisciplinary group of specialists, invested with essentially preventive functions, those responsibility for advising the employer, workers, and their representatives, in their compliance to the standards of safety, health, and work environment.

4.36 Welding and cutting: are those activities that consist of the heating of materials and the coalescence located of them for the increase of their temperature for its union, with or without application of pressure, and with or without employment of contributing material.

4.37 Open cut mine: is an open pit mining work for exploiting diverse minerals.

4.38 Chair lift: is a system of transport of workers through an endless cable, with hanging seats.

4.39 Shaft: is the conduit of a vertical or inclined mining work, where activities of ascent and descent of workers, materials, and equipment are performed.

4.40 Receiving hopper: is a deposit of large dimensions, for containing and regulating the flow of the materials.

4.41 Unit of verification: is the individual or company accredited and approved Under the terms of the Federal La won Metrology and Standardization, for verifying the degree of compliance of this Standard.

4.42 Mining unit: is one or more mines operated Under a single technical and administrative office; includes the beneficiation plants, slag pits, roads, and other installations.

4.43 Blast: is the action of blasting the work heading of the mine with explosives.

4.44 Secondary blasts: are the discharges that are performed for breaking rocks that are too large, for their movement or for removing obstructions of blockages in the hoppers.

5. Obligations of the employer

5.1 To show the labor authority, when requested, the documents that this Standard obliges him to create or possess.

5.2 Have the analysis of potential risks, according to that established in Chapter 7 of this Standard.

5.3 Inform all the workers in writing of the risks to which they are exposed, at the beginning of activities and, at least once per year.

5.4 Have a plan of attention to emergencies, available for consultation and application, according to that established in Chapter 8 of this Standard.

5.5 Comply with the health and safety conditions established in Appendix B in open pit mines; those of appendices C to M in underground mines and those of appendices C to O in underground coal mines, of this Standard.

5.6 Have the health and safety procedures referred to in Chapter 9 and with those that apply from Appendix B in open pit mines; those of the Appendices C to M in underground mines, and those of Appendices C to O in underground coal mines of this Standard.

5.7 Comply with that established in Chapter 10 of this Standard for the beneficiation plants.

5.8 Comply with that established in the Official Mexican Standard in matters of occupational health, safety, and environment issued by the Secretary of Labor and Social Welfare for all other installations of the mining unit, such as offices, personnel services, shops, and warehouses among others.

5.9 Provide qualification to all the workers involved, according to their activities, under the health and safety conditions, and procedures established in clauses 5.5, 5.6, and 10.2 of this Standard.

5.10 Authorize in writing only the qualified workers, in the respective procedures, in order to operate and give maintenance to locomotives, machinery, vehicles, and motorized winches, and to those that store, transport, or use explosives.

5.11 Have extinguishers that comply with that established in clause 5.5 of NOM-002-STPS-2000.

5.12 Comply for the handling of materials, according to that established in NOM-006-STPS-2000.

5.13 Provide workers with the personal protective equipment, according to the results of the analysis of potential risks, and to that established in NOM-017-STPS-2001, for utilizing it during the performance of their normal and emergency activities.

5.14 Have Health and Safety Commissions, according to that established in NOM-019-STPS-1993.

5.15 Give notice to the Secretary of Labor and Social Welfare of the occupational accidents occurred, in conformity to that established in NOM-021-STPS-1993 and comply with that established in Chapter 11 of this Standard.

5.16 Evaluate the conditions of illumination according to that established in Chapters 8, 9, and 10; Appendices A and B of NOM-025-STPS-1999, and comply with the limits established in Appendix J of this Standard.

5.17 Comply with that established in NOM-026-STPS-1998, for all the signs and the identification of pipelines.

5.18 Comply with that established in NOM-027-STPS-2000, resides that stipulated specifically for underground coal mines in Appendix O of this Standard, when heating, welding, or cutting activities are performed.

5.19 Comply with that established in NOM-020-STPS-2002, for the containers subject to pressure and generators of steam or boilers

5.20 Perform the oversight to the health of personnel occupationally exposed to physical and chemical agents, in conformity to the contents of the medical examination established in the Official Mexican Standards that are issued by the Secretary of Health for that purpose. In the case of the non-existence of Standards from the Secretary of Health, the doctor of the company will determine the contents of the medical examinations, their schedule, and the measures of oversight to health.

5.21 Prevent minors of 16 years of age and pregnant women from laboring in the interior of a subterranean mine or in the heading work o fan open pit mine.

5.22 Have the Preventive Services of Occupational Health and Safety according to that established in the Official Mexican Standards that the Secretary of Labor and Social Welfare issues for that purpose and comply with the provision in Appendix A of this Standard.

6. Obligations of the workers

6.1 Comply with the health and safety procedures established by the employer.

6.2 Participate in the qualification and training provided by the employer.

6.3 Comply with the instructions for the use of the personal protective equipment.

6.4 Utilize the safety devices installed in machines, tools, installations, and structures; abstaining from connecting, disconnecting, changing, or withdrawing, in an arbitrary manner, these devices.

6.5 Operate and give maintenance to the machinery, locomotives, vehicles, and motorized winches and transport, use, or store explosives, only when they have specific qualification for it and written authorization from the employer.

6.6 Be responsible for their integrity and health, as well as that of third parties that can be affected by their acts or omissions.

6.7 Advise immediately their supervisor or the personnel of Preventive Services of Occupational Health and Safety, of any situation of imminent risk that by themselves they cannot correct and only continue their activities when the situation has been corrected.

6.8 Render help for the time that is required in case of emergency or any situation of imminent risk.

6.9 Participate in the evacuation drills and in the practices of attention to emergencies established in Chapter 8 of this Standard, when it is required of them.

6.10 Submit themselves to the medical examinations required according to their activities and provide truthfully the reports requested by the doctor that performs the examination.

6.11 The pregnant women must notify the employer of their condition, attaching the pertinent medical documentation for complying to that established in clause 5.21 of this Standard.

7. Analysis of potential risks

7.1 The analysis of potential risks must be permanently updated, available in written for consultation of the Occupationally exposed personnel, and signed by the employer and by the Preventive Services of Occupational Health and Safety.

7.2 Before performing any change that modifies the planned work area, for the processes of exploration, extraction, drilling, fortification, systems of ventilations, or any other change that can alter the health and safety conditions and procedures referred to in Clauses 5.5, 5.6, 10.2 of this Standard, the analysis of potential risks must be reviewed. Changes must only be authorized when they do not increase risks to workers or the workplace, in which case the analysis of potential risks and the health and safety procedures and conditions must be updated.

7.3 The analysis of potential risks must be performed by areas, processes, and activities, in all mines and must contain at least:

a) the analysis of the work areas.

b) the identification of the occupationally exposed workers and of the activities of their job positions, Under normal conditions as well as emergency conditions;

c) the identification of the risks of major impact, their type of risk (to health, flammability, and explosively) and the hazardous activities to which the workers are exposed, taking into consideration, at least, the health and safety procedures established in Chapter 9 and in the applicable appendices of this Standard, besides the following:

1) the provisions to consider in the plan of attention to emergencies;

2) the possible impact, for which the magnitude of the damages that can occur to the worker or the workplace must be evaluated, and the number of workers that can be affected. The cases in which the exposure exceeds the physical capacity of the worker for chronic or acute effects must be considered;

3) the probability of occurrence, taking as a reference the statistics of risks that occurred in that workplace or in other workplaces with similar characteristics, depending on the health and safety conditions, for which is assigned a potential risk, the number of events per unit of time that can occur. This result must be combined with the comparative analysis that, when applicable, is made of the evaluation of hazardous activities against their corresponding maximum permissible limits;

Note: If the results of the evaluation are above the aforementioned limits, immediate measures of prevention and control must be established, modifying the health and safety conditions or procedures, the personal protective equipment or the qualification and, when applicable, apply the plan of attention to emergencies;

d) hierarchization of the risks depending on their probability of occurrence and impact;

e) the proposal for occupational health and safety conditions and procedures to implement, for the control o the risks detected.

8. Plan of attention to emergencies

8.1 For the purpose of being able to act opportunely on the risks that are identified in the analysis of potential risks, each mining unit must have a plan of attention to emergencies that comply with that established in this Chapter, approved and signed by the employer and by the Preventive Services of Occupational Health and Safety.

8.2 Describe the anti-fire equipment, of adequate type and capacity, the machinery as well as the areas that require it.

8.3 Establish the integrating of one or more brigades (squads) for combating fires, rescue and lifesaving, evacuating and first aid..

8.4 In the plan of attention to emergencies, for each mine, it must:

8.4.1 Detail the personnel that integrates the brigades, the same that must be qualified based on an annual program of qualification, at least, in the procedures established in clause 8.4.8 of this Standard.

8.4.2 Indicate that the brigades must have personal protective equipment, FIRE fighting equipment, rescue, lifesaving, and first aid equipment (including first aid kits) for performing their tasks and receiving training in their use, through the drills and practices of attention to emergencies.

8.4.3 Detail that the equipment must be located, marked with signs, and defined according to the results of the analysis of potential risks, and submitted to maintenance alter having been utilized, according to that established in the occupational health and safety standards that has been issued by the Secretary of Labor and Social Welfare. The location of the equipment must be reviewed by the brigades at least once a month.

8.4.4 Detail that the members of the brigades must submit themselves, at lest, to an annual medical examination, the content of which must be determined by the doctor of the company.

8.4.5 Indicate that in each mining unit there must be a person responsible for coordinating the activities of all the brigades that preferably have a certificate of occupational competence.

8.4.6 Establish the performance, once a year, o fan evacuation drill to a safe place, in conformity to the procedures established in clause 8.4.8 of this Standard and with the participation of all the workers. The brigades must perform, at least, a practice of attention to emergencies every three months including, at a minimum, fires, floods, leaks and escape of gases. The results of all the drills and practices must be recorded, and the documentation kept for at least two years.

8.4.7 Indicate that there must be an alarm system, that contains a specific code known to all the workers, for the purpose of living notice of evacuation in case of emergency, and with a capacity that guarantees that all workers found in the mine may be alerted.

8.4.8 Have the following procedures:

a) specific procedures for the fighting of fires, rescue and lifesaving, evacuation and first aid, including operations and responsibilities of the brigade members, and that consist of:

1) in matters of first aid, it is established that the care of the injured worker must continue until he receives the required medical attention, and that the administration of medications can be granted only Under medical prescription and oversight

2) in matters of rescue and lifesaving, the evaluation of the affected areas is established before acting;

b) coordination of the brigades;

c) control of access to the mine so that:

1) at any moment the names of all the workers that are found in the interior of the mine can be known;

2) access to the mines is for authorized workers and access only is permitted to visitors to the interior of the mine, when they are accompanied by authorized workers;

3) in the underground mines, besides the personal protective equipment provided to the workers as a result of the analysis of potential risks, before entering the mine each worker is provided with a safety lamp with batteries of a minimum duration, at least, of 1.25 times the shift of the worker;

4) in cases of grave and imminent risk activities are suspended partially or totally unit the situation has been controlled;

d) when returning to the workplace, it is specified that the return of workers to work only Hill be permitted, once the brigade members and the personnel of the Preventive Services of Occupational Health and Safety have evaluated that the mine has health and safety conditions, and living notice that the emergency has been controlled.

8.4.9 Describe the following information for the brigades:

a) the inventory and location of the equipment available for attending to emergencies;

b) the location of the operations centers and of help for emergency cases.

9. Health and safety procedures

9.1 These procedures must be established in writing, in Spanish, be authorized and signed by the employer and the Preventive Services of Occupational Health and Safety. They must contain the instructions for preventing the exposure to agents that can cause occupational accidents and illnesses, according to the process that applies for:

a) installation, operation, inspection, tests, maintenance, and trials of equipment, machinery, systems and structures, including the activities, their Schedule, and records;

b) inspection of the abandoned mines before reinitiating activities, including:

1) oxygen contents;

2) toxic, biological-infectious, and flammable substances, and substances explosive in the air;

3) structural resistance and support conditions of the open pit mine and the land;

4) accumulation of water;

5) noxious or hazardous fauna.

9.2 In the health and safety procedures the following must be taken into consideration, at least:

a) the qualification of the workers;

b) the health and safety conditions;

c) the oversight to the health of the workers;

d) the administrative control measures, such as the administration of time and frequencies of work;

e) the results of the analysis of potential risks established in Chapter 7 of this Standard

10. Beneficiation plants

10.1 The beneficiation plants must be adjusted to the compliance of the conditions established in the Official Mexican Standard in matter of occupational health, safety, and environment, that apply in that which refers to:

a) locales and installations;

b) prevention of fires;

c) machinery and equipment;

d) storage, transport, and handling of flammable, combustible, irritating, and toxic substances;

e) handling of materials;

f) contamination in the work environment, by chemical substances;

g) noise;

h) thermal conditions;

i) Preventive services of Occupational Health and Safety;

j) personal protective equipment;

k) identification and communication of risks from chemical substances and fluids conducted in pipes;

l) health and safety commissions on the job;

m) reports of accidents;

n) static electricity;

o) illumination;

p) welding and cutting;

q) safety colors and signs;

r) containers subject to pressure and boilers.

10.2 The health and safety procedures for the activities that are performed in the beneficiation plants, must be Developer taking into consideration that established in Chapter 9 of this Standard, including at least, the processes of:

a) crushing;

b) preparation of reactive substances;

c) grinding and yield extraction;

d) filtering;

e) scrap pits;

f) processes of leaching.

11. Occupational accidents and illnesses

There must be procedures for:

a) record keeping;

b) perform and investigation for the purpose of determining their causes;

c) study the manner of avoiding repetition;

d) propose measures of control and follow up the measures approved by the employer until their implementation (including chronogram of activities and those responsible for their compliance).

12. Procedures of evaluation of the conformity

12.1 Article 73 of the Federal La won Metrology and Standardization and Article 80 of its Regulation specify that the appropriate departments will establish the procedures for the evaluation of the conformity to the Official Mexican Standards, and permit that said procedures contained in the same Official Mexican Standard, for which for the purposes of this Standard, the labor authority as well as the private organs called Units of Verification, must verify, for evaluating the conformity of the compliance to this Standard, as it corresponds in the clauses of Chapter 5 and all other clauses or chapters that are referenced.

12.2 The employer can contract, in order to have results with official recognition, a Unit of Verification, accredited and approved Under the terms of the Federal La won Metrology and Standardization for verifying the degree of compliance to this Standard, essentially in clauses 5.2 to 5.22.

12.3 The Units of Verification that participate, at the request of the party, for verifying the degree of compliance to this Standard, must deliver to the employer their documents and reports of the results, that Hill contain, at least, the following:

a) data of the workplace verified:

1) name, company name or corporate status;

2) complete address;

b) data of the Unit of Verification:

1) name, company name, or corporate status;

2) complete address;

3) approval number granted by the Secretary of Labor and Social Welfare;

4) consecutive number of identification of the official report;

5) date of verification;

6) code and name of the Standard verified;

7) results of the verification;

8) place and date in which the official report is issued;

9) name and signature of the legal representative;

10) effective period of the report.

12.4 The effective period of the official report issued by the Unit of Verification will be two years, while the same conditions that served as reference for its issuing are maintained.

12.5 The evaluation of the conformity will be verified by the Units of Verification through physical and documentary proof, and when necessary through interrogation of the workers, the representatives of the Preventive Services of Occupational Health and Safety, the representative of the employer, the members of the Health and Safety Commission, as required in the provisions that are verified.

12.6 The Units of Verification can orient the employer for his compliance to the provisions that apply to him.

12.7 The Units of Verification must not perform the following activities for the company evaluated:

a) monitoring, studies, manuals, or procedures;

b) create plans or documents for complying with the documentary conditions established in the Standard;

c) provide qualification to the workers.

APPENDIX A

FUNCIONES DE LOS SERVICIOS PREVENTIVOS DE SEGURIDAD E HIGIENE EN EL TRABAJO

A.1 Create the Occupational health and safety program that gives compliance to that established in this Standard and plan, organize, direct, control, and record its implementation.

A.2 Establish the frequency, procedures, and inspection records on the advancement of compliance to the occupational health and safety program.

A.3 Perform at least every six months audits of the compliance to the occupational health and safety program, and report in writing the results to the employer and the workers, or their representatives.

A.4 Supervise so that there are health and safety conditions and that all the workers comply with the procedures that are established in this area.

A.5 Establish immediate measures of prevention, protection, and control when a grave and imminent risk is detected.

A.6 Perform the investigation of occupational accidents and illnesses according to that established in Chapter 11 of this Standard.

A.7 Review, and when applicable, correct and sign the approval of :

a) plans and studies;

b) analysis of potential risks;

c) plan of attention to emergencies;

d) health and safety procedures;

e) health and safety conditions;

f) the report of the inspection of abandoned mines before resuming activities;

g) the performance, termination, or cancellation of the activities of welding and cutting in coal mines.

A.8 Establish in the mines, programs for inspection, tests, and maintenance of:

a) the structural systems;

b) the systems of ventilation;

c) the installations and the equipment for prevention and protection from fires and falling material;

d) the electrical and pneumatic systems;

e) the illumination systems;

f) the personal protective equipment for the conservation of hearing.

A.9 Record the results of:

a) the daily measuring of concentrations of methane;

b) the control of dust;

c) the movement of workers;

d) the movement of materials.

APPENDIX B

OPEN PIT MINES

B.1 Health and Safety conditions.

B.1.1 In the mines in which nocturnal activities are performed, an emergency lighting system must be installed that functions automatically when there is a failure in the supply of electrical energy, covering, at least, the evacuation route and the areas where the lack of Light can generate risks to the workers.

B.1.2 The excavations must be performed in work headings that present instable banks, with an inclination not greater than that recommended by the study of soil mechanics.

B.1.3 The work banks for the excavation must not exceed the following heights:

a) 3 meters in the manual excavation work banks of unconsolidated or loose material, product o fan explosion;

b) 8 meters in other manual excavation work banks;

c) in mechanized mines, the height must be determined by jeans o fan engineering study, taking into account the nature of the terrain, and type of machinery utilized, in which are established the specific safety conditions and procedures for the case.

B.1.4 When the Works in any of the banks of a sand mine are interrupted, for a period greater than a week, the slopes must be brought down to the angle of repose of the material, for which the width of the grades must be Such that permits this operation.

B.1.5 Establish and place signs for the maximum velocity of circulation of vehicles.

APPENDIX C

PLANS, STUDIES, AND SUPPORTS

C.1 Safety conditions.

C.1.1 Plans. There must be permanent plans of the open pit mines and exploitations, created in Spanish, updated, approved, and signed by the employer, as well as by the personnel of the Preventive Services of Occupational Health and Safety, taking into consideration the compliance to the health and safety procedures and conditions, all those that correspond for each type of mine and be available for consultation by the occupationally exposed personnel. For the underground mines, the plans must contain at a minimum the following information:

a) vertical sections, they must show the shafts, crossways, galleries, gearings of exploration and exploitation, undercuts, packing, and other underground miming works; furthermore, they must show the profile of the surface, including the fills, sinkholes, and any other known deposit of water;

b) permanent or provisional underground mine Works, Such as shafts, crossways, galleries, faces of exploration and exploitation, cofferdams, pumping stations, and winch machines;

c) ventilation, showing the velocity and the direction of the air; the location of the equipment, pipes, sluice gates, and elements required for the characteristics of the mine, including the points of interconnection with other mines;

d) electrical installation, showing the diagrams of connection and charging panels, whether of surface or underground installation, their physical location, the wiring voltage, and the electrical equipment;

e) system of anti-fire protection, rescue, and lifesaving, first aid, and personal protective equipment for cases of emergency, showing it physical location and the applicable diagrams of installation and control.

C.1.2 Studies. The preliminary studies and their updates must be approved and signed by the employer and by the Preventive Services of Occupational Health and Safety, in order to establish the health and safety procedures and conditions, with the following minimum contents:

a) geologic, mechanical studies of soil and rocks, for locating geological faults and establishing the procedures of excavation and fortification;

b) hydro geologic, in order to evaluate the risks of flooding, including procedures for their control.

C.1.3 Criteria of design and selection of the support and the materials to employ, taking into consideration the plans and studies.

C.2 Safety procedures.

C.2.1 For the performance of activities of installation of supports and contents, scheduling, and recording of the inspections of the same, it must be considered, at least, the form of identifying geological faults, defects, changes of soil, or rock, and their possible risks of failure.

C.2.2 For establishing the precautions necessary in sites where the plans and studies determine the existent of geological faults or defects Such as blockages, petrified trees, or excessive humidity.

APPENDIX D

VENTILATION

D.1 Health and safety conditions.

D.1.1 A volume o fair equal to 1.5 cubic meters per minute per worker must be supplied to the interior of the mine; for each mule or horse 3 cubic meters o fair per minute, and each horsepower of diesel combustion motor driven machinery located in the interior of the mine, 2.13 cubic meters o fair per minute must be supplied.

D.1.2 When any heading, gallery, or well, machinery is operated by combustion diesel motors, a minimum velocity of air of 15.24 meters/minute must be maintained.

D.1.3 In the headings, galleries, or crossways under construction where it is necessary to use pipes for achieving the required ventilation, the end must not be more than 30 meters from the limit of the excavation heading.

D.1.4 Emergency ventilation pipes must be installed with a perforated valve at the foot of the development of wells, chambers, or countershafts, that permit a continuous discharge of compressed air. The end of the pipe must be at least five meters from the cover, which must be supervised daily. When these activities are performed the place must be ventilated for at least 10 minutes before entering the work.

D.1.5 The principal ventilators can only be installed in the interior of the mines, when the following requirements are complied with:

a) the clean air that enters the mine is not mixed with the contaminated air leaving the mine;

b) the sites where they are installed must be maintained free of combustible materials.

D.1.6 If the mine can have contaminants or flammable or explosive gases, there must be auxiliary ventilators or ventilators of intensification of current.

D.2 Health and Safety Procedure.

D.2.1 In the case of ventilation being stopped for a duration greater than 10 minutes, in places where the material can generate toxic, flammable or explosive gases, it must be reported immediately to the Preventive Services of Occupational Health and Safety, in order to adopt the measures necessary for conserving the safety of the workers.

APPENDIX E

PREVENTION Y PROTECTION FROM FIRE

E.1 Health and Safety conditions.

E.1.1 The curbs of wells, extraction towers, stations or shaft vents, patios, galleries, and extraction faces, must be maintained free from flammable wastes.

E.1.2 The support and the extraction towers of the principal shafts must be constructed from non-combustible materials. In the existing shafts with wooden supports, sprinkler systems of water or of another non-toxic substance, or another non-asphyxiating substance that extinguishes fire and that can be operated from the exterior of the mine.

E.1.3 There must be lifesaving respirators that guarantee the movement of all workers until their exit from the mine.

E.1.4 There must be appropriate extinguishers, portable or movable, buckets of sand, or inert powder, as determined applicable, distributed strategically in:

a) the sites where fuel or flammable materials are stored;

b) the principal systems of distribution of electrical energy;

c) the extraction towers of the shafts and, in general, in the accesses to the mine;

d) the stationary installations.

E.1.5 The material of the bases and supports of the electrical motors, of transformers, or of any other electrical equipment, as well as the locales where they are installed must be of non-combustible materials.

E.1.6 In the interior shops, machine rooms, and electrical substations in a mine, the oils and grease must be stored in fireproof containers or metal containers, and only in quantities limited for a weeks consumption; the wastes of this grease and oil must be accumulated in closed containers, and be evacuated according to the established procedure and not exceed one week.

E.1.7 Signs must be posted that prohibit smoking and using equipment or devices with an open flame, in places where fuel is stored or distributed.

E.2 Health and Safety Procedures.

E.2.1 Health and safety procedures must exist for the inspection and maintenance of the anti-fire systems and equipment, according to a program that is developed for that purpose.

E.2.2 Procedures must exist for verifying the good condition of the lifesaving respirators, according to the inspection program, that is developed for that purpose.

APPENDIX F

MOVEMENT AND HANDLING OF EXPLOSIVES IN UNDERGROUND MINES, IN OPEN IT MINES, AND COAL MINES

F.1 Health and Safety procedures.

F.2 There must be health and safety procedures for the movement into and out the interior of the underground and coal mines, that at least include the instructions in order to comply with:

a) moving them separately from the workers and other materials;

b) being moved the explosives and their fuses separately;

c) moving them under the direct supervision of a worker qualified and authorized by the employer.

F.3 There must exist health and safety procedures for the handling of explosives in the interior of the coal and underground mines, at least, that include the instructions for:

a) the blaster of the supervisor of the area requesting daily in writing the quantity required for the shift;

b) If at the end of the shift there are explosives not utilized, they are to be returned to the magazine, attaching a document of transfer of the materials signed by the blaster or by the supervisor of the area;

c) access only being permitted to the borehole loading site to the blaster and his assistant;

d) before initiating the connection of the detonators, the blaster delimits the danger zone and has guards at the access points;

e) before proceeding with the blast, the blaster verifies that there are not workers in the danger zone;

f) the blaster inspecting the site of the blast after the smoke and toxic gases have dissipated (taking special care when there exists the possibility of nitrous oxide, sulfuric anhydride, or carbon monoxide being released or produced) and dispersed, at least:

1) 10 minutes in underground coal mines and secondary blasts in underground mines;

2) 30 minutes in all other blasts in underground mines.

g) no worker can enter the site where the blast was performed, until the blaster has verified that:

1) there are no unexploded boreholes (if boreholes of this type are found, they must be discharged again or washed personally by the blaster);

2) that the walls, floor, and roof are secure.

h) discharges are not performed if their vertical projection is at least 30 meters from surface installation or of an open pit mine, if precautions for evacuating all the workers to the surface have not been taken.

F.4 Procedures for the movement and handling of explosives in open pit mines.

F.4.1 For the movement of explosives into and out of the mine, the procedures, at least must include the instructions to comply with:

a) to move them separated from their fuses;

b) to move them separated from their fuses;

c) to move them under the direct supervision of a worker qualified and authorized by the employer.

F.4.2 Furthermore for the handling of explosives in open pit mines, the procedures must include, at least, instructions for:

a) before carrying out a discharge, verifying that an alarm has been activated with a scope greater than 500 meters from the site where it is executed, for the purpose of warning of the danger to any person in that area. This alarm must sound continuously, at least, 10 minutes before initiating the discharge and 10 minutes after the last borehole has been discharged;

b) before proceeding with the blast, the blaster verifies that there are no workers in the danger zone;

c) the blaster inspects the site of the discharge after it has dissipated, at least 30 minutes and the dust cloud has dissipated;

d) the workers cannot enter the site where the blast was discharged, unit the blaster has verified that:

1) there are no unexplored boreholes (if boreholes of this type are found, they must discharged again or washed personally by the blaster);

2) that the pit and the land are secured;

i) blasts are executed in a radius garter than 60 meters from installation or underground mines, if beforehand precautions have been taken for evacuating all the workers

F.5 For the use of explosives in coal mines, additionally, the following must be complied with:

a) explosives and fuses only permitted in coal mines are utilized;

b) not making a simultaneous discharge of more than 12 boreholes;

c) the boreholes must be struck with wooden utensils;

d) in straight headings, the blaster and the workers must be located at least, 150 meters from the place of the discharge and, at least, 100 meters from other headings.

APPENDIX G

EXCAVATION

G.1 There must be health and safety procedures that consider, at least,

a) the machinery to be utilized;

b) the characteristics of the materials of excavation and fill;

c) that the excavations can connect to a source of water or saturated material;

d) that when the exploitation is performed on a system of continuous extraction there is a type of support specific to the particular characteristics of the block of exploitation, that provides sufficient space for operating the roof support equipment with safety, the equipment for knocking down materials and transporting materials, that includes besides the verification that the pressure from earth that may exist on the support, produce forces lower than the resistance to the pressure that permit establishing anticipating the conditions and the procedures for the installation and dismantling of the equipment;

e) not withdraw any fortification of the galleries, wells, or any other type of tunnel or underground cavity, unless the cavity is filled immediately after withdrawal of said fortifications.

APPENDIX H

MOVEMENT OF MATERIALS

H.1 Health and safety conditions.

H.1.1 The conveyor belts must have:

a) emergency breaking cable the whole length of the belts;

b) passage areas of bridges in the personnel crossing zones;

c) safety protection in the motor and terminal poles of the unit.

H.1.2 The motorized vehicles for carrying materials must comply with the safety requirements established in NOM-004-STPS-1999 and NOM-006-STPS-2000.

H.2 Health and safety procedures.

H.2.1 There must be a procedure for carrying materials that considers at least:

a) the equipment to utilize;

b) the materials to be carried;

c) the loading and unloading of materials;

d) the systems of signals to the operator;

e) the maximum velocity permitted, including their signs;

f) the instructions of circulation.

APPENDIX I

MOVEMENT OF WORKERS

I.1 Health and safety conditions.

I.1.1 The workers only can be transported in vehicles designs for this purpose or in loading vehicles without materials, that have safety devices that permit the workers to secure themselves and that are platforms with lateral protection or boxes that do not have voltage mechanisms.

I.1.2 When chair lifts are utilized for the movement of workers the following safety measures must be adopted:

a) the cable employed must be the type that does not require lubrication;

b) the stations for ascending and descending must be ample, be marked with signs, and with flat non-skid steps.

I.1.3 The belts for moving workers must be equipped with ascent and descent stations, must operate at a speed lower or equal to 2 meters/second, and must have an emergency stopping system the whole length of the trajectory.

I.1.4 The cages for moving the workers must comply with:

a) have a roof of resistant metal laminate;

b) be lined with metal laminate to a height of, at least, 1.5 meters from the floor. The remaining part to the roof with metal mesh;

c) have bars or handrails that the workers can hold on to;

d) have doors that can be secured during the movement of the cage for avoiding them opening during shaking or impacts;

e) having a minimum free height of 2.10 meters (does not apply in underground coal mines).

I.1.5 In the winches the following must be complied with:

a) have signs that restrict the entry to the winch control room;

b) be provided with a depth indicator and a bell that functions on the arrival to each station, that is seen and heard easily by the operator, and have depth markers on the drum of the cable. When they employ pulleys of adherence it must be verified and, if it is necessary, to correct each time that the route is adjusted, or the cable changed, or tied;

c) the winches that the drums can disengage must have a system that avoids disengaging the drum without activating completely the brakes and that impedes the release, when the mechanism is no applied completely. The controls for engaging the clutch and disengaging the clutch must be protected permanently to avoid the accidental activation;

d) the winches with velocity greater than 4 meters/second must have an automatic velocity control, that breaks it before the cages exceed the upper or lower station, and that impede the cage arriving at the lower or upper station with a velocity greater than 1.5 meters/second;

e) the drums for the coiling of the cable must be provided with rims or arms, and that in the case of conical drums, they must have guides or other devices that impede the slipping of the cable;

f) the end of the cable must remain solidly secured to the drum and must remain always on it, at least, 3 turns when the cage or calash is found at the deepest end of the shaft;

g) the diameter of the drums for winding the cable must be, at least, 30 times the diameter of the cable;

h) when holding or friction pulleys are employed, their diameter and their guide must be specific to the type and diameter of the cable employed, but their diameter must not be less than 30 times the diameter of the cable;

i) the brakes of a winch employed for the ascent and descent of workers, must have two independent systems of brakes that act on the drum and pulley or on the axis, capable of stopping the cage at a slowed rhythm, not greater than 5 meters/second, nor at the maximum acceleration that the winch can produce when it holds the maximum load, activate automatically if the motor power fails, or diminishes the pressure of the braking system, and that in case of the failure of one of the systems, the braking capacity of the other system remains available for being able to control the cage;

j) the cages supported by a single cable or with a single point of union of the cable}, must have a braking system that acts on the guides automatically in case of rupture of the cable or its union.

I.2 Health and safety procedures.

I.2.1 The safety procedures must consider, at least, that:

a) at the beginning of each shift and after each stop for repairs, the empty cage must be moved the length of the shaft, for the purpose of assuring that no obstacles or defects exist in its operation;

b) the descent or ascent of material simultaneously with the workers in the same floor of a cage is not permitted;

c) in the case of doubt of any signal, the operator does not place the winch into movement until receiving a new signal;

d) if water exists at the base of a shaft, it is anchored at the height not greater than 1 meter below the last station or service window;

e) the operator of the winch before abandoning the controls applies the brakes, cuts the electrical power, and takes the precautions necessary for preventing another worker not authorized from starting the winch ;

f) the inspections and tests are made by workers qualified and authorized by the employer, in maximum periods of:

1) one day: for the visual inspection of the cables, chains, peaces of connection, and supports of the cables, and the safety devices that avoid the free fall of the calash or carts, in case of rupture of the cable;

2) one week: for the visual inspection of the exterior elements of the machines, the extracting tower, the calashes, and other elements required in these shafts;

3) two weeks: for the visual inspection of the support system and the walls of the shafts;

4) one month: for the inspection of the motors, brakes, clutches, and the testing of the safety devices that avoid the fall of the calashes or carts in case of rupture of the cable;

g) the inspections, tests, and maintenance of the shafts, winches, cables, cages, carts, tailings pails, safety devices, and other accessories, signed by the Preventive Services of Occupational Health and Safety and by the worker authorized for performing the corresponding inspection, review, test, or maintenance are recorded;

h) in winches of two points that do not raise or lower workers with the drum or pulley disengaged, except in the maintenance and emergency tasks, provided that they are not loaded with materials;

i) at least every 6 months the points of the cables are cut in a minimum length of 2 meters in the parts where they are secured to the drum and to the cages, or when the program of inspections and tests determine it.

APPENDIX J

INSTALLATIONS

J.1 Health and safety conditions.

J.1.1 the access in the shafts must be protected with doors or bars.

J.1.2 the shafts for access and exit of the workers must have emergency escape stairs .

J.1.3 If cavities or sinkholes form in the surface, they must remain protected and signs placed for the purpose of avoiding the fall of workers, vehicles, and materials .

J.1.4 have protection and signs and wells, or secondary wells, and in any other type of opening that presents a danger for the workers .

J.1.5 The tunnels that are not designated for the movement of workers must have signs and barriers or devices that prevent passage.

J.1.6 All the curbs of wells and wells must have warning signs and protection for preventing the accidental fall of workers, or that workers enter into contact with any movable part of the system of ventilation. The doors must be provided with safety devices for avoiding them opening involuntarily.

J.1.7 In the extraction towers of the shafts, stations, or vents of the shafts, winch rooms, stations for ascent and descent of workers, motor units of the transporters for movement of materials, electrical substations, pumping stations, and general unloading hoppers, as web as another stationary installations provided with machinery, must have an illumination of, at least, 200 luxes and 50 luxes in the areas of movement of workers of these installations.

J.1.8 there must not be any exterior installation at least 20 meters from the shaft.

J.1.9 Have a regular tunnel or well of access and exit from the mine and other works independent and marked with signs for emergency exits .

J.1.10 In undercuts, in exploitation there must be two access routes connected to each other .

J.1.11 The galleries for hauling by means of gondolas on tracks must have a width that leaves on each side of the road, at least, 75 centimeters free between the wall or the support, and any other projection from the gondolas or the locomotive or have safety niches each 30 meters, marked with signs, and of dimensions sufficient for sheltering at least, two persons.

J.1.12 In the galleries where a conveyor belt is installed, there must be left, at least, 60 centimeters free between a side of the conveyor and the wall or support; if it requires the normal circulation of workers, the minimum free space must be of, at least, 90 centimeters in the side designated for this circulation.

J.1.13 The free space between the highest point of the prism of the material of a conveyor belt and the lower part of the support, must be at least 20 centimeters.

J.1.14 The stairs must comply with the following safety conditions:

a) their holders must be independent of the extraction shaft, but in case they are in the same web, they must be separated by means of wood or of another resistant material;

b) have rest platforms at least every 6 meters of height;

c) have the dimensions necessary so that a man carrying the rescue equipment of a greater size than is required in the mine, can move freely;

d) extends over, at least, 90 centimeters of the upper platform or have a handrail that extends over at this same height;

e) maintain a minimum distance of 15 centimeters free between the interior limit of the step, and any other part extending from the wall, support, or installation;

f) if the steps have a high greater than 2.5 meters, must provide continue support to the back of the worker at no more that 70 centimeters of the step, measured transversally to the step ;

g) the steps of cable in the works at depths of wells must comply with:

1) not have lengths greater than 15 meters;

2) be provided with skids that separate them, at least, 10 centimeters from the walls or supports;

h) they must be inspected for at least once a month, and must have a maintenance for guaranteeing that they always are in safe conditions of use.

APPENDIX K

ELECTRICAL INSTALLATIONS

K.1 Health and safety conditions.

K.1.1 There must not be temporary electrical installations.

K.1.2 The electrical motors of the equipment controlled at the distance must have safety switches with signs and located within the reach of the workers that work with this equipment. These switches must avoid the motor starting up until the switch has been manually closed.

K.1.3 The substations and areas of distribution boxes, and transformers must be protected and marked with signs to warn of the danger and restrict access.

K.1.4 In the substations the following must be complied with:

a) be located in ventilated sites;

b) be at the distance not less than 50 meters from any explosives storage;

c) have protection devices against overcharges or any other failure, in each circuit derived from low tension;

d) be connected to ground according to that established in the NOM-022-STPS-1999, in the metal parts that protect the equipment and the structures that contain it;

e) have at least one type ABC extinguisher.

K.1.5 The locales designated for the installation of banks of batteries, with electrolyte solutions must be ventilated, and must be marked with signs, and smoking prohibited in their interior or the use of any other instrument of open flame, or that cause sparks, and sources of heat.

K.1.6 The transformers must be protected, identified, and marked with signs, or within rooms designated for this purpose, according to that established in NOM-001-SEDE-1999.

K.1.7 The movable or portable machinery activated by electrical energy transmitted from an external source, must comply with the following:

a) the movable supply cables must be flexible, for rough use, and be secured firmly to the machinery to avoid damaging their terminals or accidental disconnection they must be laid out in a way that they are not excessively tensed and in flooded zones are located on supports to avid getting them wet;

b) the cable not utilized must be rolled in mounted carts above the machine, and if there are additional extensions they must be maintained in containers designed for them;

c) in direct current circuits for power supply to locomotives and other equipment, the return line to ground must have its connections welded, and be of the caliber necessary for avoiding stray currents, and electrifying water pipes, and compressed air pipes ;

d) the outlets of cables with tension of 440 volts or greater, must be installed in distribution boxes on metal poles, in the galleries, or in the headings, and must not be located in the extraction towers, in the stations, or vents, or the length of the shaft well.

K.1.8 The telephone and signal systems must be installed independently from the systems of power and lighting, protected against the possibility of entering into contact with lines from other systems.

K.2 Health and safety procedures. Health and safety procedures applicable to the activities of inspection, repair, and maintenance of the installations and electrical equipment must exist for:

a) cutting the current, opening, and blocking the circuit breaker for working, and it can only be closed by the same worker that blocked it;

b) avoid the discharge of a possible residual tension;

c) prevent the use of a tension circuit in places where there are explosives, liquids, or flammable gases, unless it is indispensable, in which case, besides using the personal protective equipment, an insulated tool is utilized, and there must be authorization in writing and the supervision necessary to perform the tasks without accidents.

APPENDIX L

VEHICLES

L.1 Health and safety conditions in trains:

a) the locomotives that are utilized in the interior of a mine must be provided with a front beacon light, whose effective reach is at least 60 meters;

b) all the trains pulled by locomotives must carry a luminous signal or reflecting signal in the rear part of the last cart or gondola;

c) the carts or gondolas not in service must be broken and blocked;

d) when trolley type locomotives are employed they must have the following safety measures:

1) the contact lines of a trolley must be provided with protection from over tension;

2) the supply lines must have switches or cut off switches in all the supply lines from the different branches;

3) the minimum height of the trolley lines must be of 2.15 meters above the rail, or above the floor when there is no rail, or have protection to avoid their contact with workers;

4) the free distance between the lines of the trolley and the roof, walls, or projections from the supports must be at least 15 centimeters;

5) have protections of insulating material for avoiding the trolley lines from making contact with the equipment in the cross ways, in hoppers, and lunch boxes in work areas and in dinning rooms;

e) the trains, and the excavating machines mounted on rails or other type of guides must be operated or moved if the good state of the route or guide has not been verified;

f) the locomotive batteries only must be stored and substituted in the loading stations conditioned for this purpose.

L.2 safety conditions in motors of internal combustion:

a) the internal combustion motors that are utilized for activating equipment or machinery in the underground mines, must be diesel motors of the compression-ignition type, designed with a catalytic converter and for operating only with diesel fuel;

b)the diesel fuel utilized must not contain more than 1.5% of sulfur by weight;

c) in the places where diesel combustion motors are operated, there must be evaluations of concentration of exhaust gases performed, at least once a month, when there is the suspicion of malfunctioning, after each mayor

maintenance or tune-up, and at the maximum distance of 30 centimeters from the exhaust pipe, in such a way that the concentration of gases does not exceed the following limits in volume:

1) carbon monoxide: 0.25%;

2) nitrogen dioxide: 0.10%;

3) sulfur dioxide: 0.10%;

4) aldehides: 0.001%;

d) the fuel storage stations must be located outside of the mine at the distance of at least 50 meters, or comply with::

1) be equipped with provisioning systems that avoid the spiel of the fuel and with a collection system;

2) be surrounded by a border so that in the case of a spelt of fuel, the extending of the fuel into other areas is avoided;

3) the quantity of fuel stored must not exceed the consumption of 72 hours;

4) introduce the fuel to the underground mines in metal barrels, in wagons with hermetic containers or in pipes;

e) when a vehicle run by combustion motors presents anomalies during operation, additional noise in the motor, emissions of smoke in an excessive form, the motor must be stocked immediately and withdrawn from service .

APPENDIX M

FLOORS AND ROADS

M.1 Health and safety conditions in floors.

M.1.1 In the areas where workers of vehicles have transited, the floors must remain free of material wastes an other objects that can cause an accident.

M.2 Health and safety conditions in roads.

M.2.2 The roads must comply the following:

a) have a width at least 60 centimeters greater than the greatest width of the vehicles that transit each road;

b) have a height of at least 20 centimeters higher than the greatest height of the vehicles that transit each road, but never less than 2 meters;

c) have widened areas sufficient for the crossing and passing of vehicles, located or marked with signs, in a way that they are visible from both directions;

d) have watertight enclosures where stagnant water may be present;

e) the ramps must have a maximum incline of 27.5%. If the ramp ends in a dumping site as a well or hopper the maximum incline must be of 12%.

APPENDIX N

UNDERGROUND COAL MINES

N.1 For the prevention and protection against fires the following must be complied with:

a) Place signs prohibiting the introduction to the mines of matches cigarettes, lighters, and equipment with open flame;

b) have a procedure for executing automatic dusting during the operation of the coal cutting machinery, with inert powder on ceiling, floors, and walls, that considers at least:

1) the type of aspiring instruments utilized;

2) the type of devices for capturing, suppression, and prevention of coal dusts;

c) prevent the combustion of coal dust in the sites where blasts are going to be made by means of sprinkling of inert powder, ventilation, or humidification;

d) store inert powder in dry places and at least 50 meters from any access tunnel.

N.2 The methane content fans in the atmosphere must not exceed 1.5% in volume.

N.3 A procedure for measuring methane gas in the atmosphere must be applied that complies with the following:

a) be made in the following places and time frames with the indicated equipment:

1) daily in all work headings, with portable methanometers;

2) continuous , in the diesel machinery and coal cutting machinery, while it is in operation, with portable methanometers installed and connected to the machinery;

3) continuous, in the currents of ventilation, generals, and principal returns with stationary methanometers;

Note: the methanometers must have a precision of ±0.2%, or better.

b) use in the daily evaluations and in the continue evaluations, methanometers that have annual certificates of calibration, according to the established in the Federal Law of Metrology and Standardization, and monthly maintenance must be given to them;

c) comply in the measurement with the portable methanometers with:

1) inspect daily that the battery charge is within the operating range of the equipment;

2) adjust them to zero in the exterior of the mine;

3) take the measurements at no more than 1 meter from the heading, or more then 30 centimeters from the roof;

4) record the measurements and points in which they were made, and the adjustments and activities of maintenance of the equipment;

5) have the written procedure of the operation of the methanometer, in Spanish, and in agreement with the instructions of the manufacturer;

6) that it is performed, preferably, by the members of the Preventive Services of Occupational Health and Safety, qualified for the operation;

d) evacuate the workers, move them to a circuit of clean air, and give compliance to the plan of attention to emergencies, when concentrations of methane are greater than 1.5% in volume.

N.4 the coal cutting machinery must have:

a) a device of automatic interruption of the electrical energy, when percentages are detected of methane greater than 1.5% in volume;

b) a system of irrigation of water, in advance of the cutting machinery.

N.5 The machinery run on diesel motors must have an audible alarm within the reach of the operator that warns him to suspend the operation of the equipment, or deactivated automatically, when percentages of methane greater then 1.5% in volume are detected.

N.6 The machines of continuous excavation that discharge on a conveyor belt must have their controls connected with those of the transport system, in a way that they can operate if the transport of the material is interrupted.

N.7 The hitching or unhitching stations, with exception of those of the heading being pulling down, must have an illumination at least of 200 luxes..

N.8 The vehicles run by diesel fuel motors, when they are out of service, must be parked outside the mine, of in places that have two exits, that are constructed with non-flammable material and ventilated in a way that the polluted as passes directly to an air return.

N.9 Ventilation:

a) Measurements must be made with a maximum frequency per shift, daily , or weekly, according to that information established in the corresponding procedures, noting the information in a log. The measurements will consist of the volume of the air of entry and exit, temperature, or relative humidity, and percentage of methane in the air, in each district of ventilation;

b) the principal ventilators must be installed in the exterior of the mine and must have at least a secondary ventilator, run on an energy source independent from that which supplies the principal ventilator, the ventilators can only be installed in the interior of the mines if run by electric energy, and comply with the following:

1) the motor is tested for explosivity;

2) that the base and the ventilation pipe are of non-combustible of flame retardant materials;

3) it is installed in a way that air recirculation does not exist;

4) that has safety devices that interrupt their operation when registering a percentage of methane above 1.5% in volume, if it is of suctioning type;

5) that have a manometer of capacity greater than the limit of operation of the ventilator and with an automatic alarm device that warns, in case of the ventilator stops;

6) that the electrical circuits are independent from other circuits;

c) before turning on an auxiliary ventilator or when an interruption of a ventilator exists during 5 minutes or more, the concentration of methane gas must be determined. If the concentration is greater of equal to 1.5% in volume, it must be reduced to a level lower than the aforementioned 1.5%, applying a procedure that complies:

1) evacuation from the workers in the area;

2) closing of the sluice gates of the pipe;

3) opening of the vents of the sluice gates of the pipe;

4) gradual opening of the sluice gates of the pipe;

5) gradual closing of vents, when diluting the percentage of methane below of 1.5%;

d) to avoid the entry and the exit of air from a circuit that mixes them, the doors must be installed in a way that close by themselves;

e) the curtains, skirts, elbows, and plugs must be of self-extinguishing or fire retardant materials;

f) in the cases in which galleries are created of single work, the pipe for the ventilation must be of sufficient and adequate capacity for assuring that the air arrives to the limit of the gallery;

g) the maximum distance between crossways in the creation of galleries must be determined by:

1) the capacity of ventilation for maintaining the percentage of methane within the established limits;

2) the capacity for support in the creation of the gallery;

3) the exploitation of large headings;

h) the operation of the principal ventilators must not be stopped without a written of the Preventive Services of Occupational health and Safety, and without having evacuated the workers. If the ventilators were without movement, no worker must be permitted to enter the mine until after they have been activated, and the Preventive Services of Occupational Health and Safety necessary, have been applied for to make sure that the atmosphere of the mine does not offer danger;

i) the control of the air volume must be done by means of covers, doors, and regulators of variable areas, this depends on the volume that is necessary to distribute, that which in all cases will be regulated by the personnel responsible for ventilation;

j) the bridges for conducting of the air must be constructed with non-combustible materials;

k) the areas that are not in exploitation must be sealed with explosion or fire proof covers, of non-combustible materials: In the sealed area, one or more of the covers must have devices that permit determining the nature of the gases and their reassure, through the necessary and duly calibrated apparatuses;

l) when the emissions of methane gas are of such magnitude that the air in the circuits of ventilation is insufficient for diluting the concentrations to less than 1.5%, alternate systems of control of gas can be utilized, provided that they have the following requirements:

1) the contents of methane in the conducting lines must not be lower than 30%;

2) there must be a permanent monitoring of methane;

3) when concentrations lower than 30% are detected, the operation of the degasification system must be immediately suspended until reaching this percentage;

4) when in the system a secondary pipe connected to the principal pipe is utilized, there must be measuring points and control points of methane in each one of them;

5) the discharge point of methane gas in the exterior of the mine must have a perimeter protection connected to ground, and with a safety device that prevents the backward movement of flame.

N.10 Coal dust. The following must be complied with:

a) during cutting water under pressure must be utilized;

b) in the area of discharge of material, there must be dust collectors or other measures for reducing the dispersion of coal dust from the source;

c) the electrical motors and switches must be constructed tested for explosivity;

d) the equipment must be maintained free of accumulation of coal dust;

e) perform permanent measurements that permit guaranteeing that the limits established in NOM-010-STPS-1999 are not exceeded.

N.11 For electrical installations:

a) only the use of safety lamps with locks are permitted;

b) the conductors and the electrical equipment must be inspected monthly, and a report must be created indicating the conditions that are found;

c) the electrical equipment that is installed in places exposed to explosive atmospheres must be explosion tested, according to that established in NOM-001-SEDE-1999;

d) the portable equipment with electrical supply that exceeds 440 volts, must have a system of continuous monitoring equipped with automatic cutting devices when there is a failure of ground;

e) the equipment, materials, and devices of electrical protection must be specific to the voltage that is utilized;

f) the construction of the substations of transformers must be made with non-combustible materials;

g) the transformers must be specific for the interior of coal mines;

h) the stations of battery charging must be of non-combustible materials or fire tested and with a self-ventilation circuit, for avoiding the return air passing through the workplaces;

i) during their charging, the batteries must be maintained open for permitting that the hydrogen generated be carried by the air of circulation;

j) the electrical conductors, the unions between the same, and other accessories must be explosivity tested;

k) the electrical equipment that is installed farthest from the last open crossing must comply with the characteristics for their installation in places exposed to explosive atmospheres;

l) the circuits for telephones or low voltage signs must be installed on the same side (same wall) in which are located other conductors of electrical power, When these cables are introduced in the mine by a borehole, the cables of communications, and those of power must be separated, and within metal covers connected to ground;

m) the electrical cables used for connecting portable equipment must be flexible, of flame resistant type, be insulated, and be of the caliber adequate for preventing damages by overheating; furthermore, they must be protected against short circuit in the point of connection to the power circuit.

N.12 In the inactive work sites and the abandoned works must have the corresponding plans, including the location of the covers, and the gases control devices.

APPENDIX O

CUTTING AND WELDING IN UNDERGROUND COAL MINES

O.1 All the welding or cutting activities performed in the interior of coalmines must comply with the provision in the NOM-027-STPS-2000 and with that established in this Appendix.

O.2 In the activities of welding or cutting with gas, liquid petroleum gas must be utilized.

O.3 Create in writing a request for authorization for performing the activity that has all the requirements established in Model 0.1 according to the following procedure:

a) the worker responsible for the activity must fill the sections 1, 2, and 3, at section 4, obtain the authorizations corresponding to section 5, attach other recommendations, and deliver copies with all the signatures of those responsible for their authorization;

b) before initiating the activity, the worker responsible for the same must verify that all the applicable conditions are complied with and record it in a verification list, including the personal protective equipment, after analysis of the specific risk;

c) when finishing or canceling the activity, the worker responsible for it must assure that the area has been abundantly covered with water, that the welding machine is moved outside the mine, process the signatures of authorization of section 6, and give copies to those responsible for the authorization according that established in section 7.

O.4 The conditions of the place where the activity will be performed must comply with the follow:

a) that the contents of methane do not exceed 0.5% in volume. This implies the evaluation of the area before and during the performance of the activity, in conformity with the procedures established in Chapter 9 of this Standard;

b)cover abundantly with water the floor, roof, and walls of the area where the activity will be performed;

c) cover a radius, minimum, of 10 meters from the place of activity with inert powder;

d) have two extinguishers of type ABC dry chemical powder and with a reserve of at least 5 sacks of inert powder;

e) the machinery, equipment, or installations to repair must be cleaned beforehand to avoid the accumulation of coal dust or grease;

f) that there are neither lubricants nor flammable substances near the activity;

g) in the area or district of the mine where the activity is carried out, only the personnel involved and the supervision personnel should remain;

h) the Preventive Services of Occupational Health and Safety and those responsible for maintenance, of ventilation, and of the area, must supervise the activity and remain in the place at least 30 minutes after their termination for verifying that no risks derived from the activity remain.

O.5 The Preventive Services of Occupational Health and Safety must analyze the results of the activity and determine if the conditions, procedures, and recommendations provide sufficient security to the workers and, when applicable propose the modifications to the employer.

MODELO O.1

AUTHORIZATION FOR HEATING, WELDING, OR CUTTING ACTIVITIES IN COAL MINES

1) AUTHORIZATION FOR HEATING, WELDING, OR CUTTING ACTIVITIES IN COAL MINES					
MINE:					CONSECUTIVE NUMBER:
2) REQUEST					
REQUESTED BY:		EFFECTIVE PERIOD. NOTE: BEGINNING AND TERMINATION DATE AND TIME			
POSITION:					
DATE AND SIGNATURE:					
AREA/ EQUIPMENT/ INSTALLATIONS		DESCRIPTION OF WORK			
3) COMPLEMENTARY PERMITS		DESCRIPTION OF COMPLEMENTARY PERMITS			
ELECTRICAL INSULATION					
MOVEMENT OF EQUIPMENT:					
OTHERS:					
4) PROCEDIMIENTOS DE SEGURIDAD					
ANEXOS:					
5) AUTHORIZATION OF THOSE RESPONSIBLE FOR PREFENTIVE SERVICES OF OCCUPATIONAL HEALTH AND SAFETY, AREA OF MAINTENANCE AND VENTILATION					
AFTER INSPECTING THE EQUIPMENT AND THE WORK AREA, DETERMINATION THAT THE WORK CAN BE PERFORMED UNDER SAFE CONDITIONS					
NOTE BEGINNING DATES AND TIMES					
SIGNATURE: DATE: TIME:					
6) CANCELLATION OR TERMINATION					
SIGN AND WRITE YOUR NAME AND DATE OF THE CANCELLATION OR TERMINATION					
7) DISTRIBUTION OF COPIES					
APPLICANT	PREVENTIVE SERVICES OF OCCUPATIONAL HEALTH AND SAFETY	PARTY RESPONSIBLE FOR THE AREA	PARTY RESPONSIBLE FOR MAINTENANCE	PARTY RESPONSIBLE FOR VENTILATION	MINE MANAGER

13. Oversight

The oversight to the compliance of this Standard is the responsibility of the Secretary of Labor and Social Welfare.

14. Concordance with international Standards

No concordance exists with any international standard at the moment of its creation.

15. Bibliography

a) Repertoire of practical recommendations on health and safety in open pit mines, International Labor Organization, 1991.

b) Repertoire of practical recommendations on health and safety in coal mines, International Labor Organization, 1986.

c) Support systems of mining work in the mines of Micare and Mimosa. Grupo Acerero del Norte, 1995.

d) Training manual in control of roofs, Grupo Acerero del Norte, 1995.

e) Federal Regulation of Occupational Health and Safety, 1997.

TRANSITORY ARTICLES

FIRST.- This Official Mexican Standard becomes effective 180 calendar days following its publication in the **Official Daily of the Federation**.

SECOND.- During the lapse stipulated in the alter article, the employers will comply with the Official Mexican Standard NOM-121-STPS-1996, Health and Safety for the tasks performed in mines, or the adaptations for observing the provisions in the Official Mexican Standard will be performed, and in this last case, the labor authorities will provide at the request of interested employers, advise and orientation for implementing their compliance, without the employers being liable to sanctions for the non-compliance to the Standard in effect..

THIRD.- When This Official Mexican Standard becomes effective, the Official Mexican Standard NOM-121-STPS-1996, Health and Safety for the tasks that are performed in mines published in the **Official Daily of the Federation** on the 21st of July of 1997 remains cancelled.

México, Federal District, on the 28th day of the month of July of 2003. The Secretary of Labor and Social Welfare, **Carlos María Abascal Carranza**.- Signed.

APPENDIX D
Video Equipment and Analysis

Summary of Equipment Specifications

Vehicle

Mfg: Ford
Model: Excursion
Year: 2002
Engine: 200 hp, V-8, Gasoline
Transmission: Automatic
Traction: 4 x 4 on demand
Modifications:

- Enhanced clearance
- Power take-off
- Inverter
- Skid Plates
- Substantial Front Bumper
- Video Technician Work Bench
- Stiffened Bed for Winch and Boom Attachments

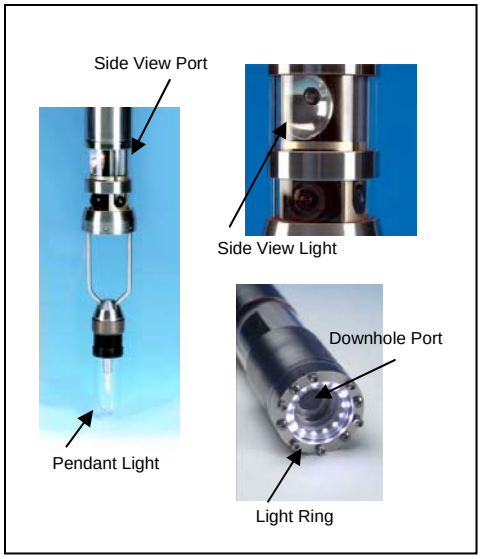
Hoist

Mfg: CCV
Drive: Hydraulic
Spooling Capacity: 5,000-ft Coaxial
Controls: Hydraulic

Video Camera Features

- *Type*: Single Lens, 3.5-inch, Dual View
- *Mfg*: BT 9600 single lens color TV camera
- Sealed camera housing (submersible)
- 360-degree side view rotation
- Ifs and metric distance log
- Variable light intensity

- Horizontal resolution of 480 TV lines horizontal
- Hermetically sealed
- Charged with up to 10 psi of nitrogen gas
- 2.3 mm lens
- maximum field of view of 94 degrees
- Stainless steel water tight underwater housing
- Weight less than 19 lbs
- FSK/digital control technology
- Internal diagnostic check system
- Centralizer spring set
- 10 inch lighthead with 100W halogen bulb
- Minimum illumination of 2 lux



Video Capture

Images recorded through DVD, VHR and on to TV monitor. Geophysical data recorded on to computer hard drive and on to thermal printer.

Travel Route

Total one-way distance traveled: 1,370 miles

Summary of Events

Friday, July 27, 2007		Presentation and verbal acceptance of terms of engagement
Thursday, August 9, 2007		Coal company clearances received
Friday, August 10, 2007		Retainer received
		Finalize documentation/trip planning
	12:00 PM	Depart Lexington, KY
	8:00 PM	Arrive Memphis, TN (450 miles)
Saturday, August 11, 2007	7:30 AM	Leave Memphis, TN
	11:30 AM	Lunch Little Rock, AK
	5:30 PM	Arrive Waco, TX
Sunday, August 12, 2007	6:00 AM	Leave Waco, TX
	12:30 PM	Lunch Eagle Pass, TX
		Communications with Daniel Lira
		Arrange meeting 9:30am next day
Monday, August 13, 2007	8:20 AM	Meet at hotel Eagle Pass, TX
	9:00 AM – 3:00 PM	Process through VDL

	6:30 PM	Leave Piedras Negras
	9:00 PM	Nueva Rosita
Tuesday, August 14, 2007	9:00 AM - 9:00 PM	Video capture 7 boreholes
		Post-video conference
Wednesday, August 15, 2007	8:00 AM - 9:00 PM	Video capture 8 boreholes
	9:00 PM – 10:00 PM	Post video conference
Thursday, August 16, 2007	8-9:30am	Nueva Rosita to Piedras Negras
	9:30-11:00 AM	Wait Time
	11-2:00 PM	Process across border
	2 – 5:00 PM	Eagle Pass, TX to San Antonio, TX
Friday, August 17, 2007	3:00 AM – midnight	San Antonio, TX to Lexington KY

Summary of Borehole Video Recording Events

Day 1 August 14, 2007

(all depths recorded in meters and taken from ground level)

Borehole ID	Video Casing	Top Mine Void[1]	Top Video[2] Void	Video Total Depth/ Void Height	Comments
DG-5 – *Video 1* 11:00 AM – 1:00 PM	115.7	135.0	136.0	137.4 1.4	Dry open entry. Hole offset.
DG-7 - *Video 2* 1:15 – 2:00 PM	138.6	138.6	138.6	141.0 2.4	Dry open mine. Conveyor belt.
C-6 - *Video 3* 2:40 – 3:15 PM	119.4	136.0		124.5	Hole collapsed. Condensation.
C-5 - *Video 4* 3:25 – 4:15 PM	126.8	135.0	136.0	138.5 2.5	Open void – dry Debris – rock.
M-7 - *Video 5* 4:30 – 5:00 PM	6.0	138.0		86.4	Chased rock downhole, then bridged off. Wet.
C-23 - *Video 6* 5:10 – 5:50 PM	131.5	144.0		134.0	Collapsed hole. Muddy casing.
C-15 - *Video 7* 6-7:00 PM	136.2	145.0	145.0	146.5 1.5	Flooded. Rock debris. No gas bubbles.

[1] Top Mine Void is depth given to videographer as depth to top of mine void.
[2] "Video" depicts depths taken from camera images.

Day 2 August 15, 2007

Borehole ID	Video Casing	Top Mine Void	Top Video Void	Video Total Depth/ Void Height	Comments
M-18 - *Video 8* 9:15 – 10:45 AM	6	138.8	136.3	142.2 5.9	Mine void intact. Wet. Inside crib. Then into entry. Floor submerged.
C-10 - *Video 9* 10:55 – 11:30 AM	105.0	133.0	138.6	120.0	Collapsed borehole. Dripping water. Horizontal stress.
DG-11 - *Video 10* 11:45am – 12:30 PM	128.9	139.0	138.6	140.0 1.4	Void area. No visible supports. Dry.
C-24 - *Video 11* 12:401 – 1:30 PM	124.1	140.9	141.1	144.0 2.9	Open dry entry. Dark, debris. Fallen timbers.
C-26 - *Video 12* 1:45 – 2:45 PM	130.7	138.8		137.6	Collapsed borehole.
C-11 - *Video 13* 3:50 – 4:30 PM		154.0		144.0	Water level check 145 feet. Gas bubbles. (no VHS recording)
C-20 - *Video 14* 4:40 – 5:30 PM	124.0	140.0	139.8	142.2 2.4	Mine void. Wet. Rubble. Timbers upright.
T-3 - *Video 15* 5:40 – 7:00 PM	128.4	152.1	148.5	149.5 1.0	30-inch casing torn inwards twice. Collapsed. Wet. No timbers.

Notes: Depths are all in meters from ground level.

Video Analysis

On the morning of Tuesday, August 14, 2007, MM&A's downhole video technician, Philip Waters, began recording the scenes in and around 15 boreholes drilled from the surface into the voids of the Pasta de Conchos Underground Coal Mine in Mexico. Waters completed his work on Wednesday, August 15, 2007. The boreholes occupied by Waters in the course of his assignment had been completed by the owner and/or operator of the mine. MM&A was not privy to the actual installation dates of each borehole.

Figure 1: Borehole DG-5, Video 1 - The mine void observed through the borehole revealed that the rehabilitated area is holding up. *(Dry conditions.)*

MM&A recorded the video imagery collected from the boreholes onto individual digital video discs *(DVDs)* and, subsequently, surrendered those discs to Dr. Antonio Nieto-Vega for distribution to members of an investigative panel of experts.

Borehole Location Map (Map 1) and *Borehole Description Map* (Map 2) are attached hereto for the reader's reference purposes. MM&A would like to thank Mr. Steve A. Richards, P.E., for the use of base maps in the creation of these maps.

The following are summary descriptions of key observations made by Waters in the course of his video capture activities, as well as his subsequent review of the contents of the VHS tapes retained by MM&A. The screen captures used in the following summaries were also provided by Richards.

1. Borehole ID: DG-5 (***Video 1*** • August 14, 2007, 11:00 AM to 1:00 PM)

Borehole DG-5 is the northernmost borehole reviewed by MM&A and is located within the underground entry rehabilitation area. MM&A began lowering the camera the 135.0 meters to the reported top of the mine roof at 11 AM. The hole casing ended at a depth of 115.7 meters. Hole enlargements in the natural strata above the mine entry were noted at depths 120.0 to 121.0 meters and 125.0 to 127.0 meters. An offset in the borehole at the second enlargement made passage into the lower section of the hole difficult.

The depth to the top of the mine void, as measured by the downhole video equipment, was 136.0 meters - 1.0 meter deeper than the 135.0 meters reported by the mine operator. A total video depth of 137.4 meters was noted, giving a mine void height of 1.4 meters.

The video of the mine void showed a dry, open mine entry. A mine atmosphere hose ran through the borehole into the mine. The video log of the borehole was completed at 1 PM. Two runs were made down the borehole.

2. Borehole ID: DG-7 (***Video 2*** • August 14, 2007, 1:15 PM to 2:00 PM)

Borehole DG-7 is also located within the underground entry rehabilitation area. The depth from the surface to the mine roof was reported by the mine owners to be 138.0 meters.

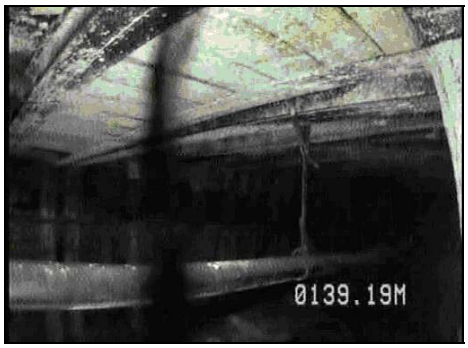


Figure 2: Borehole DG-7, Video 2 - The mine void observed through the borehole revealed that the rehabilitation area is holding up. *(Dry conditions)*

Video logging of the borehole began at 1:15 PM on August 14, 2007. The video revealed that the hole had been cased in its entirety and, aside from the presence of a flexible mine atmosphere sampling hose suspended therein; nothing of particular interest could be noted inside the casing. According to the meter of the video, this casing extended to a depth of 138.6 meters, and that depth appears to coincide with the top of the mine opening. Lowering the video gear to the mine floor revealed a total depth of 141.0 meters. This indicated a mine void height of 2.4 meters.

MM&A noted a dry, open mine and the presence of a mine conveyor belt. The video log of the borehole was completed at 2:00 PM.

3. Borehole ID: C-6 (***Video 3*** • August 14, 2007, 2:40 PM to 3:15 PM)

Figure 3: Borehole C-6, Video 3 - Hole is closed off at a depth of 124 meters.

Borehole C-6 is not located within the underground mine entry rehabilitation area. The depth to the mine roof was reported to be 136.0 meters.

Video logging of Borehole C-6 began at 2:40 PM on August 14, 2007. The meter on the video revealed that the borehole casing extended to a depth of 119.4 meters. MM&A noted condensation inside that casing. A diamond-shaped breakout was observed in natural strata at a depth of 123.0 meters. The hole was found to be collapsed at 124.5 meters. Video logging was unable to continue past that point, and the camera was withdrawn from the hole without making further observations.

No mine atmosphere sampling hose had been placed inside this particular borehole.

4. Borehole ID: C-5 (***Video 4*** • August 14, 2007, 3:25 PM to 4:15 PM)

Borehole C-5 penetrates the unrehabilitated portion of the mine. It is located approximately three “breaks” from the underground mine rehabilitation area, near Borehole C-6. The mine owner reported a depth of 135.0 meters from the borehole collar to the mine roof.

Figure 4: Borehole C-5, Video 4 - The mine void observed through the borehole revealed the presence of a roof fall and related debris.

MM&A began lowering the video camera into the borehole at 3:25 PM. Unlike Borehole C-6, Borehole C-5 had not collapsed. The borehole casing was found to extend to a depth of 126.8 meters, and a hole enlargement was found in the natural strata at a depth of 130.0 meters.

No mine atmosphere sampling hose had been placed inside this particular borehole.

The depth meter of the video camera recorded the top of the mine opening at 136.0 meters (1.0 meter deeper than that reported by the mine owner). MM&A was able to lower the camera an additional 2.5 meters to the bottom of the mine void (total depth of 138.5 meters from the surface). No roof supports were visible in the video of the mine void. Debris and fallen rocks were noted during a scan of the mine opening. The video logging was completed at 4:15 PM.

5. Borehole ID: M-7 (***Video 5*** • August 14, 2007, 4:30 PM to 5:00 PM)

Borehole M-7 is located within the underground mine rehabilitation area. *(Note that M-7 is located near Borehole M-8.)* The depth reported by the mine owner from the borehole collar to the mine roof was 138.0 meters.

Figure 5: Borehole M-7, Video 5 - The hole is blocked by debris at a depth of 85.43 meters.

The video camera revealed that the borehole casing extended to a depth of only 6.0 meters below the ground surface. Water inflow through the natural strata was observed at a depth of 17.8 meters from the surface. The hole was blocked at a depth of 44.0 meters. MM&A was able to push the blockage to a depth of 85.4 meters, but no further.

Video logging took place from 4:30 PM until 5:00 PM.

A mine atmosphere sampling hose had been placed inside this particular borehole.

6. Borehole ID: C-23 (***Video 6*** • August 14, 2007, 5:10 PM to 5:50 PM)

Borehole C-23 is located within an entry running along the back of longwall Panel No. 1 and just north of Borehole C-15. It is not located within the rehabilitated portions of the underground mine entries. The mine owner reported a depth of 144.0 meters from the borehole collar to the mine roof.

Figure 6: Borehole C-23, Video 6 - Loose rock at 133.62 meters almost trapped the video unit in this hole. The mine void could not be reached and observed through this borehole.

Video logging of Borehole C-23 began at 5:10 PM on August 14, 2007. The video camera depth meter revealed that the borehole casing extended to a depth of 131.5 meters from the surface. The inside of the casing was observed to be muddy and moist.

The natural strata of the borehole below the end of the casing had collapsed between 133.0 and 134.0 meters from the surface. As a result, the mine void could not be reached for observation purposes. Video logging was completed at 5:50 PM.

No mine atmosphere sampling hose had been placed inside this particular borehole.

7. Borehole ID: C-15 (***Video 7***, August 14, 2007, 6:00 PM to 7:00 PM)

Borehole C-15 was the final borehole to be video logged on August 14, 2007. This borehole is located just south of Borehole C-23 and within the same entry penetrated by Borehole C-23. (Like Borehole C-23, C-15 is not located within the rehabilitated portions of the mine workings.) The depth from the surface to the mine roof was reported by the mine owner to be 145.0 meters.

Figure 7: Borehole C-15, Video 7 - Water at a depth of 145.9 meters was found in this hole. *(Side view)*

MM&A began logging the borehole at 6:00 PM. The video revealed that the borehole casing extended to a depth of 136.2 meters from the surface. No borehole enlargements were observed in the natural strata exposed in the section between the end of the casing and the top of the mine roof. The video camera depth meter recorded 145.0 meters at the observed top of the mine void (thus, confirming the reported depth of this borehole).

MM&A lowered the camera an additional 1.5 meters, to the bottom of the mine void, for a total depth of 146.5 meters. The visible roof appeared to be smooth and relatively undisturbed. The top of a pool of water was observed 1.0 meter below the mine roof. No gas bubbles were noted in this pool of water. Unidentifiable debris, along with rocks, was noted on the floor. Video logging was completed at 7:00 PM.

No mine atmosphere sampling hose had been placed inside this particular borehole.

8. Borehole ID: M-8 (***Video 8***, August 15, 2007, 9:15 AM to 10:45 AM)

Borehole M-8 was the first to be completed on the second day of this assignment. This borehole is located within the mine entry rehabilitation area. The depth to mine roof was reported to be 138.8 meters.

Video logging began at 9:15 AM, and the depth meter on the video camera revealed that the borehole casing extended to a depth of 6 meters from the surface. Water infiltration was observed in the exposed natural strata at a depth of 19.2 meters. Enlargements in the natural strata were found at multiple intervals in this borehole. These enlargements were located at:

57 to 60 meters;
81 to 82 meters;
112 meters (diamond shaped);
124 meters (diamond shaped);
126 meters (diamond shaped);
127 meters (diamond shaped); and,
128 meters (diamond shaped).

Figure 8: Borehole M-8, Video 8 - Hole is located within a crib installed in the mine entry. The crib appeared to be intact.

The video camera depth meter recorded the depth to the top of the mine void as 136.3 meters - 2.5 meters closer to the surface than reported. Upon entering the mine void through the borehole, the camera recorded the presence of what appeared to be additional roof support. The additional roof support was comprised of cribs located on top of steel beams. (The borehole penetrated the mine roof in the middle of the crib.) The camera was lowered below the additional roof support, and an intact mine void could be observed through the side-looking feature of the camera. The floor appeared to be wet with debris and wood floating in some shallow pools. The video logging continued to the bottom of the mine void at 142.2 meters. The total mine void height was 5.9 meters. Video logging was completed at 10:45 AM.

No mine atmosphere sampling hose had been placed inside this particular borehole.

9. Borehole ID: C-10 (***Video 9***, August 15, 2007, 10:55 AM to 11:30 AM)

Borehole C-10 is located at the intersection of the 2-OTE section and the entry running along the back of longwall Panel No. 1. The mine workings in this area had not been rehabilitated. The depth from the surface to mine roof was reported by the mine owner to be 133.0 meters.

Video logging of Borehole C-10 began at 10:55 AM. The depth meter on the camera revealed that the borehole casing extended to a depth of 105.0 meters and was dripping clear water. Diamond-shaped borehole enlargements were observed in the natural strata below the bottom of the casing at the interval between 106.0 to 109.0 meters and again between the interval of 112.0 to 116.0 meters. Rubble was observed in the borehole at the 119.0 to 120.0 meter depth and video logging was unable to continue past this point. The video equipment was brought to the surface at 11:30 AM.

Figure 9: Borehole C-10, Video 9 - Hole collapsed at a depth of 119.0 meters.

No mine atmosphere sampling hose had been placed inside this particular borehole.

10. Borehole ID: DG-11 (***Video 10***, August 15, 2007, 11:43 AM to 12:30 PM)

This borehole is the southernmost borehole in the "main" entries logged by MM&A. It is also the borehole nearest to one of the continuous miner sections. Borehole DG-11 does not penetrate the rehabilitated portions of the underground mine. The depth from the surface to the mine roof was reported by the mine owner to be 139.0 meters.

Figure 10: Video 10 - Reached a void at a depth of 139.7 meters revealing a fall. *(Dry conditions)*

Borehole DG-11 was video logged from 11:43 AM to 12:30 PM. The video revealed that the borehole casing extended to a depth of 128.9 meters from the surface, and its interior surfaces appeared to be dry. The video reveals that the borehole is angled into the roof of the mine void at a depth of 138.6 meters. MM&A was able to lower the camera to the bottom of the mine void, a total depth of 140.0 meters from the surface. The mine void height was, therefore, calculated to be 1.4 meters.

A 360 degree side-view scan of the mine voids revealed rubble and the indications of a pervasive roof fall. No roof supports could be discerned in the course of this scanning activity. The area appeared to be dry.

No mine atmosphere sampling hose had been placed inside this particular borehole.

11.-Borehole ID: C-24 (***Video 11***, August 15, 2007, 12:40 PM to 1:30 PM)

Borehole C-24 was explored from 12:40 PM until 1:30 PM on August 15, 2007.

Borehole C-24 is located within the 1-OTE section along the northern side of longwall Panel No. 1. This borehole does not penetrate into the rehabilitated portion of this mine. The depth from the surface to the mine roof was reported by the mine operator to be 140.9 meters.

Figure 11: Borehole C-24, Video 11 – Rock on the floor of the mine void at the depth of 144 meters from the surface.

The video camera depth meter revealed that the borehole casing stopped at a depth of 124.1 meters from the surface. The interior of the casing was observed to be dry.

The top of the mine opening was intercepted at a depth of 141.1 meters, a difference of 0.2 meters from what had been reported by the mine owner. The downhole camera was lowered to the mine floor, a total depth of 144.0 meters from surface. The mine void height was, therefore, calculated to be 2.9 meters.

A coal pillar with rubble at its base was discernible through the side-looking feature of the camera lens. Some fallen roof support timbers were noted within the observable vicinity of this borehole. No standing roof support timbers were noted nearby the borehole, although some standing roof support timbers could be observed at some distance away from the borehole. Although the roof appears to have no support in this area, it appears to be intact and smooth.

No mine atmosphere sampling hose had been placed inside this particular borehole.

12.-Borehole ID: C-26 (***Video 12***, August 15, 2007, 1:45 PM to 2:45 PM)

This borehole is located in the center entry of the 2-OTE section running between longwall Panels 1 and 2. This borehole does not penetrate the roof of the rehabilitated portions of the mine.

Figure 12: Borehole C-26, Video 12: Hole collapsed at a depth of 137 meters. *(Dry conditions)*

Video logging of this borehole started at 1:45 PM and was completed at 2:45 PM (including a 15 minute break for lunch.)

The depth meter of the video camera revealed that the borehole casing extended to a depth of 130.7 meters from the surface. The camera also recorded the presence of hole enlargements in the exposed strata of the walls of the borehole at the interval between 130.7 to 134.0 meters and again at the interval between 137.0 to 137.6 meters of depth.

Borehole C-26 had collapsed at a depth of 137.7 meters, near the reported 138.8 meter depth to the mine roof. The mine void could, therefore, not be observed, and the camera was withdrawn from the borehole at this point.

No mine atmosphere sampling hose had been placed inside this particular borehole.

13.-Borehole ID: C-11 (***Video 13***, August 15, 2007, 3:50 PM to 4:30 PM)

The westernmost borehole investigated by MM&A was Borehole C-11. This borehole is located within the 2-OTE section, nearest to the location of a continuous miner section. It does not intercept a rehabilitated portion of the underground mine. The total depth to mine roof was reported by the mine owner to be 154.0 meters.

Figure 13: Borehole C-11, Video 13 - Water with gas bubbles at a depth of 145 meters from the surface.

Video logging began at 3:50 PM and was completed by 4:30 PM on August 15, 2007.

Water with gas bubbles was found inside the casing of the borehole at a depth of at 145.0 meters. The mine owners requested that MM&A not go below the water surface. The video camera was, therefore, withdrawn from the borehole and MM&A demobilized for travel to the next borehole.

No mine atmosphere sampling hose had been placed inside this particular borehole.

14.- Borehole ID: C-20 (***Video 14***, August 15, 2007, 4:40 PM to 5:30 PM)

Figure 14: Borehole C-20, Video 14 – Interior view of the mine void at a depth of 141.74 meters revealing standing roof support timbers, rubble, and some water.

Borehole C-20 is located within the center entry of the 2-OTE section, near the “mains.” It does not penetrate a rehabilitated portion of the underground mine. The total depth to the mine roof of Borehole C-20 was reported by the mine owner to be 140.0 meters

Video logging began at 4:40 PM and was completed by 5:30 PM on August 15, 2007.

The video camera depth meter revealed that the borehole casing extended to a depth of 124.0 meters below the surface. The meter further indicated a depth to the top of the mine opening of 139.8 meters. No hole enlargements were noted along the exposed natural strata segment of this borehole. The natural strata, as well as borehole casing, however, appeared to be wet.

The camera was lowered to the mine floor, a total depth of 142.2 meters, in order to determine the mine void height of 2.4 meters. Roof hanging material, similar to limestone cave stalactites, was noted in a side-view scan of the roof of the mine opening. The side-view scans of the opening revealed standing roof supporting timbers and rubble on the floor, as well as along the rib lines.

No mine atmosphere sampling hose had been placed inside this particular borehole.

15.- Borehole ID: T-3 (***Video 15***, August 15, 2007, 5:40 PM to 7:00 PM)

Borehole T-3 is a ventilation shaft located in the 3-OTE section. This hole is not within the rehabilitated portions of the mine. The borehole is the nearest hole to a continuous miner section. The depth from the surface to the mine roof was reported by the mine owners to be 152.1 meters.

Borehole T-3 was the last hole to be completed on the final day. The video logging began at 5:40 PM and ended at 7:00 PM. Two runs had to be made down the hole to accommodate a light bulb change for the video camera system.

The casing extended to a depth of 128.4 meters and had water dripping along its interior surfaces. Inward-bent casing tears were located at 98.0 meters and 110.0 meters; both casing tears were allowing water to enter the borehole.

Figure 15: Borehole T-3, Video 15 – End of casing and one of several strata enlargements. Hole is offset in more than one location. *(Some water*

The video recorded a total borehole depth to the top of the mine void of 148.5 meters. The video also recorded enlargements in the strata exposed between the base of the casing and the top of the mine void. These enlargements in the borehole were noted from 128.0 to 135.0 meters and between 141.0 to 142.0 meters. Furthermore, several offsets were noted in the natural strata.

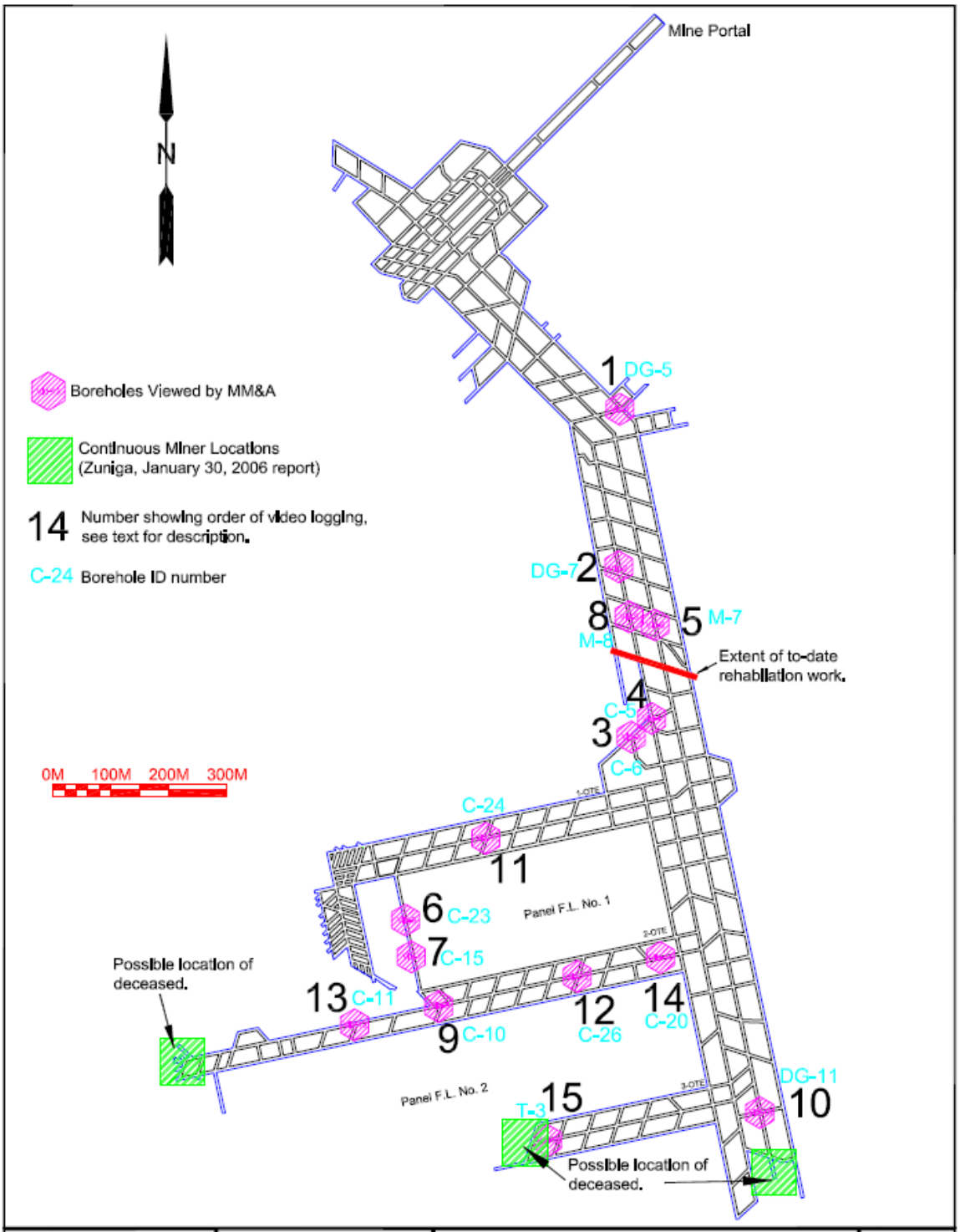
Collapsed rock could be observed below the top of the void by use of the side-view option of the downhole video camera. No roof supports were observed in the process.

The camera was lowered to the floor of the mine opening for a total depth of 149.5 meters. This reveals a mine void height of 1.0 meter.

No mine atmosphere sampling hose had been placed inside this particular borehole.

Videographer's Observations and Comments

1. From casing depth to mine void, there is evidence of caving due to weakness of rock and crushed material. Sometimes cylindrical or diamond-shaped holes could indicate horizontal stress.
2. An offset in some boreholes and movement of the camera to a preferred side indicates angled boreholes and potential horizontal movement of the strata penetrated by the borehole (subsidence).
3. For future work, we recommend additional downhole equipment capable of reading hole size (caliper) and natural gamma (stratigraphy). Temperature logs could help in determining gas inflow within the borehole column, and a deviation log would aide in the determination of offsets and whether these are in the same direction.
    - Cross-hole camera work can be used to determine the extent of the open entries and can be achieved by lowering an MSHA approved light source by means of a second truck or winch. The camera will be lowered into a nearby borehole. If sufficient boreholes are known to be in line of sight, leap frogging can be done, i.e., camera in Borehole A, light in Borehole B, camera in Borehole C, light in Borehole D, etc.
4. The natural strata associated with the boreholes tend to deteriorate with time; setting the casing deeper into each hole helps preserve the utility of that borehole. Regular videotaping of the boreholes can help monitor horizontal movement and/or deterioration.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Boreholes Viewed by MM&A
Continuous Miner Locations
(Zuniga, January 30, 2006 report)
14 Number showing order of video logging, see text for description.
C-24 Borehole ID number
0M 100M 200M 300M
1 DG-5
DG-7 2
8 M-8
5 M-7
Extent of to-date rehabilitation work.
4 C-5
3 C-6
C-24
11
6 C-23
Panel F.L. No. 1
7 C-15
Possible location of deceased.
13 C-11
9 C-10
12 C-26
14 C-20
Panel F.L. No. 2
T-3
15
DG-11
10
Possible location of deceased.
Prepared by:
MARSHALL MILLER & ASSOCIATES
Lexington, Ky
Drawn: hs
Checked: EL
Date: 09/21/07
Scale: See Scale on map
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File No.: Drillholelocation.dwg
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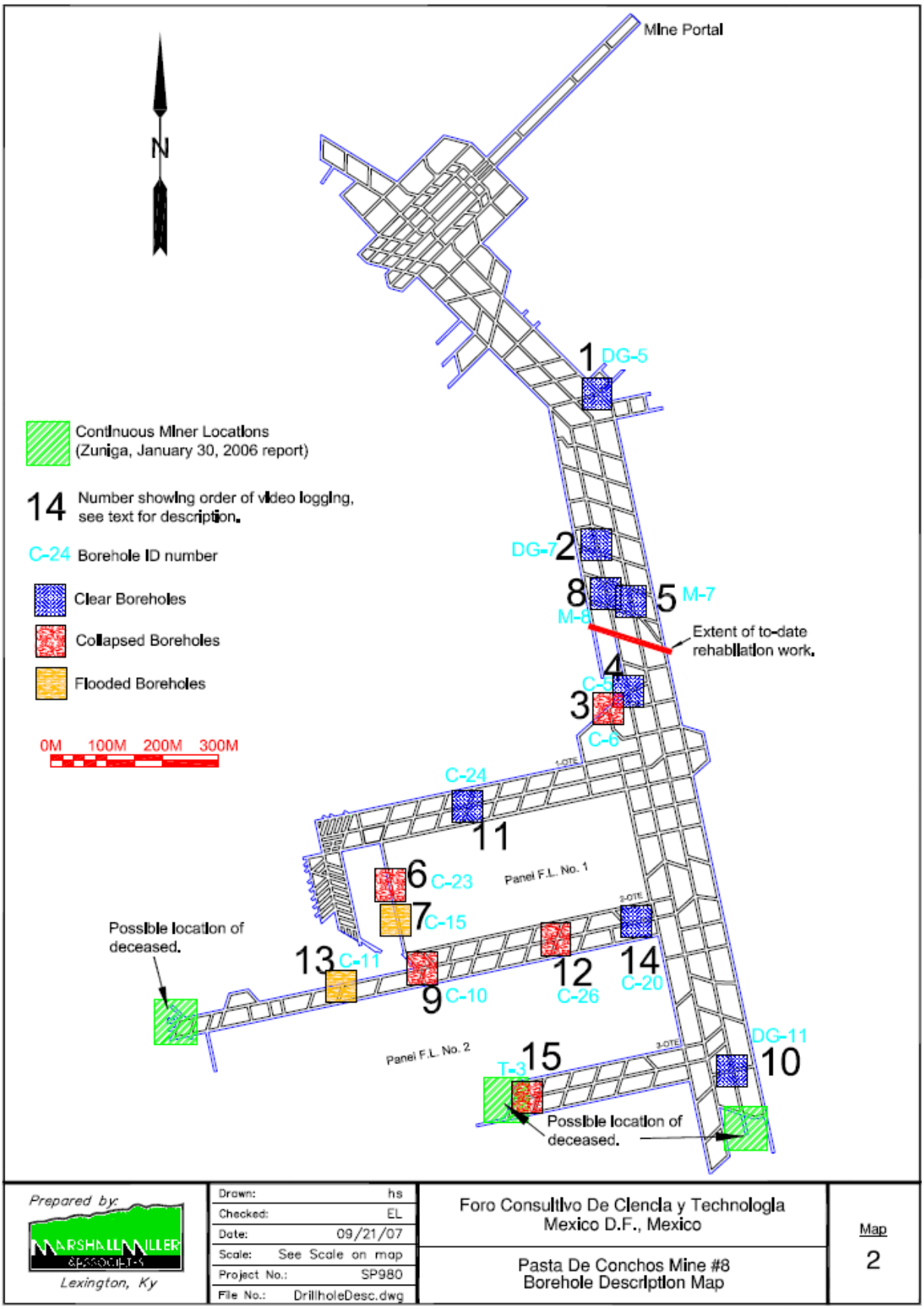
Mexico D.F., Mexico
Pasta De Conchos Mine #8
Borehole Location Map
Map
1


Mine Portal
N
Continuous Miner Locations
(Zuniga, January 30, 2006 report)
14 Number showing order of video logging, see text for description.
C-24 Borehole ID number
Clear Boreholes
Collapsed Boreholes
Flooded Boreholes
0M 100M 200M 300M
1 DG-5
DG-7 2
8 5 M-7
M-8
Extent of to-date rehabilitation work.
4
C-5
3
C-6
C-24
11
6 C-23
Panel F.L. No. 1
7 C-15
Possible location of deceased.
13 C-11
9 C-10
12 C-26
14 C-20
Panel F.L. No. 2
T-3
15
DG-11
10
Possible location of deceased.
Prepared by:
MARSHALL MILLER & ASSOCIATES
Lexington, Ky
Drawn: hs
Checked: EL
Date: 09/21/07
Scale: See Scale on map
Project No.: SP980
File No.: DrillholeDesc.dwg
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Mexico D.F., Mexico
Pasta De Conchos Mine #8
Borehole Description Map
Map
2

APPENDIX E
Water Analysis
Borehole Photos

Figure 4.7 is the screen capture from C-15 as it encounters the water level at 145.85 meters.

Figure 4.7. Water level in C-15

Nearby hole C-10 at 119.71 meters shows a rock blockage and some incoming water, but the rock is above the water level at this time. Figure 4.8 is of the same hole at 119.4 meters.

Figure 4.8a. Debris Blockage in C-10 as seen from 119.71 meters

Figure 4.8b. C-10 Blockage as seen from 119.4 meters

Figure 4.9 is Hole C-11 at 144.31 meters. This well shows a presence of water and gas.

Figure 4.9. Water and gas bubbling at C-11

C-23 shown in Figure 4.10 encountered a loose rock in the side of the hole that almost trapped the unit in the hole. The camera could not proceed past 133.62 meters.

Figure 4.10. C-23 Obstructed borehole at 133 meters

Hole C-26 shown in Figure 4.11 is a dry hole down to 137 meters. The hole collapsed below that point and stopped the camera from going further.

Figure 4.11. C-26 Obstructed borehole at 137 Meters

Figure 4.12 shows T-3, a ventilation intake hole. The hole has shifted significantly since it was drilled.

Figure 4.12. T-3 Ventilation intake hole

A second shot of T-3 in Figure 4.13 shows the offset in the hole.

Figure 4.13. Offset in T-3

This third photo of T-3 shown in Figure 4.14 is at the bottom revealing a void characteristic of the top of a fall. There was some water inflow.

Figure 4.14. Rock Fall evidence in T-3

The Degas -11 borehole shown in Figure 4.15 reached a void indicating a fall at 139.66 meters. The hole was dry.

Figure 4.15. Degas Hole 11 Obstructed by rock fall at 139 Meters

Hole C-20 shown in Figure 4.16 had a little water. It reached the coal seam and timbers are shown. There is rubble on the floor, but few things other than the posts are identifiable.

Figure 4.16. Borehole C-20 support posts still standing

The De-Gas 5 hole in Figure 4.17 shows the area that has been rehabilitated is holding up.

Figure 4.17 De-gas 5 Hole intact support structure

The De-Gas 7 hole, Figrue 4.18 is holding up generally and is dry. This is in the rehabilitated area of the mine.

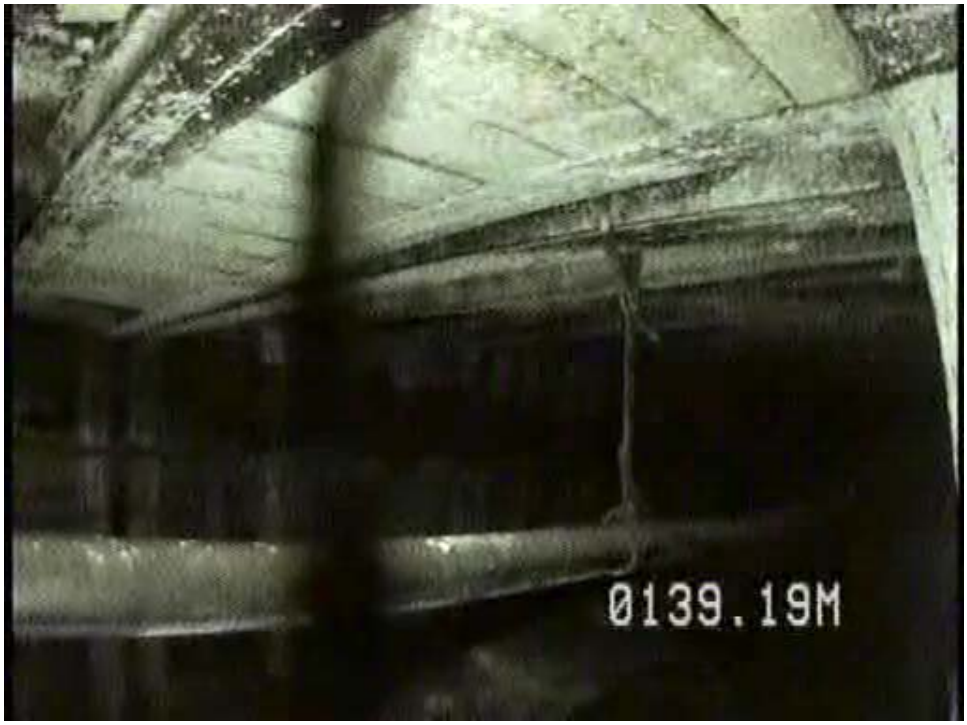

Figure 4.18. De-gas 7 Shows rehabilitate structure still intact

The photos in Figure 4.19 and Figure 4.20 of C-24 shows the mine works holding naturally with the timbers and steel supports on the ground. This area is open, but upon close review it appears there are reflections from the floor indicating there are some small puddles of water on the floor in some places.

Figure 4.19. C-24 materials on the floor

Figure 4.20. C-24 materials on the floor

C-5 in Figure 4.21, shows an open area with a fall. It looks like an intersection. The timbers and steel beams are knocked out and there is a lot of debris on the floor. The area appears dry.

Figure 4.21. C-5 rock fall

C-6 in Figure 4.21 is closed off around 124 meters and does not indicate much other than a possible fall at this location.

Figure 4.22. C-6 Obstructed at 124 Meters

Figure 4.23. Running water in Obstructed M-7 at 85 meters

The M-7 hole shown in Figure 4.23 was blocked at 85.43 meters. There was a steady stream of water entering through this hole.

Figure 4.24. M-8 Inside the cribbing

The M-8 hole shown in Figure 4.24 was located inside a crib. The crib appears to be intact. There is some inflow of water in this hole

Another photo of M-8 shows the crib in place in Figure 4.25.

Figure 4.25. Another view of M-8 cribbing