of the near-surface strata and possible near-surface fractures associated with the predicted subsidence could reactivate or initiate landslides. Mr. Dunrud observed that many of the existing landslides, including the landslides north and south of Minnesota Reservoir became unstable and moved during the period of high precipitation in the mid 1980s. The landslides on the southeast side of West Flatiron and on the west side of Deep Creek in the Apache Rocks area appear to have been unaffected by longwall mining beneath the areas. It therefore appears apparent that wet seasons affect landslides more than does longwall mining. During very wet periods, however, landslides that are already unstable may locally be triggered by mine subsidence. The following are known locations within the present permit area, the South of Divide and Dry Fork mining areas where the reactivation of a landslide could occur as a result of future mining:

South of Divide mining area:

An extensive landslide located south of Minnesota Reservoir just north of projected Panels LWE16 and LWE17 in the NW¼ of Section 32.

Dry Fork mining area:

There are three slides identified on the Deep Creek Ditch in Section 2, of Township 14 South, Range 90 West, 6th P.M., one that warrants concern, this slide is located above the bleeder entries along the south side of Panel E 6 the other two land slides are outside the influence of mining. The slide will be monitored both visually and by survey methods.

A discussion regarding the monitoring plans for the landslide located on the south abutment of the Monument Dam are included in Section 2.05.6 (6)(e)(i)(D) - Detailed Description of Predicted Subsidence Phenomena, Subsection "Effects Of Subsidence And Mine-Induced Seismic Activity On Man-Made Structures And Renewable Resources", Monument Dam - Minnesota Reservoir. A discussion concerning the preventative measures to be employed to protect Monument Dam from mining induced impacts is contained in Section 2.05.6(6)(f)(iv)(A-D) - Detailed Description of Mitigating Measures.

Presently, there are four known locations within the permit area where the reactivation of a landslide could be potentially linked to past or current mining. The first area, in Lone Pine Gulch (Section 20, T13S, R90W, 6th P.M.), contains numerous old landslide features, including steep, hummocky topography with many smaller surficial slumps. Cracking and slumping occurred on one section of a jeep trail in this area in early October 1994. The cracks appeared during mining of the 5NW longwall panel in the B-Seam. Location of the cracks coincides with the boundary of earlier F-Seam room-and-pillar panels. The second area, discussed previously, is above the 8NW longwall panel. This landslide activity, which could not be definitively linked to longwall mining, is described in considerable detail in a CDRMS inspection report (CDRMS 1996). The third area is above the 9NW longwall panel. Another known landslide area is south of Highway 133 near Box Canyon within the Box Canyon Permit revision area. These landslides are outside the projected longwall mining subsidence effects (i.e., 19 degree angle of draw) by more than 600 feet as described in Exhibit 60C, 60D and 60E.

Rockfall

The most current evaluations of subsidence impacts can be found in the quarterly subsidence monitoring reports each year. In past years, as discussed in Section 2.04.6, *Geology Description*,

subsidence. As such, the conservative approximate limit of the maximum predicted E-seam angle-of-draw is 19 degrees.

Water and Methane

Observations of the north and west flanks of Mt. Gunnison during an October 1996 field trip, revealed numerous talus and rock glacier deposits that occur in the valleys and lower part of this intrusive body. Snow melt and rain can easily infiltrate these deposits, which may eventually enter any permeable rocks, faults, fractures, and joints near the mountain. Coal beds and rocks in the deformed zone around Mt. Gunnison might also contain increased methane where the coal is metamorphosed to a higher rank by the intrusive body. Great quantities of water and methane may therefore be expected as coal is mined closer to Mt. Gunnison.

Effects Of Subsidence And Mine-Induced Seismic Activity On Man-Made Structures And Renewable Resources

Man-made structures and renewable resources in the South of Divide mining area basically consist of 1) A dam and reservoir (Monument Dam - Minnesota Reservoir), 2) stock watering ponds, 3) streams (primarily Dry Fork and the upper part of Lick Creek), 4) roads, and 5) local cabins. Minnesota Reservoir, the ponds, and the Deep Creek Ditch diversion to Dry Fork serve the dual purpose of being both man-made structures and containment structures for the valuable water resources in the area. Based on past subsidence observations in the Jumbo Mountain, Apache Rocks, and Box Canyon mining areas during the last nine years, the following information is considered appropriate for the South of Divide mining area.

Monument Dam - Minnesota Reservoir

Monument Dam - Minnesota Reservoir, which provides storage water primarily for irrigation, is located between two landslides—one beginning at the north shore and the other beginning at the south shore. As explained above, landslide movement on Jumbo Mountain occurred during unusually wet periods before mining began, during mining, and after mining and subsidence was complete. The conclusions were that landslide movement occurs in response to ground saturation and is not noticeably affected by subsidence and seismic activity produced by longwall mining beneath, or near, landslide areas.

The landslides north and south of Minnesota Reservoir occur in surficial material (loose rock, gravel, sand, silt, clay, and soil) and local bedrock outcrops. The author therefore expects that the mining of longwall panels LWE16 and LWE17 will not noticeably affect the large landslide south of Minnesota Reservoir.

Mining of the longwall mining panels in the South of Divide mining area did not affect Minnesota Reservoir. The reservoir is located outside the area of mining influence, using the most conservative angle of draw. Measured ground subsidence nor seismicity caused by longwall mining affected Monument Dam and Minnesota Reservoir.

blanket of clay-rich surficial material (debris flows, alluvium, and colluvium), or have a source from within the surficial material. Subsidence may affect a spring or aquifer source located in bedrock, whereas effects may or may not be expected where the spring source is within the surficial material. Tension cracks produced in sandstone bedrock during the subsidence process, for example, may divert water to a lower rock layer and therefore change the flow location. However, local aquifers in permeable zones, which are interlayered with clay-rich zones (Wasatch clays) in the surficial deposit, may yield to tensile stresses without cracking. There is no field documentation known to Mr. Dunrud to either support or refute this statement. Annual Hydrology Reports submitted to the CDRMS each year provide monitoring data and note potential impacts from mining.

Springs

Decreed Spring 21 is located within the areas of mining influence of longwall panels LWE5, LWE6, and LWE16 in the NE¼ of Section 5, (Township 14 South, Range 90 West). Maximum tilt and strain is expected to occur in this area, because it is located above the projected haulageway and barrier pillar to the haulageway. The overburden depth at this spring site to the E seam is about 650 feet.

Springs mapped in the South of Divide mining area, which have been found flowing at every site visit, include: 1) a spring located 800 feet west, southwest of the Minnesota Reservoir dam - outside the area of any planned mining influence; 2) a spring located along Dry Fork 700 feet west of the confluence of Poison Creek and Dry Fork, above longwall panel E2 in about 650 feet of overburden to the E seam; 3) Deep Creek Spring over Panel E3; 4) the 96-2-2 Spring over Panel E4; and 5) a spring located south, and outside of the area of influence of longwall panel E8.

Of the springs mapped, Deep Creek Spring over Panel E3, the 96-2-2 Spring over Panel E4, the decreed Spring 21, and the spring located along Dry Fork and above longwall panel E2 (J-7), were projected to be impacted by longwall mining. The source of decreed Spring 21 may be a local aquifer in bedrock of the Mesaverde Formation, whereas, the source of the spring along Dry Fork (above longwall panel E2) is likely to be a local aquifer in colluvium or alluvium derived from debris flows. The Deep Creek Spring and the 96-2-2 springs are in colluvium in Deep Creek.

Aquifers

Horizontal strain produced during subsidence could impact local water-bearing bedrock beneath the blanket of clay-rich surficial material. It also may impact local aquifers in surficial material, where permeable and saturated zones are stratigraphically positioned in zones of tensile strain. Impacts may occur for long periods of time where the aquifer is located above mined boundaries and barrier pillars - areas where permanent strain occurs. On the other hand, dynamic strains and related cracks produced by subsidence above moving longwall faces in a given area are nil and close when the longwall faces move out of the area of influence of this area. Based on this evaluation, any mining effects on local aquifers can best be identified by monitoring any changes in flow and water levels in springs and ground water.

subsidence. As such, the conservative approximate limit of the maximum predicted E-seam angle-of-draw is 19 degrees.

To document subsidence features, MCC conducts visual surveys, and any necessary traditional surveys, semiannually each year and provides the information in a written subsidence report by the end of September and April each year. A summary of the visual observations and monitoring is provided in first and fourth quarter letter reports to CDRMS and to the USFS. If any mechanical response is detected during these visual inspections that is not consistent with what has been previously observed, MCC will notify CDRMS within ten working days of our observations.

The Spring and Fall reports of the visual surveys will include photographs to document any subsidence features, including cracks, rockfalls, landslides, revegetation, and other relevant features. A map will also be included that identifies the location of the photographer and the aspect of the image for each photograph. An additional map will be prepared that identifies the location and extent of the observed features. MCC will attempt to revisit previously identified subsidence features to note any changes that have occurred since the previous visit. MCC will also attempt to replicate the aspect of the photographs taken previously to document the progression of subsidence and subsequent healing. The discussion of the field observations will in particular address the development and healing of the subsidence features, utilizing the photographic documentation. In addition, MCC will discuss baseline conditions observed in areas prior to undermining. The report will document how the inspection was conducted, and include such observations as weather and ground conditions.

In addition to performing the visual surveys, aerial or other type photos will be taken prior to beginning mining in an area, periodically during mining, and after mining when subsidence is complete to document landslides, rockfalls, vegetation, etc. over the areas being mined. This documentation will provide a broader, more extensive view from which to associate or assess landslide and other surface activity due to mining.

1) Verification and Accuracy of Predictions

In order to verify and demonstrate the accuracy of subsidence predictions, based on the results of past subsidence observations in prior mining areas, MCC will implement the following procedures to monitor Monument Dam prior to mining. The following procedures will be implemented as soon as permitting allows, in order to account for seasonal precipitation changes.

1. Conduct annual aerial photo surveys of the landslides located north and south of the reservoir, using the July 2004 photos as a baseline reference. Surveys will continue while mining is occurring within panels LWE16 and LWE17.

2. Install, and measure, survey monuments strategically located on the dam and on the north, south, and east edges of the reservoir to monitor any movement prior to, during, and after mining in the area. During the monument surveys, conduct visual inspections along the monument transects for surface cracks. Monitoring (surveying and inspections) of stations in the Minnesota Reservoir area and across the crest of the Monument Dam will be initiated at least one month prior to mining of Panel E12 and continue for two to three months after mining is complete in the panel. MCC will initially survey the

monuments on the dam axis quarterly and then monthly when E-seam longwall mining is occurring within one mile of the dam. The results of the surveys will be submitted in the semi-annual subsidence reports. While mining is occurring within the one mile radius, weekly inspections will be made of the dam for cracks or other potentially damaging features and the inspection reports will be included with the semi-annual subsidence reports. The monuments along the dam and reservoir basin will be resurveyed as soon as possible if a seismic event occurs that exceeds the "threshold event" as described below. If, during the inspections, cracks or other potentially damaging features are noted to be occurring in the reservoir basin or dam structure, CDRMS, the Minnesota Reservoir Company, SEO, USFS and other appropriate agencies will be notified by MCC immediately and, depending on the severity of the damage, mining may cease until a new mine plan can be approved and mitigation performed.

In addition to the survey monuments on the dam, in cooperation with Minnesota Canal & Reservoir Company, MCC will measure the water level in the piezometers installed in the crest of the dam on monthly basis, April through October, when accessible. The water level measurements will be included in the semi-annual subsidence reports.

3. Mining of panels LWE16 and LWE17 will be from the south to the north. Monitoring (surveying) of stations to the south of the Minnesota Reservoir and across the crest of the Monument Dam will be re-initiated at least one month prior to mining of panels LWE16 and LWE17 and continue for two to three months after mining is complete in the panels. MCC will initially survey the monuments on the dam axis quarterly and then monthly when E-seam longwall mining is occurring within one mile of the dam. The results of the surveys will be submitted in the semi-annual subsidence reports. While mining is occurring within the one mile radius, weekly inspections will be made of the dam for cracks or other potentially damaging features and the inspection reports will be included with the semi-annual subsidence

   reports. The monuments along the dam and reservoir basin will be resurveyed as soon as possible if a seismic event occurs that exceeds the "threshold event" as described below. If, during the inspections, cracks or other potentially damaging features are noted to be occurring in the reservoir basin or dam structure, CDRMS, the Minnesota Reservoir Company, SEO, USFS and other appropriate agencies will be notified by MCC immediately and, depending on the severity of the damage, mining may cease until a new mine plan can be approved and mitigation performed.

4. The landslide feature that is located on and is part of the left (south) abutment will be monitored for movement when mining is within the angle of draw. MCC will install survey monuments within the landslide on the hill to the south of the dam and within the toe of the landslide. These monuments will be surveyed monthly, when accessible, during the months of February through July (if accessible) when movement due to high soil moisture content would be expected. The monuments will be surveyed once every three months in the period of August to January (if accessible) when soil moisture content is expected to be lower. If a seismic event equal to or greater than the threshold event for the Monument Dam as described below occurs, the monuments will be inspected for movement. The results of the survey will be submitted to CDRMS in the semi-annual subsidence report. If movement along the landslide appears to potentially damage the

Subsidence Control Plan - 2.05.6 (6)(b)(iii)(B), (6)(d)(i&ii), (6)(e)(iv) & (6)(f)(i-vii)

Description of Mining Methods – 2.05.6 (6)(f)(iv)(A& B)

As discussed in Section 2.05.6(6)(e)(i)(A), *Brief Description of Mining Method*, the longwall mining method is planned for the SOD, Apache Rocks West, Southern Panels and Sunset Trail mining areas. A general east-west panel layout, is planned except for the E-seam longwall panels LWE16 and LWE17 that will be in a north-south orientation. Although longwall mining may initially induce more caving and fracturing of the roof rocks, it offers the advantages of maximizing resource recovery. The longwall method also causes more uniform subsidence (full extraction of panel) and causes equilibrium conditions to be reached in a shorter period of time (i.e., there is no additional, lingering pillar crushing in panels). See further discussions in the current version of Exhibit 60E.

Although subsidence is primarily a result of the secondary recovery of coal from a longwall coal panel, subsidence type features may occur when developing main entries/roadways under shallow, unconsolidated and saturated cover. Such was the case in October 2020 when developing main entries under South Prong Creek. To avoid similar issues in the future, MCC has performed an analysis of the minimum depth of cover required for development mining in the West Elk Mine to avoid the potential for this type of surface subsidence impacts. MCC will adhere to the recommendations for development mining beneath perennial streams as detailed in Appendix A of Exhibit 60E.

Preventive Measures – 2.05.6(6)(f)(iii)

State-of-the-art longwall mining technology will continue to be utilized for extraction of the B Seam and E Seam coal within the permit area. Although longwall mining may initially induce more caving and fracturing of the roof rocks, as compared to the room-and-pillar method, it offers the advantages of maximizing resource recovery; more complete subsidence; equilibrium conditions occurring in a shorter period of time; more uniform and predictable parameters necessary for the evaluation of probable hydrologic consequences; and in general, fewer and less significant adverse hydrologic impacts than room-and-pillar mining.

A small portion of Deep Creek Ditch may be undermined by E seam and B Seam longwall panels. (As mining approaches the ditch, the pre-mining condition of the ditch will be documented in a pre-subsidence survey. This survey will be added to the permit application in the semi-annual subsidence reports. Before, during and after mining, the amount of the ditch that is subsided will be determined by surveying reflector stations in the ditch, as set forth in Section 2.05.6(6) (c). In addition to the surveying, changes in the ditch caused by subsidence will be detected by visually inspecting the ditch on a weekly basis while active longwall mining is within 1000 feet of the ditch. MCC will repair any mining-caused damage found during the monitoring or during visual inspections, in accordance with the agreement between MCC and the Minnesota Canal and Reservoir Company. If mining activity disrupts flow in the ditch, MCC will apply methods set out in the subsidence mitigation plan or injured parties will be compensated with water resources that are owned by MCC per its adjudicated water augmentation plan.. These water resources are identified in Exhibit 52.

Anticipated Effects – 2.05.6 (6)(f)(iii)(A)

Long-term impacts on the surface are predicted to be minimal above the mined longwall panels. The few surface cracks over the mining panels that may occur are expected to close once the longwall face moves past the surface area of influence. Surface cracks present above the chain or barrier pillars or mine boundaries may remain open where permanent tensile strains remain after mining is completed. However, at least several hundred feet of unfractured rock will typically exist between any mine-induced surface fractures and the upper part of any mine-induced fractures above the caved zone in the mining panels. Therefore, from a practical standpoint, no interconnection between the surface fractures and the mine workings is anticipated. Again, under a worst case scenario, if a surface fracture were to occur concurrently within an area controlled by faults or bedrock lineaments, there could be interconnection between adjacent sandstones. However, even under these conditions, the fractures would most likely not extend through the claystones and shales present in the overburden.

Monument Dam and Minnesota Reservoir are located outside of the angle of mining influence of the eleven longwall panels (panels LWE1 through LWE17) within the South of Divide mining area (see Map 51). The northern portions of panels LWE16 and LWE17, which are nearest to the reservoir, are located several hundred feet away. The angle of draw to this nearest area of mining is 69°. The angle is much greater than the maximum of 19° projected for the SOD mining area. This means that Minnesota Reservoir will not be affected by longwall mining in projected panels LWE16 and LWE17.

Reduction Measures (Underground) - 2.05.6 (6)(f)(iii)(B)(I-III)

Underground measures that may be taken to reduce surface strains above the chain pillars could include, but are not limited to; (1) Designing the pillars to yield and crush after mining (thus minimizing humps in the subsidence profile), and/or (2) Planning a rapid and uniform mining rate. Any plans in order to reduce chain pillar dimensions to reduce subsidence impacts must, of course, be balanced with health and safety conditions in the mine. Plans for a rapid and uniform mining rate are affected by market demands (or lack there of) for constant, high volumes of coal. MCC will notify CDRMS if plans that may affect the subsidence profile are implemented.

As discussed in previously in section 2.05.6, Wright Water Engineers has completed detailed subsidence modelling and evaluations from longwall mining in the SOD, Southern Panels, Apache Rocks West, Dry Fork and Sunset Trail mining areas and provided recommendations for longwall mining heights and cover depths. MCC will adhere those recommendations as detailed in Exhibit 60E, including not longwall mining where actual overburden depths are less than 250'. E seam overburden depths are shown on Map 19 and were based on surface topographic surveys compared to top of seam elevations derived from nearby drillhole data. MCC will continue to survey actual roof elevations in the mine as each longwall panel is developed and adjust the panel length as necessary to ensure that no longwall mining occurs where actual overburden depths are less than 250'.

Preventive Measures (Surface) - 2.05.6 (6)(f)(iii)(C)(I-V)

Surface measures that may be taken to reduce or prevent damage to applicable structures or water resources could include, but are not limited to; (1) Engineering, design, and construction of

If surface cracks were to form and if they were to intercept stock ponds or ephemeral channels, they could potentially intercept surface water. Field evidence at the Section 17 cracks, evaluation of the soft plastic shales occurring in the Barren Member above the F Seam, and theoretical subsidence stress-strain relationships discussed elsewhere in the subsidence section of the application, each strongly suggest that surface cracks would not extend to any great depth.

Two factors will also tend to heal the cracks, if they were to intercept water. First, the shales of the Mesaverde Formation are known to have shrink-swell capacity. If the saturation of these shales were to be increased, they would swell and this could be expected to help heal the crack. Secondly, Mr. Jeff Hynes of the Colorado Geological Survey (1994) has stated that a greater factor in crack healing would be increases in the plasticity of the shales as water saturations were increased. Simply stated, as the shales become wetter, they soften and will squeeze into and heal the cracks.

An important consideration regarding mining in the Apache Rocks, South of Divide and Dry Fork permit revision areas are potential impacts to the Minnesota Reservoir. The water rights implications of mining in the tributary area to the reservoir are discussed later in Section 2.05.6 (3)(b)(iii & viii) *Water Rights*. MCC has committed to maintaining a buffer zone between active mining and the dam of over 1,000 feet, which is greater than the distance utilizing the conservative angle of draw 25 degrees. With a setback of this margin, there is no risk of either a crack developing under the reservoir or aggravation of the existing structural problems with the dam as a result of MCC's mining activities. Mining of longwall Panel 13 in the B Seam occurred at a distance of approximately 700 feet from the reservoir with no adverse impacts to the structure. The additional distance for longwall panels LWE16 and LWE17 is very conservative given that the E Seam is stratigraphically higher and, therefore, has a smaller area of influence at a given angle of draw.

Wetlands

Based upon inspection of conventional and infrared aerial photographs and reconnaissance-level field investigation, the wetlands in the permit area are confined primarily to manmade stockponds in the drainages. They are intermittent in nature. Very few "natural" riparian wetlands are evident. The total acreage of potential jurisdictional wetlands in the permit area is approximately 7 acres (as defined by the U.S. Army Corps of Engineers (USACE)). Field surveys conducted in August 1995 verified this estimate. An additional 2 to 3 acres lies above the 10NE and 11 NE longwall panels.

Field surveys in the South of Divide permit area in 1996 found additional wetland/riparian areas along the valley bottoms within the Dry Fork and Lick Creek drainages and in association with hillside spring and seeps (refer to Section 2.04.10). Another study was conducted November 2004 showing these additional wetland areas and is included in Exhibit 32B, Drawing 1.

Although most of the wetlands are found in drainage channels, there are small, isolated wetlands on the hillsides where springs and seeps emerge. There are other isolated wetlands in association with landslides and slumps. In these instances, the wetlands are associated with the uppermost portion of the landslide/slump, where a relatively flat area has been created and water has tended to collect and saturate the soils.

- Approximate Box Canyon Mining Area (B Seam) – Longwall Panels (46,930,000 ft.^{2}) and Development Areas (23,121,000 ft.^{2})

- Approximate 10NE and 11NE Longwall Panel Area (B Seam) – Longwall Panels (6,603,000 ft.^{2}) and Development Areas (4,362,000 ft.^{2})

- Average sustained inflows (2003) observed into the mine (100 gpm, 161.3 AF/yr or 7,026,738 ft.^{3}/yr.)

- Maximum inflows (1996) observed into the mine (8,000 gpm) or (175,668,449 ft.^{3}/yr)

- Approximate South of Divide mining area LWE1-LWE17 panels (E Seam) – Longwall Panels (92,996,122 ft^2) and Development Areas (1,787,471 ft^2)

- Average additional sustained inflows into the E Seam workings from the SOD mining area (100 gpm or 7,026,738 ft.^{3}/yr)

- Maximum additional inflows into the E Seam workings from the SOD mining area (1,700 gpm)

Using these revisions to the "time to fill" calculations results in the following:

- Time to fill F Seam workings (100 gpm) = 14.9 years

- Time to fill Jumbo Mountain (8NW and 9NW) B Seam workings (100 gpm) = 17.7 years

- Time to fill Northwest Panel (1NW to 7NW) B Seam workings (100 gpm) = 26.6 years

- Time to fill Apache Rocks (three western and four eastern panels) B Seam workings (100 gpm) = 65.8 years

- Time to fill Apache Rocks (three western panels) E Seam workings (100 gpm) = 31.0 years

- Time to fill the 10NE and 11NE Panels B Seam workings (100 gpm) = 7.5 years

- Time to fill Box Canyon (18NE to 23NE) B Seam workings (100 gpm) = 49.9 years

- Time to fill SOD (E1-E17) E Seam workings (100 gpm) = 73.5 years

Cumulatively, the estimated "time to fill" the entire West Elk Mine workings in all three coal seams is approximately 290 years (maximum fill time) based on current inflow observations and those additional inflow estimates assumed for the South of Divide mining area.

F Seam Impacts on Groundwater