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INCIDENT INVESTIGATION REPORT

Notice of incident number	Date of incident	Location of incident
2009113820050	**February 22, 2009**	**Montrose site Toba Inlet area, B.C.**
Lead investigating officer **Barbara Deschenes**	Investigation file number **2009-166**	Incident outcome **FATAL**
Report approved by manager, Fatal and Serious Injury Investigations **John Eldridge**	Signature	Date March 31, 2010

PARTIES INVOLVED IN INCIDENT

	Name and address	Employer ID	Industry classification
Employer	**Peter Kiewit Sons Co. Corporate Offices 120-10651 Shellbridge Way Richmond, BC V6X 2W8**	**76110**	**721028 Industrial construction**
Worker	[redacted]	[x] Deceased	Occupation **Rock scaler**

Persons mentioned in report

Name	Known in the report as	Role in the incident/investigation
[redacted]	Scaler 1	Deceased in incident
[redacted]	Scaler 2	Directly witnessed incident
[redacted]	Excavator Operator	Witnessed rock rolling down hill toward work area; warned others by radio about rock rolling toward them
[redacted]	Earthworks Foreman	Was operating another excavator uphill from the Excavator Operator
[redacted]	Ranger Drill Operator	Witnessed rock come over the crest of the hill toward Scaler 1; initiated call to central first aid
[redacted]	Hoe Drill Operator	Witnessed incident; did first assessment of Scaler 1 for vital signs
[redacted]	Blaster	Day shift blasting foreman who did second assessment of Scaler 1 for vital signs
[redacted]	Night Shift Blasting Foreman	Worked with Scaler 1 on February 6
[redacted]	Earthworks Superintendent	Was parked on main access road to site at the base of the hill; came to incident scene immediately after the fatal incident
[redacted]	Nurse/FAA	RN with master's degree in nursing. Provided first aid at the scene and pronounced death
[redacted]	Drill and Blast Superintendent	Managed drilling, blasting, and scaling crews; not present on day of fatal incident
[redacted]	Drill and Blast Engineer	Provided supervision of drilling, blasting, and scaling in absence of Drill and Blast Superintendent; present at site before the incident; directed scalers to hand drill boulder
[redacted]	Earthworks Engineer	Provided information about work practices and events before incidents and after incidents
[redacted]	Construction Manager	Overseeing manager of construction
[redacted]	Project Manager	Senior manager of project

P.Eng. , P.Eng.	Geotechnical Engineer 1 Geotechnical Engineer 2	Wyllie & Norrish Rock Engineers Ltd. conducted inspections of site to recommend rock stabilization
	Project Safety Manager 1	Provided information about the February 8 incident and corrective measures taken
	Project Safety Manager 2	Attended incident scenes on February 21 and 22

Scope

This incident investigation report sets out WorkSafeBC's analysis and conclusions with respect to the cause and underlying factors leading to the workplace incident of February 22, 2009, at Montrose Creek near Toba Inlet, British Columbia. The purpose of this report is to identify and communicate the findings of this incident to support future preventative actions by industry and WorkSafeBC.

This investigation report does not address issues of enforcement action taken under the *Workers Compensation Act* and the Occupational Health and Safety Regulation. Any regulatory compliance activities arising from this incident will be documented separately.

Synopsis

On February 22, 2009, at approximately 13:00, a large rock rolled downhill on a run-of-the-river project construction site located near the headwaters of Toba Inlet. The rock struck a scaler as he hand drilled a boulder to prepare it for blasting. The scaler, a young worker, immediately sustained fatal head injuries.

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1 Factual Information

This investigation report outlines the circumstances of two rock fall incidents that occurred on consecutive days. On February 21, 2009, a large rock rolled down a slope into a work area where several workers were working and struck a hoe drill, causing serious mobile equipment damage. On February 22, 2009, a young worker employed as a scaler died when a large rock struck him as it rolled down a slope into a work area where the scaler and four other workers were working. WorkSafeBC came in to investigate after the February 22 incident.

1.1 Workplace

1.1.1 The owner: Plutonic Power Corporation

Plutonic Power Corporation (Plutonic) is a Vancouver-based Canadian company that develops renewable energy projects, such as run-of-the-river hydroelectric generation. Run-of-the-river hydroelectric generation uses the natural flow and elevation drop of a river to generate electricity. Plutonic has proposed a number of such power generation projects for development in B.C. coastal inlet areas. Currently, the company has applied for or holds licences on 40 rivers in the province, on which the company proposes to generate nearly 2,000 MW of renewable power.

Plutonic and GE Energy Financial Services are partners in the Toba Montrose General Partnership. In July 2007, construction started on the partnership's first project, the East Toba and Montrose Project located 100 kilometres north of Powell River. The Toba Montrose project consists of two run-of-river power facilities located at the headwaters of the Toba Inlet on the East Toba River and Montrose Creek. This 196-MW project will produce 745 GW h/a of electricity (the amount of electricity needed to supply 75,000 homes) and will cost approximately $660,000,000 to construct. The East Toba and Montrose power facilities are expected to start operation in mid-2010. BC Hydro will purchase all the electricity generated by Toba Montrose under a 35-year sales contract.[1]

1.1.2 The prime contractor: Peter Kiewit Sons Co.

Plutonic contracted Peter Kiewit Sons Co. (Kiewit) as the prime contractor to construct the East Toba and Montrose projects, including the 144-kilometre transmission line for connection to the power grid. Kiewit has its corporate head office in Omaha, Nebraska, and has many other offices across the United States and in Canada. Kiewit is a very large construction contractor with many years experience in constructing highways, bridges, mass transit systems, mine sites, hydroelectric powerhouses, dams, and industrial facilities. The firm also specializes in grading, paving, excavation, and structures. During February 2009, approximately 250 people were working at Toba Inlet in construction and support services for the projects.

[1] All the information in section 1.1.1 is from the Plutonic Power Corporation website: http://www.plutonic.ca/s/Home.asp

1.2 Work activity

1.2.1 Montrose project construction

The Montrose project entails intake of a portion of the water flowing from Montrose Creek (at an elevation of 512 metres) through a water conveyance system to turbines and generators in a powerhouse near Filer Creek (at an elevation of 51 metres). The water conveyance system, approximately 4 kilometres in length, includes the intake structure on Montrose Creek, an 1,800-metre length of low-pressure conduit, and a 2,200-metre length of large-diameter steel penstock. The water from the conveyance system will flow down the mountainside to the powerhouse (see Figures 1 and 2).

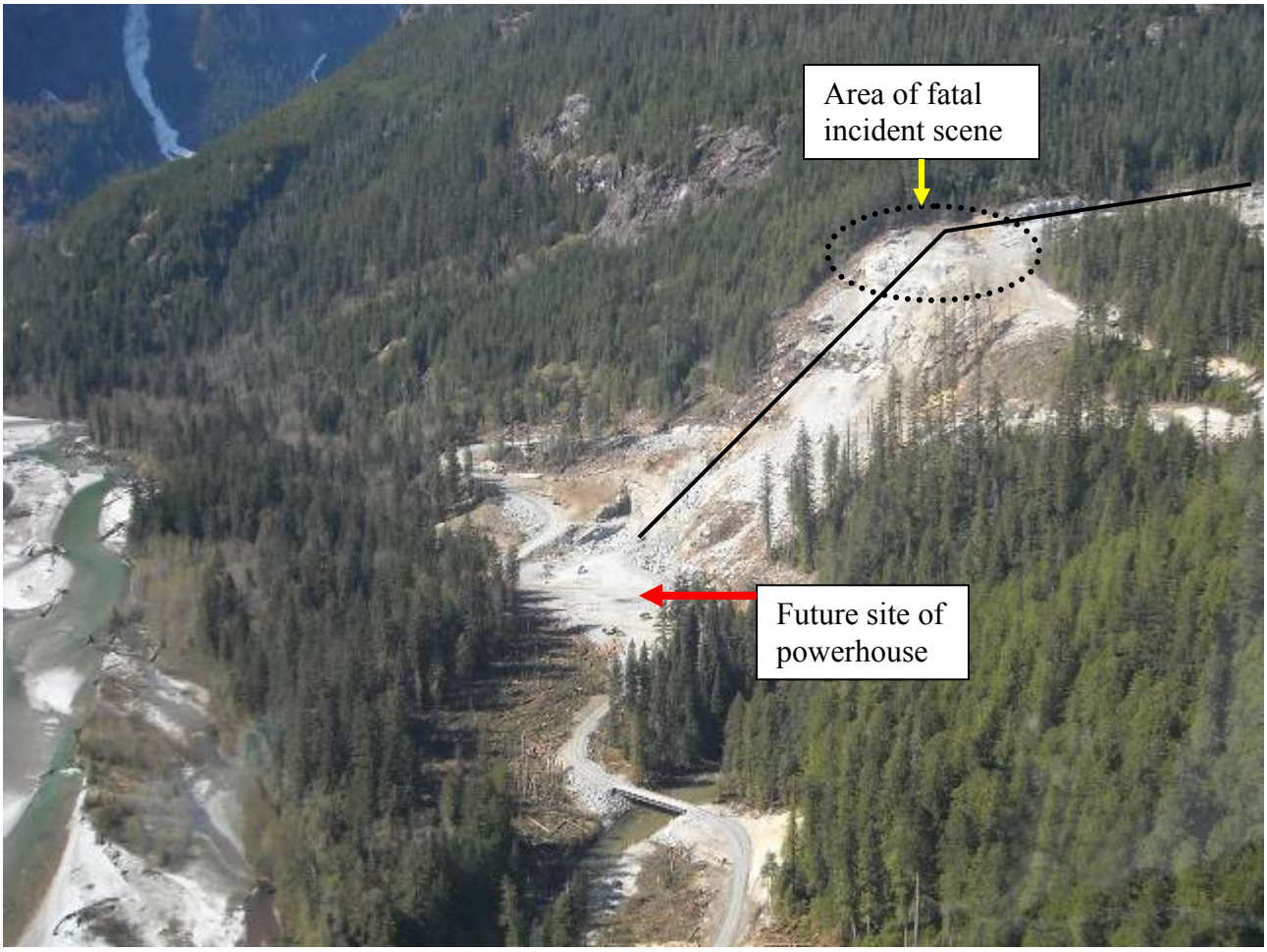

Figure 1. *File photograph of Montrose site sourced from the Plutonic Power Corporation website. The inserted line approximately indicates a portion of the penstock route.*

To prepare to place the penstock on the steep terrain, new road construction and site logging occurred in the early summer of 2008 to remove the virgin timber. A large volume of earth and rock material on the mountainside had to be drilled, blasted, and excavated to achieve the specified profile for the penstock installation. By the end of January 2009, approximately 51 percent of the planned excavation and haulage for the Montrose penstock alignment was completed.

Some of the larger rock material, particularly from the lower portion of the mountain and the future powerhouse location, was loaded onto rock trucks and hauled away for use in other areas. More commonly, excavators were used to "muck" or clear and scale organic and blasted material from work areas and roads, and to cast much of the material down the slope. One side of the slope received the majority of the casted material due to the topography of the mountain. This side of the slope provided a natural chute that carried the material away from the future penstock area. The installation plan for the penstock placed the structure diagonally on the other side of the steep slope (see Figure 2).

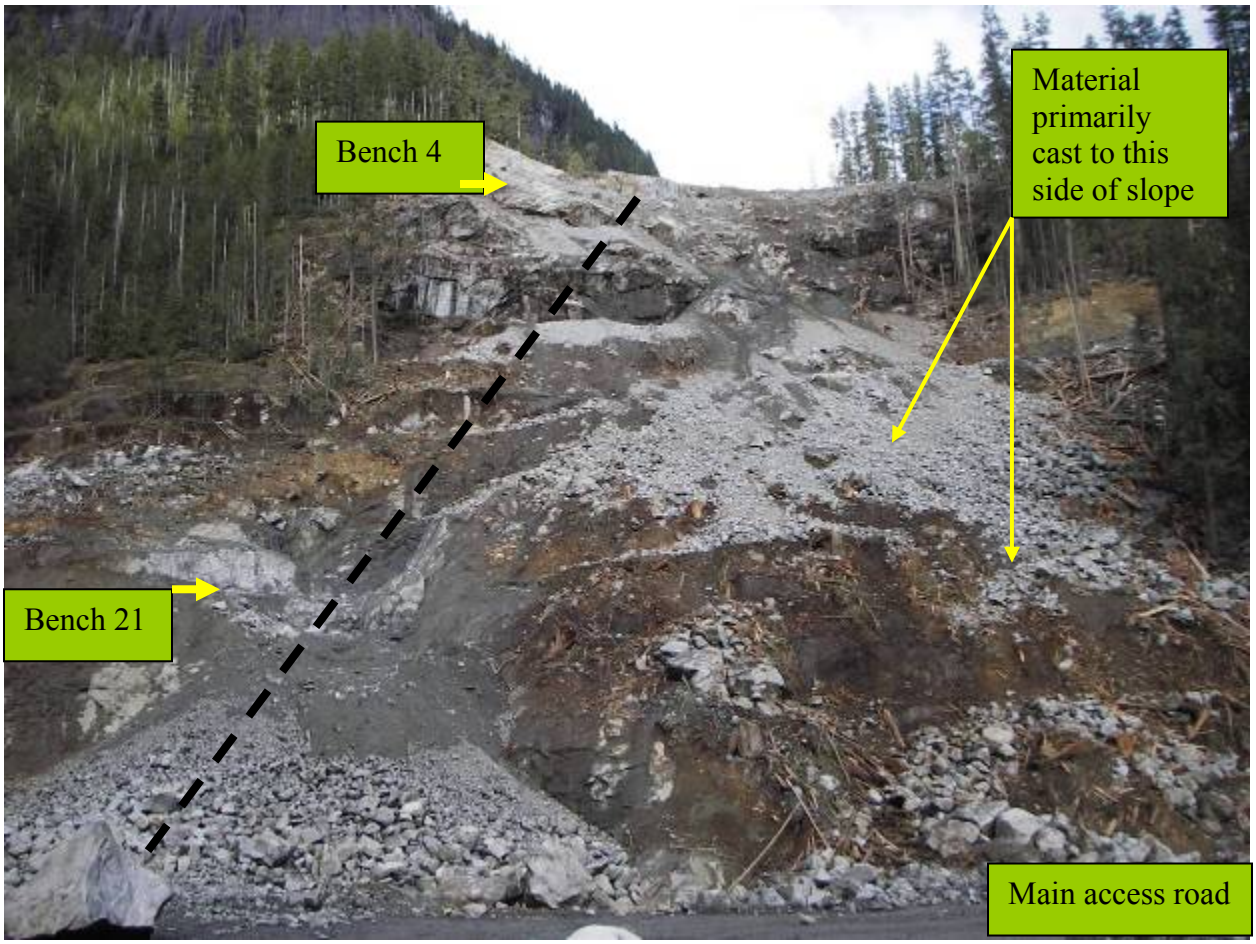

Figure 2. *Mountainside at the Montrose construction site. The work at the site involved blasting and excavation to place the penstock diagonally on the slope as approximated by the dotted line.*

Once the work achieved an 87 percent slope profile on the steepest portion of the mountain, the plans for construction entailed surface mounting a 256-metre length of penstock from the powerhouse location to the crest of the hill. On the less steep, upper portion of the mountain above the crest of the hill, the plan entailed excavation to bury the penstock from the crest of the hill to the water intake area.

1.2.2 Kiewit personnel involved

All of the personnel directly involved in the February 2009 workplace incidents on the Montrose project were Kiewit employees. Many, but not all of the workers, were members of the Christian Labourer Association of Canada union (CLAC Local 67). Personnel typically worked for three consecutive weeks and then went home for one week.

Personnel reported to an on-site Project Manager who had overall authority and responsibilities for both the East Toba and Montrose sites. Reporting to the Project Manager was the Construction Manager, who also oversaw both the East Toba and Montrose sites. The Construction Manager directly oversaw both the Drill and Blast Superintendent and the Earthworks Superintendent. The workplace also had two on-site project safety managers (Project Safety Manager 1 and Project Safety Manager 2).

The Drill and Blast Superintendent had management responsibilities for the drilling and blasting crews working on both sites. When the Drill and Blast Superintendent had time off, the Drill and Blast Engineer performed the Drill and Blast Superintendent's supervisory duties in the field. The Drill and Blast Superintendent left the worksite for his scheduled time off on February 20, 2009.

At the Montrose site, the Blaster was the foreman of the day shift drill and blast crew, which consisted of two drillers and two hand scalers (Scaler 1 and Scaler 2). In addition to scaling slopes, Scaler 1 and Scaler 2 manually drilled boulders, installed rock bolts, and assisted in blasting preparation. The scalers were both young, but experienced and trained workers. .

The Earthworks Superintendent had management responsibilities for the Montrose site only, and oversaw excavation and machine-scaling, loading, and trucking from the site. At the time of the incident at the Montrose site, the earthworks crew consisted of the Earthworks Superintendent, the Earthworks Foreman, and the Excavator Operator.

1.2.3 Consulting engineers

Kiewit contracted the geotechnical engineering firm of Wyllie & Norrish Rock Engineers Ltd. (Wyllie Norrish) to advise Kiewit's personnel on the projects' excavation and blasting design and on slope stabilization measures. Records indicate that Wyllie Norrish geotechnical engineers periodically visited the worksites during 2008 and made three visits in 2009 to the Montrose site. Geotechnical Engineer 1 visited on February 2–5 and February 12–14, and Geotechnical

Engineer 2 visited on February 17–20. These three inspections focused on post-blast terrain assessment and recommendations for stabilization measures for the area between Bench 4 and the top of the rock cut. The Drill and Blast Superintendent attended the site during the geotechnical engineers' February 12–14 and February 17–20 consultations.

Wyllie Norrish provided engineering reports documenting the geotechnical engineers' observations and recommendations, including photographs taken during their site inspections. The reports provided during February 2009 did not contain information about conditions above the crest of the hill.

1.3 Events preceding the February 21 and 22 incidents

By mid-December 2008, Kiewit had laid off many personnel for the holiday season. At the Montrose site, earthwork and drilling activities resumed by January 10, 2009. From January 10 to the fatal incident on February 22, records indicate a considerable amount of drilling, blasting, and excavating activities occurred at Montrose. Two separate drill and blast crews worked on day shift and night shift to drill and blast the terrain. The earthworks crew and excavator operators ordinarily worked only during the day shift, as did the scalers.

When the drilling, blasting and earthworks crew were off-site for their scheduled one week off, other personnel replaced them to work continuously at Montrose. However, no other hand scalers replaced Scaler 1 and Scaler 2 when they had time off. Although equipment operators were available to scale slopes with excavators, no hand scaling of the site occurred during the scalers' absences for the holiday season or for their routine time off.

1.3.1 Work at site during January and early February

Scaler 1, Scaler 2, the day-shift Blaster, and his assigned drilling crew resumed work on January 17, 2009, after the holiday lay off. From January 17 to February 5, time records indicate that Scaler 1 worked almost exclusively on blasting support duties. Some of the time he did rock bolting, but he did not perform any scaling duties during this period.

Many persons interviewed during the investigation explained that work practice at the Montrose site involved alternating the drill and blast crew with the earthworks crew at two headings (benches) of the rock cut (the steep portion of the hill). Simultaneously, the drill and blast crew would work on one bench, while the earthworks crew worked on another bench.

February 6 was the last working day of the three-week shift for the scalers and the crews involved in the February 21 and 22 incidents. On this date, Scaler 1 and the Night Shift Blasting Foreman scaled and stabilized rock, while Scaler 2 worked with the day shift blasting and drilling crew.

1.3.2 February 8 rock fall incident

On February 8, 2009, a rock fall incident caused some damage to an excavator operating at the Montrose site, which the employer categorized as a repair costing under $2,500. Weather records indicated that light precipitation occurred on that date. Shortly after a blast, workers noted the movement of rocks on the slope. A rock then rolled down the slope and struck the excavator. Corrective actions in response to the February 8 incident consisted of building a catchment berm below Bench 4 to contain falling rocks and having supervisors monitor the site.

1.3.3 Mid-February to February 21

From February 8 onward, supervisory personnel working at the Montrose site frequently documented the hazards of loose rock and the potential for rock fall during their daily crew meetings. Supervisors noted controls for these identified hazards in multiple pre-task instruction records that both the supervisors and workers signed. Instructions included being aware of the hazard, using a spotter to alert others to rock movement, and obtaining clearance before travelling on roadways.

A third scaler, who routinely worked with the crew constructing the transmission line, scaled temporarily with Scaler 1 and Scaler 2 at the Montrose site on February 14–16. Because his services were needed on the transmission line construction, he returned to his usual job after assisting Scaler 1 and Scaler 2 for three days. On February 15, while the third scaler was present, the Blaster conducted a trim blast along the tree line area beside Bench 4. (A trim blast is a light blast that removes, or "trims," unstable materials along the edge of the rock cut.)

Time records indicate that from February 17 to February 20, Scaler 1 and Scaler 2 spent half of their shifts scaling and the other half on drilling support duties. Records indicate that between February 5 and 20, blasting and excavation had removed enough rock from the Bench 4 area to lower the elevation of the bench by 15 metres, from 236 metres to 221 metres.

1.3.4 February geotechnical inspections

After the blasting exposed the new face above Bench 4, the Wyllie Norrish geotechnical engineers noted that some unstable rock wedges would slide as soon as the face was excavated and they prescribed rock bolting to stabilize these areas. Geotechnical Engineer 2 photographed the Bench 4 area on February 18 (see Figure 3). Other photographs he took included the area closer to the tree line. Near the tree line, Geotechnical Engineer 2 prescribed trim blasting to remove unstable materials along the edge of the rock cut. Before the February 21 and 22 incidents, in the last report written by Geotechnical Engineer 2, full scaling of the face above Bench 4 was recommended.

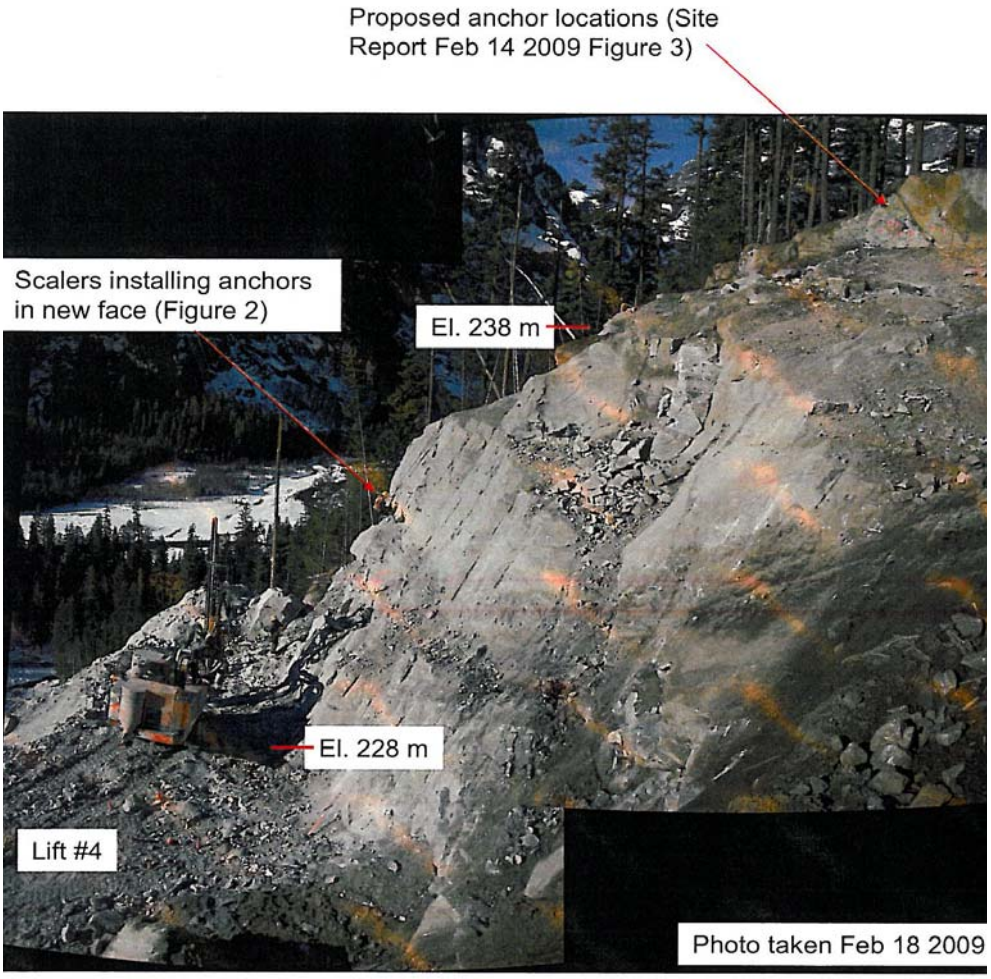

Figure 3. *Wyllie Norrish photograph. Ranger drill on Bench 4 on February 18, 2009. Note: Wyllie Norrish inserted the labels and caption in this photograph and in the Figure 4 photograph.*

During the February 17–20 geotechnical inspection, Geotechnical Engineer 2 photographed a large boulder located uphill from Bench 4. Geotechnical Engineer 2 advised the removal of the boulder because it was on the penstock alignment (see Figure 4).

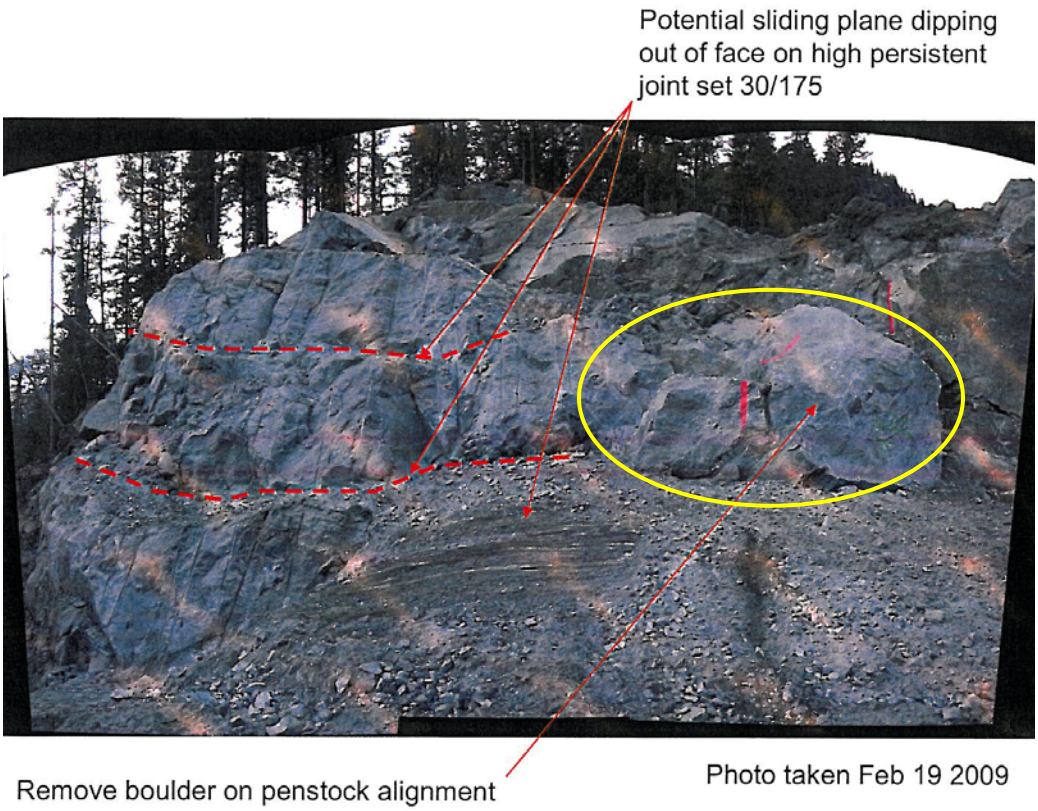

Figure 4. *Wyllie Norrish photograph. The inserted circle indicates the boulder that lay upon the penstock alignment approximately 10 metres uphill from Bench 4. Note the trough-like topography at the crest of the hill directly above the boulder. This boulder was the location of the fatal incident on February 22, 2009.*

According to witnesses' statements, the night shift crew blasted on Bench 4 during the February 19–20 shift. On February 20, Scaler 1 and Scaler 2 scaled for half of the day shift; then all crews attended a half day of driver training. The night shift crew again blasted on Bench 4 during the February 20–21 shift.

1.4 Serious rock fall of February 21

1.4.1 The incident

Early in the morning of February 21, 2009, a very serious rock fall incident occurred while the survey crew, Kiewit engineers, the drill and blast crew, and the Earthworks Foreman were working on Bench 21. It had not rained or snowed before the incident. At the time of the incident, the Excavator Operator was working uphill near the Bench 4 access road, casting loose material downhill. Scaler 1 and Scaler 2 were scaling above Bench 4 and near the tree line in the area that had been recently trim blasted.

The Earthworks Superintendent was sitting in a vehicle near the powerhouse location on or near the main access road. The Earthworks Superintendent saw a large boulder rolling down the hill in the area where the excavator was working and used his radio to warn the crew on Bench 21 to "look out, there's a rock coming down."

The boulder travelled a significant distance down the hill. It rolled down to the main access road, crossed the road, and dropped downhill and landed on Bench 21. (Figure 5 shows the terrain the boulder rolled upon. See also Figure 2 for a closer view of Bench 21).

The boulder, estimated by incident witnesses to be 5 feet in diameter, landed near the two drills positioned for work on the Bench 21, and struck the Hoe Drill Operator's machine.

Immediately after the rock struck the hoe drill, the Earthworks Superintendent radioed the Excavator Operator to direct him not to move the excavator and to advise him that a rock fall had occurred. The Excavator Operator had not seen the rock begin to move and was not aware of what had happened until the Earthworks Superintendent informed him.

1.4.2 Employer investigates February 21 incident

The Earthworks Superintendent halted the work at the site and informed his superiors of the incident. The Project Manager, Construction Manager, Project Safety Manager 2, and maintenance department personnel came to the scene. Assessment of the hoe drill determined that the boulder's impact had damaged the hoe-drill's compressor, compressor frame and a drill component, the catwalk, and the bottom section of the windshield. The estimated cost of repair was $65,000.

Once the Project Manager, Construction Manager, and Project Safety Manager 2 arrived at the site, they investigated the incident with the Earthworks Superintendent and Earthworks Foreman. This investigation team did not include a CLAC representative, a worker safety representative, or a worker member from the joint health and safety committee. The Excavator Operator had not seen the boulder moving at all, and the Earthworks Superintendent had not seen where the boulder was when it initially began to roll. The group of investigating personnel could not determine exactly where the boulder had originated. They could not tell whether it had rolled spontaneously, or if the excavator had moved it. They could not ascertain if the excavation activity had set the boulder in motion by directly striking the boulder or from causing the boulder to move and, in turn, strike other material. Records regarding the incident, and the evidence provided by the Earthworks Foreman, indicate that the boulder most likely rolled down from the penstock intake (PI) 28 area near Bench 4. (PI 27 and PI 28 are locations on the penstock intake area on the less steep terrain above the rock cut.)

Notably, the inspection of the worksite following the February 21 incident did not include an examination of the terrain above the top of the rock cut for unstable material in that area.

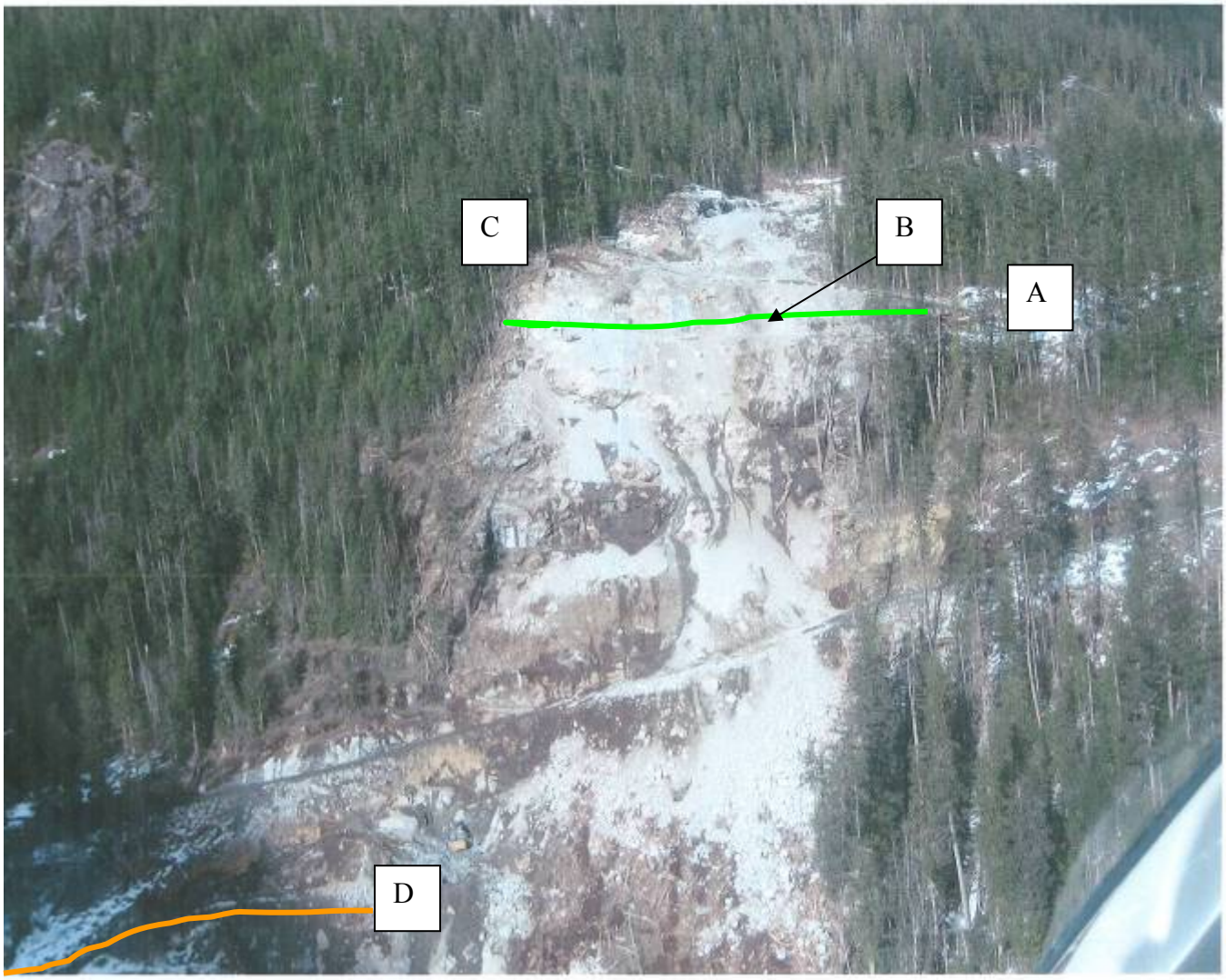

Figure 5. *Undated Kiewit aerial photograph of site. Box A shows the location of the Bench 4 access road (green line). Box B indicates the location of the Excavator Operator near the outer end of the Bench 4 access road. Box C shows the scalers' location above Bench 4. Box D indicates the location of the Bench 21 access road (orange line) and the crews working on Bench 21. It is not known with certainty whether the boulder in the February 21 incident originated from the area above Bench 4 or from below Bench 4, but it was observed rolling in the area near where the excavator was working.*

1.4.3 Safety stand-down meeting

The Project Manager directed the Construction Manager to halt work on the site until a new work plan was developed to prevent a recurrence of a similar rock fall incident. Shortly after he arrived at the site, the Construction Manager instructed all personnel to return to camp. Before the Excavator Operator returned to camp, he cleared the access road of blasted and cast material. The Construction Manager also directed the drill and blast crew and the earthworks crew to meet at camp later in the day to discuss what had occurred at a safety stand-down meeting.

According to the Earthworks Engineer, the Earthworks Superintendent asserted at the safety stand-down meeting that crews could no longer work two different headings, such as Bench 4 and Bench 21, simultaneously. The outcome of the meeting was that no upslope work would occur above crews working on the rock cut (the steep portion of the hill). Both the earthworks and drill and blast crews created new written work plans and revised their job hazard analysis sheets to reflect this change in practice.

At the meeting, some discussion also occurred about how to remove the boulder on the penstock alignment above Bench 4. It was decided that the scalers would hand drill the boulder. Several personnel interviewed confirmed that this decision was made at the meeting. However, the Excavator Operator left the meeting understanding that the boulder would be drilled with a hoe drill.

1.4.4 Scalers' concerns

During interviews conducted for this investigation, Scaler 2 stated that on February 21, Scaler 1 had voiced concerns to the Construction Manager about the lack of an emergency and rescue plan in the event that a similar rock fall injure a rope-suspended scaler during scaling. Scaler 2 said that following this discussion, the Construction Manager had the scalers draft an emergency rescue plan at camp during the afternoon of February 21.

Scaler 2 alleged that, while he was at camp during the afternoon of February 21, he went to the Construction Manager's office to discuss site safety concerns. Scaler 2 stated in two interviews conducted by WorkSafeBC, and in an interview conducted by the RCMP, that he told the Construction Manager the amount of scaling was insufficient to deal with the increasing size of the rock cut, and that additional scalers were needed. Scaler 2 stated that he gave the Construction Manager the name and phone number of a scaling contractor, and that the Construction Manager took the information from him. [redacted] Scaler 2 stated that because of these reasons, he asked the Construction Manager if a hoe drill operator could drill the boulder. Scaler 2 stated that the Construction Manager told him to speak to the Earthworks Superintendent about the matter. Scaler 2 did not discuss the matter with the Earthworks Superintendent.

When the WorkSafeBC investigator questioned the Construction Manager about the safety complaints Scaler 2 reportedly made to him, the Construction Manager denied that this conversation had occurred.

1.5 Fatal rock fall of February 22

1.5.1 Work resumes on February 22

At 05:30 on February 22, 2009, the earthworks crew, comprising the Earthworks Superintendent, the Earthworks Foreman, Earthworks Engineer, and the Excavator Operator, met at the camp to discuss their planned activities for the day. The Drill and Blast Superintendent, the Drill and Blast Engineer, the Blaster, the drill and blast crew, and the scalers were not involved in this meeting; however, they held a similar pre-work meeting.

At the earthworks crew's pre-work meeting, emphasis was placed on the revised plan that no work would take place above workers on the steeper portion of the hill to avoid a rock fall incident like the day before. The earthworks crew decided that the Excavator Operator would first clear Bench 4 of blasted material to enable the drill and blast crew to continue drilling and blasting preparation in that area. However, despite the new work plan, the earthworks crew decided that once Bench 4 was cleared, the Excavator Operator and the Earthworks Foreman would operate two excavators farther uphill between PI 28 and PI 27 to prepare more terrain upslope for the drills. Although this plan meant that the Excavator Operator and the Earthworks Foreman would be working uphill of Bench 4 and other workers, the decision to do so was based on the belief that the terrain was not as steep as that below upon the rock cut.

Following their pre-work meeting, the earthworks crew departed for the job site. At approximately 06:30, the Excavator Operator started to clear Bench 4 using a CAT 345 excavator. However, before starting his duties, the Excavator Operator did not check the terrain uphill of Bench 4 for unstable material that might have been present upslope. In addition to mucking out the blast material, the Excavator Operator spent some time constructing an earth ramp from Bench 4 to the boulder to enable a hoe drill to access and drill the boulder.

By 07:30, the drill and blast crew, survey crew, and scalers arrived at the site. Scaler 1 and Scaler 2 worked above Bench 4 near the tree line and crest of the hill for a few minutes, continuing to hand drill, scale, and dust off areas with an air wand.

By 08:00, the Excavator Operator had cleared Bench 4 of enough material to enable the survey crew, the Ranger Drill Operator, and Kiewit engineers to enter Bench 4 and partially begin their work. The Ranger Drill Operator drilled holes on the very steep rock face closer to the inner end of Bench 4 and directly below where the scalers were working.

At this time, the Drill and Blast Engineer arrived and radioed the scalers to stop scaling because people were on Bench 4 and the Ranger Drill Operator had started to drill below them. The Drill

and Blast Engineer walked above Bench 4 and went across the slope to where the scalers were working. He directed the scalers to go down the slope and to begin hand drilling the boulder on the penstock alignment. When interviewed, Scaler 2 stated that at first he refused to hand drill the boulder. He complained to the Drill and Blast Engineer that the scalers did not have enough time to complete the scaling work, that he and Scaler 1 did not want to hand drill the boulder due to safety concerns about the unscaled slope above Bench 4, and that they thought a hoe drill operator should drill the boulder instead of them. Scaler 2 stated that the Drill and Blast Engineer "[redacted]"; he responded by stating the drills had their own work to do and he persisted in directing the scalers to do the hand drilling themselves. The scalers did not continue to refuse to do the work. When interviewed for the investigation, the Drill and Blast Engineer said that Scaler 2 had mentioned something to him about needing more time; however, he denied that the scalers had made a safety complaint about the condition of the slopes above Bench 4 or about the safety of hand drilling the boulder.

The scalers moved the air line of the compressor they needed for hand drilling from the tree line area downhill to the boulder (see Figure 6).

Figure 6. *The compressor air line the scalers moved from tree line area to the boulder. The boulder was below the air line in the lower left corner of the photograph. Note the loose rocks near the air line.*

The scalers began to hand drill the boulder, taking turns doing this very physical and noisy work. Meanwhile, the Excavator Operator continued clearing the rest of Bench 4 until about 09:30–09:45. The Drill and Blast Engineer left the site while the Excavator Operator was still clearing Bench 4. After the Excavator Operator finished clearing Bench 4, the Earthworks Foreman directed the Excavator Operator to take the excavator uphill to work while the Earthworks Foreman bulldozed the road nearby to clear the rocks cast from Bench 4.

A hoe drill hauled to the site during the morning replaced the machine damaged the previous day. After Bench 4 was cleared and the blasting pattern was established, the Hoe Drill Operator positioned the hoe drill on the central area of Bench 4. The Hoe Drill Operator started drilling his portion of the blast pattern on the side of the bench closer to the Ranger Drill Operator's location, while tracking the hoe drill out toward the bench's central area.

The Earthworks Superintendent was on site throughout the shift, but for most of the time, he remained in a vehicle at the base of the hill. He was providing traffic control to keep personnel from entering Bench 21 or the main access road while work was going on uphill. After the Earthworks Foreman finished clearing the road, he went up the slope to operate a second excavator. To access the area he intended to work in, the Earthworks Foreman travelled near the area where the Excavator Operator was working above the crest of the hill. At all times while the Earthworks Foreman was above the crest of the hill, he had an unhindered view of the Excavator Operator working below him.

By the time the road and Bench 4 were cleared, it had started to rain. It rained lightly at first and then increased to a steady, moderate amount of rainfall. The Excavator Operator said that as the amount of precipitation increased, he noticed some wet material slough from the banks as he worked above the crest of the hill. At some point during this activity, the Earthworks Superintendent came up the hill to Bench 4 to bring some empty blasting-powder bags to the Blaster. He then returned to the base of the hill.

The Hoe Drill Operator finished drilling his portion of the blast pattern, and using reverse gear, travelled backward on Bench 4 to park the hoe drill about 10 metres below the boulder where the scalers were working. The Excavator Operator described that he then had the excavator positioned at a 45-degree angle to the tree line and was gathering small rocks near the machine. The excavator was about 50 metres upslope from the crest of the hill and approximately 20 metres from the tree line.

1.5.2 Rock rolls downslope to Bench 4

The Excavator Operator noticed that to the left of his machine and downhill, a 5-foot to 6-foot diameter rock was rolling out from the tree line area. The Excavator Operator described that when he first saw the rolling rock, it was on some rough ground just uphill of and near the verge of smoother ground that had been machine-scaled about a month before (see Figure 7). At times, the motion of the rock slowed on the rough ground, and the Excavator Operator thought that the

rock might stop. At one point during his observation, the Excavator Operator lost sight of the rock as it rolled behind a berm of piled material.

Figure 7. *Rough area adjacent to previously machine-scaled ground.*

Then, the Excavator Operator saw the rock again and realized it was continuing to roll. The Excavator Operator used the radio to warn the drilling crew about the rock coming toward Bench 4. He feared that the rock would enter the trough in the terrain and drop into the drilling area. He saw the rock roll over the berm of material and speed up once it rolled onto the smoother ground (see Figure 8). The rock rolled down the trough-like depression in the terrain toward a black pail sitting near the crest of the hill. The rock then dropped over the crest to Bench 4 (see Figure 9).

Figure 8. *Previously machine-scaled area. The dotted line indicates the rock's path that the Excavator Operator described.*

At this time, the Blaster was doing some paperwork in his pickup near the outer end of Bench 4. The Hoe Drill Operator was standing beside the hoe drill's front left track, conversing with Scaler 2, who was sitting in the cab of the hoe drill. The Ranger Drill Operator was drilling, and Scaler 1 was on the boulder running the hand drill. Everyone at the worksite heard the Excavator Operator's warning except Scaler 1. Scaler 1 was wearing hearing protection because of the hand drill's loud noise and he did not have a radio.

Scaler 2 and the Hoe Drill Operator started yelling at Scaler 1 to warn him. Just as Scaler 1 looked downhill at the Hoe Drill Operator and Scaler 2, the rock rolled over the crest behind Scaler 1, struck him directly, and rolled over him.

Figure 9. *Overview photograph of fatal incident area. The dotted line indicates the path of the rock that the Excavator Operator and the drilling crew described. The area within the oval at the tree line is where the Excavator Operator first saw the rolling rock. The downward arrow points to the Excavator Operator's machine, which is in the area within the rectangle. The horizontal arrow points to the fatality scene. The upward arrow points to the hoe drill.*

The rock partially fragmented after striking Scaler 1 and the boulder he had been drilling, but a large portion of the rock continued to come directly toward the hoe drill. The Blaster looked toward the area and saw the Hoe Drill Operator rapidly move from near the hoe drill's left track to escape being struck by the rock by taking shelter beside the rock face. Scaler 2 remained in the cab of the hoe drill. The rock struck the track of the hoe drill and split apart into several pieces. Some of the rock's fragments remained beside the hoe drill's left track and the rock face, and a large portion landed behind the rear of the hoe drill (see Figures 10 and 11).

Figure 10. *Fatality scene indicated by the circled area. The rock split apart during the incident. Some of the rock's fragments remained on the boulder. The arrow points to one of the rock's fragments that landed behind the hoe drill.*

Figure 11. *Rock fragments between the left track of hoe drill and the rock face are circled. The blue arrow points to where the Hoe Drill Operator moved to take shelter from the rolling rock. The yellow upward arrow points to the rock fragment behind the hoe drill.*

Both the Hoe Drill Operator and the Blaster (who had previously had Level 3 first aid certification for more than) immediately went onto the boulder to assess Scaler 1 for signs of life. Scaler 1 had no vital signs present, and it was evident that he had an extremely severe head injury, as well as other injuries. The Hoe Drill Operator and the Blaster were very certain that Scaler 1 had died.

The Ranger Drill Operator radioed the camp

to request that a first aid attendant come to the scene. As Scaler 1's airway was not clear, the Blaster moved Scaler 1 slightly in an effort to place him in a three-quarter prone position.

No resuscitation measures were attempted until the Nurse/FAA from the camp arrived at the incident site at 13:30. She assessed Scaler 1 and did not find any vital signs present. Using advanced first aid techniques and equipment, she attempted resuscitation without success. She determined that death had occurred and ceased resuscitation measures at 13:45. She made the decision to transport Scaler 1's body from the worksite to the camp and await the arrival of the Coroner and investigators. In her first aid reports of the incident, the Nurse/FAA documented that "the scene was unsafe for rescuers to remain."

Soon after the incident, Kiewit The Earthworks Superintendent and the Earthworks Foreman remained at the camp.

1.6 Cause of death

The Coroner did not require an autopsy. Severe head injury was the evident cause of death.

1.7 Site factors

1.7.1 Topographical conditions above Bench 4

Above Bench 4, there was a significant trough-like depression in the ground (see Figure 12). Persons interviewed were aware of the presence of this trough and further understood that material that rolled in the area and entered the trough would likely roll farther onto Bench 4. The terrain above the crest of the hill sloped to varying degrees in different locations; Kiewit engineering personnel estimated that the area where the rock was seen rolling had a slope of 30 to 35 percent.

Figure 12. *Trough above Bench 4. The rock rolled down the trough and beside the black pail. The upper components of the hoe drill (still where it was parked when the fatality occurred) are visible near the centre of the photograph.*

1.7.2 Loose material

The Montrose site had many areas where workers and road users were exposed to unstable or loose materials such as rocks, forest debris, damaged or disturbed standing timber, and some unsecure logs. In the area above Bench 4, there were numerous loose rocks of varying sizes evident both on the face of the rock cut, in close range of the crest, and within the 50-metre area uphill from the crest.

Some of the larger rocks near the tree line area were on top of disturbed ground and forest debris that afforded little surface stability (see Figure 13). Equipment track marks and the fresh appearance of disturbed ground indicated that mobile equipment operation had recently disturbed some of the loose materials.

Figure 13. *Unstable materials adjacent to area previously machine-scaled. A rock lying upon loose forest debris is circled.*

Some hand scaling had previously occurred near the crest following some recent blasting in that area. Scaler 2 asserted his belief that the rock that rolled and killed Scaler 1 was loose material from this area that was not removed after the trim blasts the preceding week.

On the rock face above where the drillers and scalers drilled, and above where others, such as the Kiewit engineers, the Blaster, and the survey crew had worked, there were unscaled rocks on the uphill face of the rock cut (see Figure 14). This same loose material was present and shown on the February 18 photograph taken by Geotechnical Engineer 2 (see Figure 3). In his inspection report, the engineer had recommended that the full face be scaled.

Figure 14. *Loose unscaled rock above the Ranger Drill Operator's location.*

Below the access road to Bench 4, and above the main access road to the site, there were loose rocks, forest debris, and logs (see Figure 15). These materials presented falling material hazards to persons travelling on roads or working below them.

Figure 15. *Unstable rock, forest debris, and logs below the Bench 4 access road and above the main access road.*

1.8 Safety requirements

Employers must plan, construct, use, and maintain workplaces to protect any person working at them from danger. This is stated by the reference to "Safe Workplace" in section 4.1 of the Occupational Health and Safety (OHS) Regulation. Several provisions outlined by the OHS Regulation require employers to protect workers from work areas made hazardous by falling or unsecured materials. There are requirements for employers in construction to make work areas safe from these hazards outlined in section 20.9. There are also parallel requirements specific to drilling in section 21.42(b), excavating in sections 20.80 and 20.92, scaling in section 20.97, and blasting in section 21.76. These requirements vary, but all deal with protecting workers from the hazards of unstable or loose material that may fall and strike them. Other provisions require that roadways are made safe from these hazards.

The *Workers Compensation Act*, section 115(2)(a), requires employers to remedy any workplace conditions that are hazardous to the health and safety of the employer's workers. Being struck by an object or unstable material is a common cause of serious injury—or death—in workplace incidents.

1.9 Work practices

1.9.1 Working above other crews

Until the rock fall incident of February 21, the practice at the worksite was to work two different headings on the rock cut simultaneously. The February 22 pre-work plan to have the earthworks crew work above the drilling crew contradicted safety requirements and the change in practice determined on February 21 to have no one work above other crews.

1.9.2 Scaling

The excavator operators' duties were to machine scale and to muck out blast material to keep ground available for drilling.

The Excavator Operator stated that about one month prior to the incidents, he had completely scaled the area adjacent to the crest of the hill. On the ground farther uphill from the machine-scaled area, some brush and forest debris had been previously pulled back from the terrain and piled, but this area had not yet been scaled as the drilling crews had not yet worked in that area.

1.10 Safety supervision and oversight

The Montrose site always had a number of supervisory personnel present, ranging from the lower-level line supervisors (such as the Blaster and the Earthworks Foreman) who were present on every shift, to the two superintendents (Earthworks Superintendent and Drill and Blast Superintendent) who were present most days at the site, to the Construction Manager who would usually visit the site every other day. Kiewit had comprehensive training materials on safety supervision in its written supervisor training program. The supervisors and superintendents received training on safety rules and regulations to identify and document hazards, specify forms of hazard control measures, and communicate this information to their crews and superiors.

The East Toba and Montrose projects had two on-site project safety managers responsible for delivering Kiewit's corporate safety program and the site-specific safety plan. The on-site project safety managers reviewed job safety analysis documents written by the lower-level line supervisors and superintendents, and would periodically visit the worksites. The Earthworks

Superintendent stated that during his work at the Montrose project, he had not seen any reports from the project safety managers following their site visits.

Kiewit's district office for Western Canada has safety department personnel with duties that include delivering safety training, participating in the district safety committee and conducting safety audits of Kiewit projects. Kiewit also has a corporate safety committee (from the American head office) that would randomly select a Kiewit project for a corporate safety audit. At the time of the February 21 and 22 incidents, neither the district safety committee nor the corporate safety committee had conducted safety audits of the East Toba or Montrose sites.

2 Analysis

This analysis focuses on the following:

- What factors caused the rock to roll into the work area
- Why substantial amounts of loose or unstable materials were present on the slopes
- How and why workers were assigned to work in areas subject to rock fall hazards

This analysis also considers how inadequate safety oversight systems resulted in potential rock falls not being prevented.

2.1 Movement of rock into work area

The evidence demonstrates that the Excavator Operator did not strike the rock involved in the fatal incident directly or cause the rock to be struck by another object immediately before it started to roll.

The investigation could not conclusively determine if the Excavator Operator had disturbed the rock or the surfaces the rock was close to when he scaled some area near the tree line or when he stripped some overburden from the area during the hours preceding the incident. It is possible, that while he worked in proximity to the rock, he had previously disturbed it or the underlying or adjacent materials and did not realize that he had done so. It is also possible that some other equipment operator working on a different crew may have disturbed the rock on a previous occasion when brush and forest debris was removed.

Prior logging activity and the more recent excavating and blasting operations were very likely to have altered the surface stability of the earth, rocks, and forest material. The vibration transmitted through the ground from the drills operating and the excavator working nearby could have contributed to the rock being set into motion.

The change from winter to spring conditions likely affected the surface stability of objects. The incident occurred on a rainy day—the first time it had rained in several weeks. The incident also occurred at midday, a time when the ground was most subject to thawing from increased temperature. These conditions decreased the surface friction of loose materials on the ground.

The potential effect on the stability of surface objects as a result of natural environmental factors was foreseeable given the nature of the activities, the terrain, the time of year, and the coastal weather.

2.2 Unstable material present

2.2.1 Lack of post-blasting inspections

A post-blasting requirement is to examine the affected terrain after each blast in order to identify any unstable materials that must be removed prior to resuming operations in the area. During night shift blasting, darkness made it very difficult to thoroughly inspect terrain for unstable material even if supplementary lighting was used. Therefore, the areas should have been consistently and thoroughly inspected by others during daylight at the start of the next shift. There was no formal system in place to ensure this was carried out. Rather, information about the condition of the terrain was communicated through informal discussions between the day shift and night shift blasters. Further, in the absence of any formalized system to communicate information regarding the condition of the worksite, there was ineffective co-ordination or prioritization of scaling activities to address the accumulation of unstable material adjacent to areas in which drilling crews were scheduled to work.

2.2.2 Slopes insufficiently scaled as work progressed

The amount of unstable material WorkSafeBC officers saw on the site demonstrated that the amount of scaling done was insufficient for the size of the site and the pace of site development. The Project Manager acknowledged, after the fatal incident, that the site was not properly scaled. The work was proceeding on or ahead of schedule, and persons interviewed did not indicate that they had time pressure issues that would have contributed to insufficient scaling activity. The Construction Manager could have requested more scaling resources and/or temporarily or periodically curtailed drilling and blasting activity to ensure that adequate scaling of the site could occur. The evidence indicates that scaling activities that did occur were done with a minimalist approach specific to the areas actively worked in. It was certainly possible, through design of the project's progression and planning of the work, schedule alteration, or the employment of more resources, to scale sufficiently as work progressed so that unscaled material did not accumulate and unsafe conditions did not develop.

2.3 Deficient site co-ordination and communication

The topography being prepared for the surface-mounted penstock installation was such that both earthworks and drill and blast crews were working within relatively close proximity to one and other. The earthworks crew was to keep the area clear of materials to enable access and to prepare for further drilling and blasting. While excavator operators and scalers worked, the drill and blast crew could not work on the same bench simultaneously or safely work in areas downslope. In some instances, hand-scaling activities were stopped due to drilling activity.

Though they did discuss their work to some degree informally, the earthworks and drill and blast crews did not jointly plan their overlapping work. Instead, they participated in separate pre-work meetings and did separate safety planning. Due to terrain factors, crews working in one area could not always see what other workers were doing and, in fact, did not always know what the other crew's members were doing. For example, Scaler 2 did not know that an excavator was working in proximity to the crest of the hill while the scalers drilled the boulder. The Excavator Operator thought that a hoe-drill was going to drill the boulder and his work to build a ramp for the hoe-drill is evidence of his belief that this would occur. The Earthworks Superintendent could not see what his crew was doing from his location near the bottom of the hill. While it has not been determined that the activities of the excavator above the drill and blast crew caused the loose rock to roll, the failure to co-ordinate the work processes and the clean-up of loose material resulted in the drilling crew working below an area that had not been adequately machine-scaled. This lack of effective co-ordination exposed the workers to the hazard of falling debris.

2.4 Unsafe work assignments and deficient safety supervision

Unsafe workplace conditions, work assignments, and arrangement of work areas as well as inadequate supervision exposed workers to falling materials and did not comply with safety requirements.

2.4.1 Drilling below incompletely scaled slopes

The Site Specific Safety Plan developed specifically for the Toba and Montrose projects stated: "Scaled slopes must be reviewed and approved by a qualified person before being deemed safe for work on or below." Despite this written instruction, supervisory training, and knowledge of applicable safety requirements, Kiewit's on-site management personnel and project safety managers did not ensure that necessary scaling was completed. The one-line item in the Site Specific Safety Plan regarding scaled slopes did not provide clarity with respect to who was the "qualified person" with the responsibility to review and approve scaled slopes. There was no effective system in place to ensure that thorough site assessment for scaling occurred or that an effective scaling plan for the entire site was in place.

The , had walked through the slope that had unstable material when he was with the scalers above Bench 4 a few hours before the fatality. He did not direct that more machine and hand scaling be performed, though he had the authority to do so. It was objectively evident to WorkSafeBC's investigators that the unstable material posed a risk to any workers located on Bench 4. Although the who was stated that in his opinion the work areas were safe from dangers posed by unstable material, it was clear that drilling occurred before hazardous loose materials uphill were removed.

2.4.2 Machine-scaling uphill from drilling crew

It appears the earthworks supervisors involved thought it would not be hazardous to have the excavators work upslope of Bench 4 and the drilling crew because the excavators would be working on terrain less steep than the terrain on the rock cut.

Supervisors completed written work plans with specific instructions that no one would work above others yet, soon after, permitted the operation of two excavators uphill from the drilling crew. The Earthworks Superintendent and Earthworks Foreman completed daily "Foreman's Safety/Quality Meeting Records" that specifically identified rolling and falling rock as a safety hazard. The Hazard Analysis prepared by the Earthworks Engineer and the Excavator Operator on the day of the incident was signed off by the Earthworks Foreman and the Earthworks Superintendent. It specifically identified the hazard of rolling rock as a result of excavation work being carried out above other workers. The preventive measure identified in the Hazard Analysis was to not "…work above others." Further, the Earthworks Foreman and Earthworks Superintendent completed a Foreman/Superintendent's Safety Inspection Report, also on the day of the incident. The first hazard identified on that document was "Rocks rolling downhill to workers below." The corrective action plan was "No work below until top section finished." The individuals involved with the completion of the hazard analysis and daily safety documentation, in which the hazards of crews working above others were identified, were present at the worksite on the day of the incident. There were a number of supervisory personnel present who could have directed the crews so that machine-scaling would not take place above the drilling crew. However, none of the supervisors did so, despite having specifically identified the hazard.

2.5 Lack of adequate safety oversight systems

In relation to this hydroelectric project, Kiewit had an extensive safety program in place and many levels of supervisory personnel, including safety professionals. However, there was inadequate oversight of hazard prevention for the work process in question, insofar as unsafe work practices developed and persisted without correction by supervisory personnel. These practices were identified by supervisors and acknowledged in the firm's safety documentation but were not rectified. Inspections that did occur certainly focused on hazard identification and risk assessment. However, inspections were inadequate because they did not ensure that effective hazard controls appropriate for the work were initiated and maintained at the site. The fatal incident of February 22, 2009, was a direct result of this failure to correct unsafe work practices.

Following the February 21 incident with equipment damage, the firm did not take adequate measures to prevent a rock fall recurrence. While the supervisors stopped work and walked the site, they did not conduct a thorough inspection of the whole site with terrain stability experts, such as the geotechnical engineers from Wyllie Norrish or with experts in large site scaling activities. On other recent Kiewit projects, such as the Sea-to-Sky highway construction, Kiewit employed superintendents to oversee scaling activities. Following the safety stand-down meeting after the February 21 incident, no additional actions were taken to increase the amount of scaling done by machine or hand scalers to remove hazardous, unstable materials before resuming operations.

Although worker orientation included education in the right to refuse unsafe work and the processes to follow, there was conflicting evidence as to whether concerns Scaler 2 had regarding the adequacy of scaling at the site were brought forward, or acted upon. The incident investigations were carried out by the same supervisory personnel who oversaw the general co-ordination of earthworks and blasting activities. Worker representatives from the joint health and safety committee did not participate and may not have been included in prior inspections conducted at the Montrose site.

The Construction Manager stated that the firm relied on the advice of geotechnical engineers to identify which material had to be removed or stabilized. The periodic geotechnical inspections were clearly not an effective way to oversee the management of unstable materials given that the day and night blasting frequently changed the terrain of the sites. Much of the loose material was so obviously unstable that specialized expertise was not required to identify it as hazardous.

2.5.1 Lack of effective risk assessment

Witnesses acknowledged that they were cognizant of the hazards posed by loose material left unscaled above workers and the effects of machine-scaling above work crews below. As discussed earlier in this report, these hazards were clearly identified in the firm's daily safety meeting reports and Job Hazard Analysis documentation. However, the evidence of various site personnel demonstrated that workers and management involved in the incident had varying perceptions as to whether the manner in which the earthworks and drill and blast operations were being conducted actually exposed workers downslope to the risk of falling material, as contemplated in the safety documentation. In the result, either the two crews were not fully aware that their concurrent operations exposed workers to the type of incident which occurred or they considered the level of risk to be acceptably low.

It is clear that supervisory personnel for both crews did not appreciate that the extent to which loose material was left unscaled above workers created a significant hazard. The firm's analysis of the February 21, 2009, incident is illustrative. The firm completed an incident investigation report which identified the basic root cause of that event to be "…excavator working above work area containing the hoe drill and crew." However, this was not identified as an "unsafe act." While a new Job Hazard Analysis was completed to establish a "new working arrangement," the earthworks excavators proceeded with machine-scaling above the drill and blast crew the next day. Despite having experienced an incident of debris rolling downhill into an area populated by workers, the firm did not assess the extent of loose material still remaining above the area in which the drillers were located. A site inspection carried out by the Construction Manager, the Earthworks Superintendent, Project Safety Manager 2, and the Project Manager following that incident did not include a visual inspection of the complete uphill worksite, notwithstanding the fact that they could not identify with certainty the location from which the rock rolled. There appears to have been inadequate consideration of the debris remaining from blasting and excavating activities in the upper penstock intake area and whether machine-scaling was required before drilling crews could proceed with their work at a lower position on the cut.

3 Conclusions

3.1 Findings as to causes

3.1.1 Unstable rock rolled downhill, striking scaler

A large unstable rock, approximately 5 feet to 6 feet in diameter, rolled down a slope into the area where Scaler 1 and others worked. The rock directly struck Scaler 1 and inflicted fatal head injuries.

3.2 Findings as to underlying factors

3.2.1 Loose material hazards upslope from work areas

Numerous unstable rocks were present throughout the worksite and in the area above Bench 4. These materials were not thoroughly machine-scaled or hand scaled to stabilize or remove them before work occurred downslope.

3.2.2 Deficient safety planning and supervision

Supervisors assigned work in areas subject to the potentially hazardous movement of unstable materials above workers. The unsafe conditions were routinely identified and evident. These safety deficiencies occurred despite the active presence of many supervisors at the worksite. Supervisory and management personnel were reasonably knowledgeable about safety requirements to ensure a rock fall incident did not occur, but they did not adequately control the hazards, plan the progression of the work in a safe manner, and arrange the work to ensure worker safety.

3.2.3 Lack of effective risk assessment

Supervisors for both the earthworks and drill and blast crews did not adequately assess the extent to which products of blasting, logging debris, and materials subjected to excavating activities remained above areas in which work was still to be carried out.

4 Health and Safety Action Taken

4.1 Actions taken by employer

Following the fatal incident, the employer developed an extensive mitigation and corrective action plan accepted by WorkSafeBC for application at the Montrose, Toba, and transmission line sites. Below is a summary of the immediate action items of the 20-item plan:

- Geotechnical engineering: Have a certified geotechnical engineer develop an initial rock stabilization/scaling assessment plan, which will include zones for safe work.
- Develop a sign-off stability sheet: Develop, in conjunction with a geotechnical engineer, a sign-off stability sheet for use by the drill and blast superintendent to ensure safe access before and after scaling.
- Training in use of stability sign-off sheet: Have a geotechnical company develop a training program for stabilization and a sign-off sheet for Kiewit superintendents.
- Scaling plan: Have drill and blast superintendents develop a procedure for machine and hand scaling, and then use the plan in a training program.
- Scaler competency evaluation: Have superintendents ensure that a worker has performed prior scaling work and provided proof of this experience. Have superintendents assess the worker's level of proficiency to determine if the worker has sound knowledge and good understanding of the work.
- Barrier controls: Develop a physical barrier system to control zones and methods to ensure that there is no access for people or machines above scaling zones.
- Designated operators: Develop training for designated operators for machine-scaling operations (on-site training or on-site procedures, and pre-setup inspections).
- Jobsite controls: Enhance on-site training for communications and access. Develop a written procedure for those entering the penstock and powerhouse areas. Conduct risk/hazard review.
- First aid: Ensure a first aid model is used under high-risk work and have a Level 3 certified worker in zones with a mobile treatment centre. Develop a checklist and benchmark system to ensure an effective first aid plan is in use. Ensure that this system verifies that all work zones are covered. Train all supervisors in Level 1 first aid.
- Other items in the plan addressed: training for supervisors, investigators, and safety committee; redeveloping the crisis/incident management plan; rebuilding work plan and job hazard analysis forms based on zones and adding scaling controls and barriers; providing supervisor training on completing and documenting inspections; and creating an inspection schedule for full and formal inspections to be followed by the safety department.
- Geotechnical engineers were on site on a daily basis for several months following the incident. Prior to the resumption of full construction activities, mobile equipment operators and a contracted scaling firm thoroughly conducted extensive site scaling and removed unstable materials. An engineered rock fence was built near the crest of the hill.

Appendix

How the Investigation Was Conducted

WorkSafeBC's Investigations Division conducts health and safety investigations using a methodology that involves collecting information from various sources to understand the facts and circumstances of the incident and analyzing that information to identify causal and underlying factors that led to the incident.

The field investigation generally involves the following:

- Securing and examining the incident site, including any equipment involved
- Taking notes and photographs
- Interviewing persons with relevant information such as employer representatives, supervisors, workers, and witnesses
- Collecting pertinent documents such as equipment operating manuals, written procedures, and training records
- Conducting tests of materials or equipment, if necessary

The analysis of the data usually includes:

- Determining a sequence of events
- Examining significant events for unsafe acts and conditions
- Exploring the underlying factors that made the unsafe act or condition possible
- Identifying health and safety deficiencies