Appendix 16-B

Crown Mountain Coking Coal Project
Preliminary Fossil Impact Assessment

FOSSIL OVERVIEW ASSESSMENT

(PRELIMINARY FOSSIL IMPACT ASSESSMENT)

Crown Mountain Coking Coal Project

Prepared for:

NWP Coal Canada Ltd.

Prepared by:

Aeon Paleontological Consulting Ltd.

Project No.: 21-019

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Crown Mountain Coking Coal Project
Fossil Overview Assessment

Executive Summary

NWP Coal Canada Ltd. (NWP) proposes to develop the Crown Mountain Coking Coal Project (the Project) in the Elk Valley Coal District near Sparwood, British Columbia. In September, 2021, NWP retained Georgia Hoffman of Aeon Paleontological Consultants Ltd. to prepare this Fossil Overview Assessment (FOA) for the Project area. The FOA is a component of the Project's Environmental Impact Assessment. The objective is to assess the potential for fossils to be present within the Project area, and to evaluate the level of risk that Project mining and construction activities would pose to the fossils. This assessment is based on a review of published reports, the Government of British Columbia's Fossil Occurrence Database, and the author's experience working in the Project area. No site inspection was made during this study.

The Project proposes to produce 1.8 million tonnes of clean coking coal per year from three open-pit mines on the top of Crown Mountain during a mine life of 15 years. A coal processing plant and waste rock storage areas would be located adjacent to the pits. Clean coal would be moved by conveyor to the Grave Creek Forest Service Road and trucked to a rail loop that would be constructed adjacent to the existing rail line in the Elk River valley.

The coal-bearing Mist Mountain Formation and the Morrissey Formation underlie the proposed mining areas. They have been folded into a north-south trending syncline and faulted. Additional bedrock formations and unconsolidated sediments are present along the conveyor route, the access roads, and in the proposed rail loop area.

The Mist Mountain and Morrissey Formations would be highly impacted by the mining operations. Trackways of vertebrates and other fossils have been encountered in these formations at other mining operations in the Elk Valley Coal District. The risk to fossils in the mining areas is therefore assessed to be **high**.

Disturbance to the Fernie Group shales, which are present along the access roads, the conveyor route, and in the rail loop area, would be moderate during construction in those areas. The risk to fossils in the Fernie Group is therefore assessed to be **moderate**.

Disturbance to the older bedrock formations that are present along the Grave Creek Road would be low. Although bedrock could be exposed locally during road

widening, it is typically covered by unconsolidated sediments in that area. The risk to fossils in those formations is therefore assessed to be **low**.

Unconsolidated sediments are present along the Grave Creek Road and in the rail loop area, but no fossils have been reported from unconsolidated sediments in the Fernie–Elk Valley–Crowsnest region. The risk to fossils in the unconsolidated sediments is therefore assessed to be **low**.

Because the occurrence of fossils in these formations is unpredictable, it is recommended that a Chance Find Protocol be put in place for the Project. This Protocol would establish procedures to be followed when fossils are encountered so that appropriate recovery or mitigation plans can be developed and implemented.

It is also recommended that a systematic paleontological field survey be conducted to further assess the potential for fossils by examining natural outcrops and roadcuts on Crown Mountain, the site access road, the Grave Creek Road, and in the rail loop area.

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Introduction

NWP Coal Canada Ltd. (NWP) proposes to develop the Crown Mountain Coking Coal Project (the Project) in the Elk Valley Coal District near Sparwood, British Columbia. The Project plans to produce 1.8 million tonnes of clean coking coal per year from three open pits over a mine life of 15 years. The Project would require the construction of associated infrastructure, including a coal preparation plant, a conveyor system, and a railroad loop.

In September 2021, NWP retained Lead Paleontologist Georgia Hoffman of Aeon Paleontological Consulting Ltd. (Aeon) to prepare this Fossil Overview Assessment (FOA) for the Project area. The FOA is a component of the Project's Environmental Impact Assessment. The objective is to determine the potential for fossils within the Project area and to assess the level of risk that Project mining and construction activities would pose to the fossils. This report presents the results of the assessment.

Methodology

This assessment is based on a review of published geological reports, the Government of British Columbia's Fossil Occurrence Database, and the author's experience working in the Project area and the surrounding region. No site inspection was made for this assessment.

Project Description

The Project is located in the Elk Valley Coal District near Sparwood, British Columbia (Fig. 1). The Project has a footprint of about 1280 hectares and is bounded on the north by Grave Creek, on the east by Alexander Creek, on the west by West Alexander Creek, and on the south by the confluence of West Alexander and Alexander Creeks (Fig. 2).

Mining would be done at three open pits on the top of Crown Mountain to produce 1.8 million tonnes of clean coking coal per year over a mine life of 15 years. The pit areas would be reached via a road ascending the northwest slopes of Crown Mountain. The coal processing plant and waste rock storage areas would be located adjacent to the pits. Clean coal would be moved to the Grave Creek valley by an overland conveyor system. From there, the coal would be trucked via the existing Grave Creek Forest Service Road to the existing railroad in the Elk River valley, where a rail loop would be constructed (Fig. 2). The Grave Creek Road would be widened to 12 m and upgraded to accommodate the increased traffic.

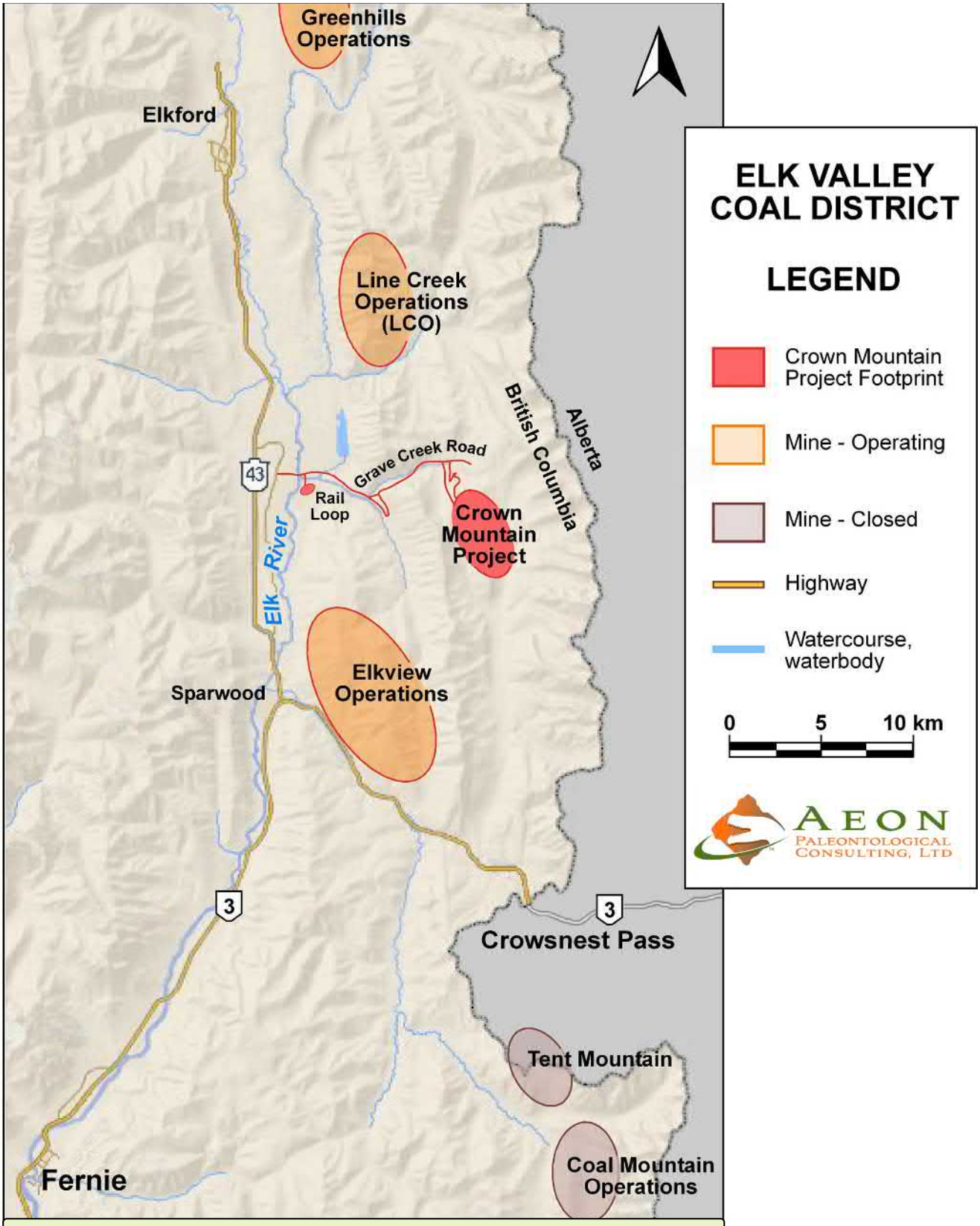

Figure 1. The Elk Valley Coal District, British Columbia

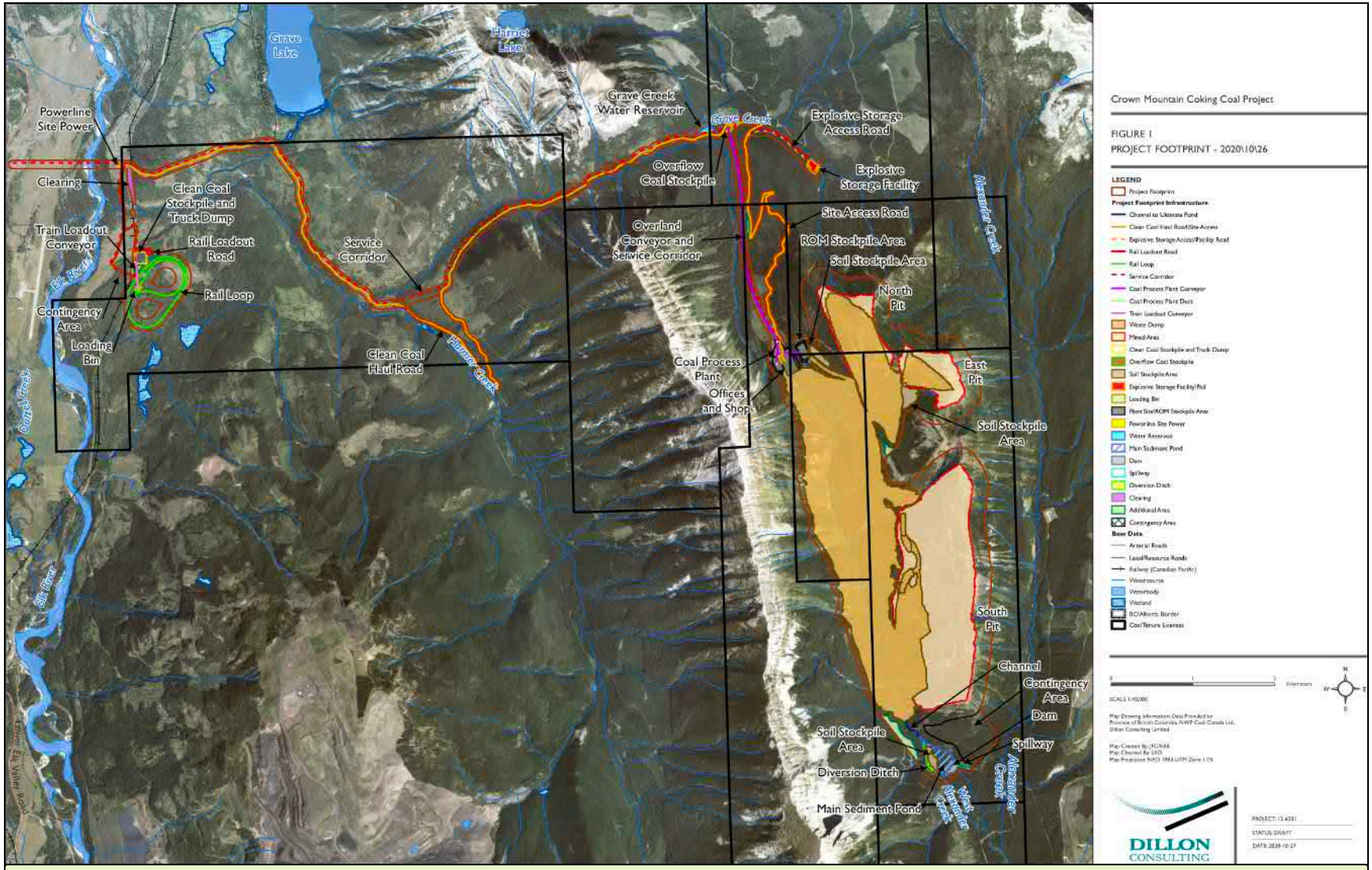

Figure 2. Crown Mountain Project footprint and infrastructure. Courtesy NWP Coal Canada Ltd.

Geologic Setting

The coal-bearing Mist Mountain Formation and the Morrissey Formation underlie the top of Crown Mountain, the location where the open-pit mining would take place. These formations were deposited during latest Jurassic to earliest Cretaceous time (Fig. 3), and were subsequently folded into a north-south trending syncline and then faulted (Price, 1962, 2013).

Additional bedrock formations of Jurassic to Mississippian age are present along site access road, the conveyor route, the Grave Creek Road, and in the rail loop area (Fig. 4). The bedrock in those areas is largely covered by unconsolidated sediments.

Unconsolidated sediments

Unconsolidated sediments deposited during Quaternary (Pleistocene to Recent) time are present throughout the Project area. Alluvium covers the bedrock in the rail loop area (Price, 2013). Along the Grave Creek Road, which follows a narrow, deeply incised valley, colluvium and landslide deposits interfinger with alluvium along the creek. Much of that material, where exposed in roadcuts, is poorly sorted to unsorted and ranges in size from mud to boulders. Thin deposits of colluvium are present on the slopes of Crown Mountain (observations by the author).

Mist Mountain Formation

The Mist Mountain Formation is present on the top of Crown Mountain and hosts the coal seams that would be mined by the Project. This formation consists of sandstone, siltstone, mudstone, and shale, as well as coal seams. Deposition took place in delta plain, fluvial plain, and fluvial channel environments during the latest Jurassic to earliest Cretaceous periods (Gibson, 1985).

Morrissey Formation

The Morrissey Formation underlies the Mist Mountain Formation and would be exposed in some of the pit walls. It records the transition from marine to nonmarine environments near the end of the Jurassic period. The upper part of the formation (the Moose Mountain Member) consists of hard, cliff-forming, medium-grained quartzose sandstones that were deposited in barrier island, beach, and sand dune environments. The basal portion (the Weary Ridge Member) consists of silty, fine-grained sandstones with minor thin interbeds of siltstone and shale; these beds were deposited in near-shore marine environments (Gibson, 1985).

Fernie Group

The Fernie Group was deposited in open marine environments during the Jurassic period and consists primarily of dark grey shales. The Fernie also includes siltstone, sandstone, limestone, and glauconitic beds in some areas (Frebold, 1957). It is present beneath the slopes of Crown Mountain and in the Elk River valley (Fig. 4) (Price, 2013).

Pre-Jurassic units

The following pre-Jurassic units are present in the area where the Grave Creek Road passes between the northern end of Erickson Ridge and the southern slopes of Sheep Mountain (Fig. 4) (Price, 1962, 2013):

- the Spray River Group (Triassic age), primarily marine shale, siltstone, and dolomitic siltstone;
- the Rocky Mountain Supergroup (Pennsylvanian-Permian), primarily marine sandstone and dolomite; and
- the Rundle Group (Mississippian), primarily marine limestone and dolomite.

AGE	FORMATION	SYMBOL	LITHOLOGY	ENVIRONMENT OF DEPOSITION	OCCURRENCE
Quaternary	**Unconsolidated sediment**	**Q**	Sand, gravel, silt, mud, peat	Hill sides, valley bottoms	Roadways, rail loop, conveyor route
unconformity					
latest Jurassic to earliest Cretaceous	**Mist Mountain Formation**	**JKmm**	Sandstone, siltstone, mudstone, shale, **coal**	Delta plain, fluvial plain, fluvial channel	Open pits
latest Jurassic	**Morrissey Formation**		Sandstone, siltstone	Near-shore marine, beach, barrier island	Open pits
Jurassic	**Fernie Group**	**Jf**	Shale, siltstone	Marine	Roadways, rail loop, conveyor route
Triassic	**Spray River Group**	**Tsr**	Shale, siltstone, dolomite	Marine	Roadways
Permian and Pennsylvanian	**Rocky Mountain Supergroup**	**PPrm**	Sandstone, dolomite	Marine	Roadways
Mississippian	**Rundle Group**	**Mr**	Limestone, dolomite	Marine	Roadways

Figure 3. Stratigraphy of the Project Area

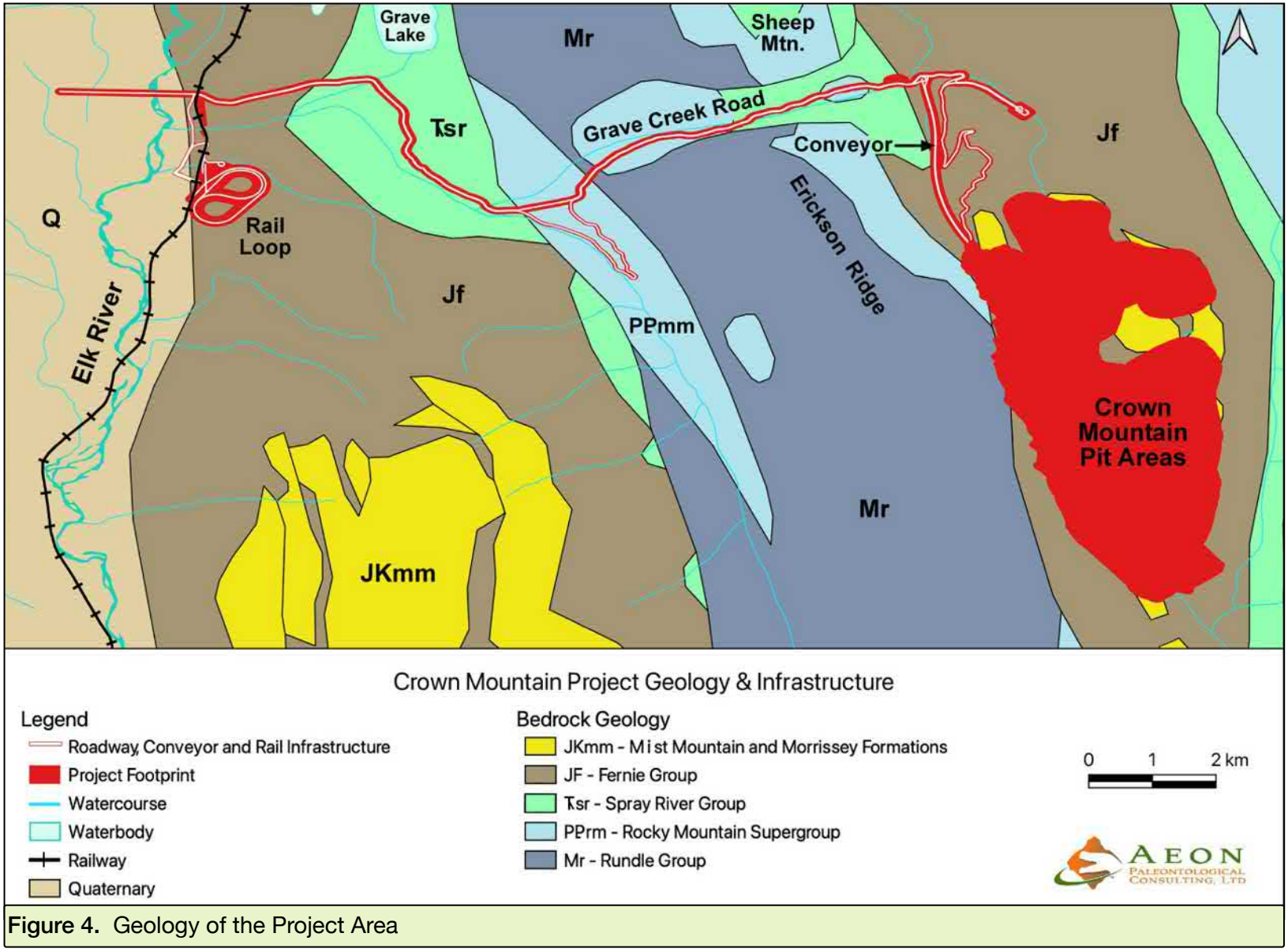

Figure 4. Geology of the Project Area

Assessment of Impact

The impact that Project mining and construction activities are likely to have on fossil resources has been assessed according to the degree of planned ground disturbance, the proximity of the disturbance to known fossil occurrences (Fig. 5), and the types of fossils that could be present. The results of the assessment are presented below for each stratigraphic unit and are summarized in Table 1.

Unconsolidated sediments

Degree of disturbance: Low to moderate. This material is present on the slopes of Crown Mountain, in the valley bottoms, and in the rail loop area. Some disturbance would occur during road widening and construction of the conveyor system and rail loop.

Proximity to known fossil occurrences: None reported in the Fernie-Elk Valley-Crowsnest region (British Columbia Fossil Occurrence Database). Much of this material in the Project area consists of colluvium and landslide deposits, which are unlikely to contain fossils.

Types of Fossils: Although bones of Ice Age animals can be present in unconsolidated sediments, they are rare.

Risk assessment: Low.

Mist Mountain Formation

Degree of disturbance: High. The Mist Mountain Formation hosts the coal seams that would be mined by the Project and would be exposed and removed during mining.

Proximity to known fossil occurrences: Close (about 12 km). Fossils have been found in the Mist Mountain Formation at Teck's Line Creek Operations (LCO), about 12 km north of Crown Mountain (Fig. 1) (McRae and Buckley, 2005; Kinnear, 2012; McCrae et al., 2014), as well as at the Coal Mountain Operations, about 35 km south of the Project area, and in the Crowsnest Pass area, about 20 km south of the Project area (British Columbia Fossil Occurrence Database) (Bell, 1956) (Figs. 1, 5).

Types of Fossils: Trackways of dinosaurs (Fig. 6), plant fossils, and impressions of logs (Fig. 7), have been found at LCO. Plant fossils (ferns, ginkgoes, cycads, conifers, and others) have also been reported from the district (Bell, 1956).

Risk assessment: High.

Morrissey Formation

Degree of disturbance: High. The Morrissey Formation would be exposed in pit walls during mining.

Proximity to known fossil occurrences: Close (about 12 km). Fossils have been encountered in the Morrissey Formation at LCO, at Tent Mountain (about 30 km south of the Project area), at Coal Mountain, and near Fernie (about 50 km southwest of the Project area) (Figs. 1, 5) (British Columbia Fossil Occurrence Database).

Types of Fossils: The Morrissey Formation includes significant ammonites and other marine fossils as well as impressions of logs. The remains of the large ammonite *Titanites* near Fernie have been described by Newmarch (1953), Westermann (1966), and Gibson (1985). That fossil is still in place in the bedrock (Fig. 8a) and is often visited by interested members of the public. A *Titanites* was also recovered at the Coal Mountain Operations and fragments of it have been displayed in Sparwood (Fig. 8b, c). Fragments have been reported from the Tent Mountain mine (Fig. 1) (Hamblin and Walker, 1979). Gibson (1985) reported the marine bivalves *Oxytoma*, *Modiolus*, and *Astarte*, and the belemnite *Pachyteuthis* from the Morrissey Formation.

Risk assessment: High.

Fernie Group

Degree of disturbance: Moderate. The Fernie shales are present along the site access road, in the conveyor route area, and along the Elk River near the proposed rail loop (Fig. 4). They would be exposed during road widening, construction of the conveyor system, and possibly in the rail loop area.

Proximity to known fossil occurrences: Close (about 4 km north of the rail loop area). Significant ammonites (*Cardioceras ferniensis* and others) have been reported from outcrops along the Elk River near the Line Creek bridge and farther north along the Elk and Fording Rivers (Fig. 5) (British Columbia Fossil Occurrence Database).

Types of Fossils: Ammonites and other molluscs, brachiopods, and remains of marine vertebrates can be present in the Fernie Group shales (Frebold, 1957).

Risk assessment: Moderate.

Pre-Jurassic units

Degree of disturbance: Low. These stratigraphic units are present along the Grave Creek Road (Fig. 4). They are typically covered by unconsolidated sediments in that area but could be exposed locally during road widening.

Proximity to known fossil occurrences: Fossils have been reported from these units in the mountains that flank the Elk River valley, about 20 km and more from the Project area (Fig. 5) (British Columbia Fossil Occurrence Database).

Types of Fossils: Brachiopods, corals, bryozoans, and molluscs.

Risk assessment: Low.

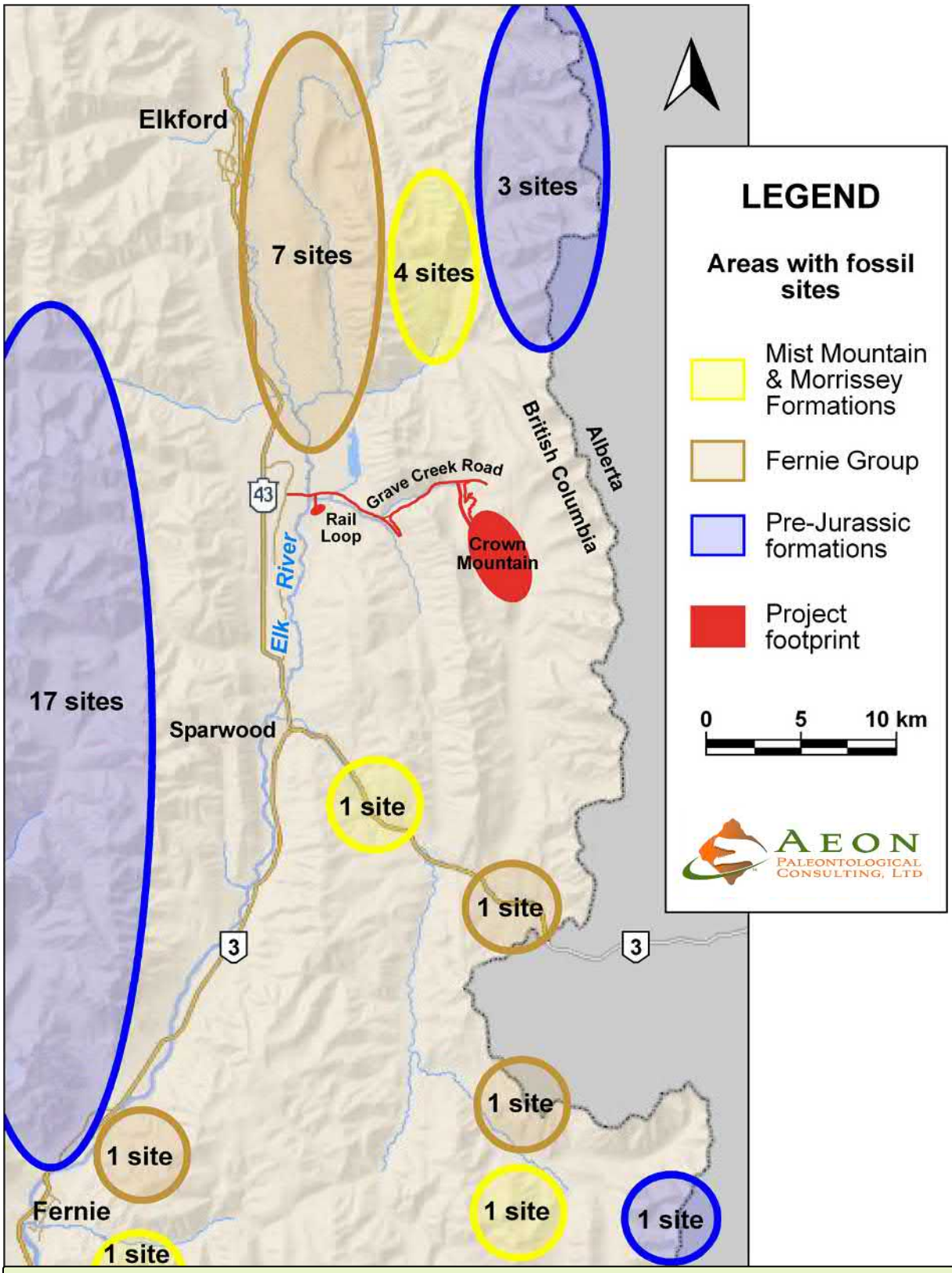

Figure 5. Areas with reported fossil occurrences, from the Government of British Columbia's Fossil Occurrence Database and published reports.

FORMATION	TYPE OF DISTURBANCE	DEGREE OF DISTURBANCE	LOCAL FOSSIL OCCURRENCES	TYPES OF FOSSILS	POTENTIAL IMPACT
Unconsolidated sediment	Roadways, rail loop	Low to moderate	None reported in District	Ice Age bones	**Low**
Mist Mountain Formation	Open pit mining	High	At mines in District	Vertebrate trackways, plant fossils	**High**
Morrissey Formation	Open pit mining	High	At mines in District	Trackways, plant fossils, ammonites	**High**
Fernie Group	Roadways, conveyor	Moderate	Along rivers in District	Ammonites	**Moderate**
Rundle Group	Roadways	Low	On mountains in District	Brachiopods, corals, etc.	**Low**
Rocky Mountain Supergroup	Roadways	Low	On mountains in District	Brachiopods, corals, etc.	**Low**
Spray River Group	Roadways	Low	On mountains in District	Brachiopods, corals, etc.	**Low**

Table 1. Summary of Impact Assessment

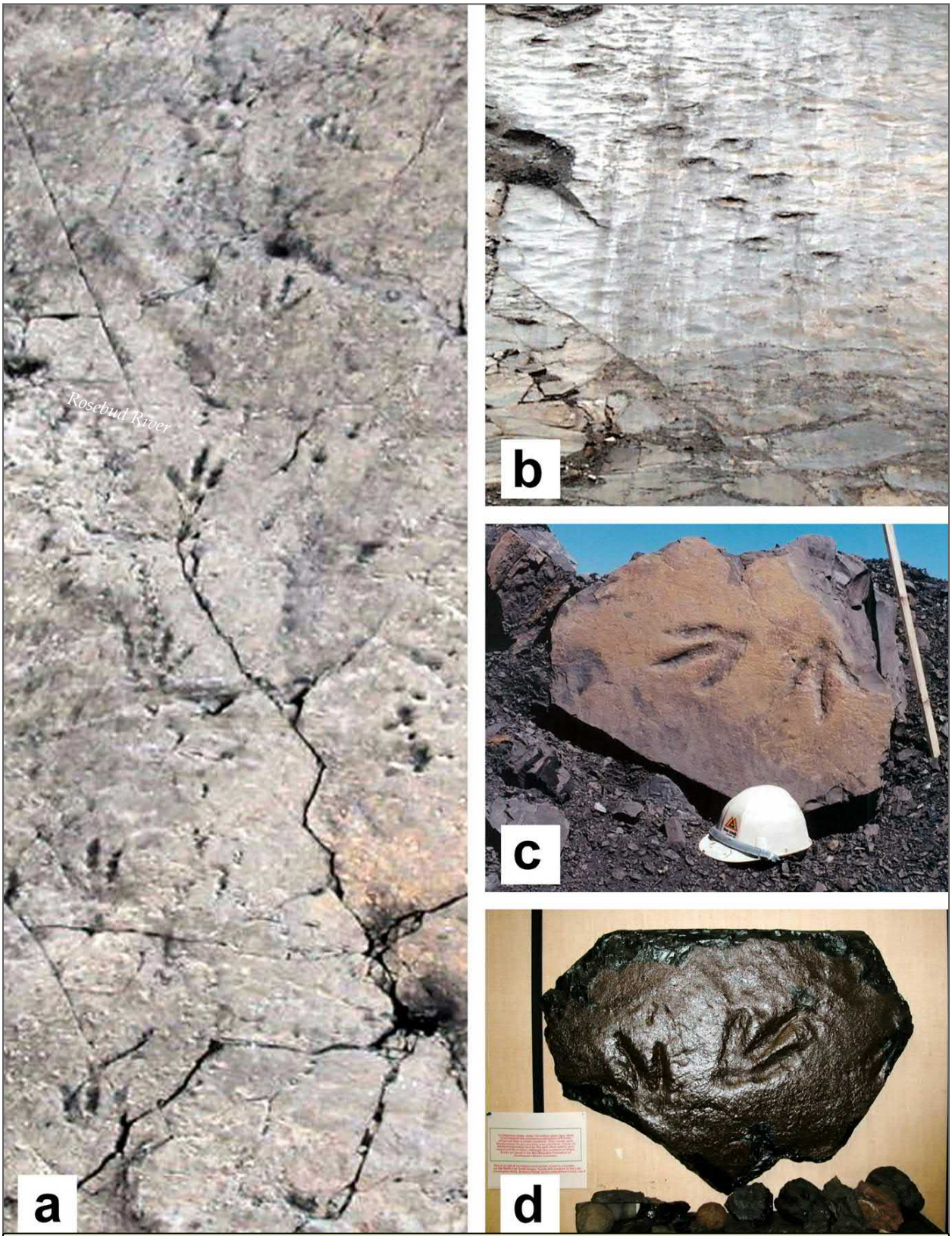

Figure 6. Dinosaur tracks at LCO: (a) theropod trackway; (b) sauropod trackway; (c) theropod tracks; (d) cast of the tracks in (c). Photographs by John Kinnear.

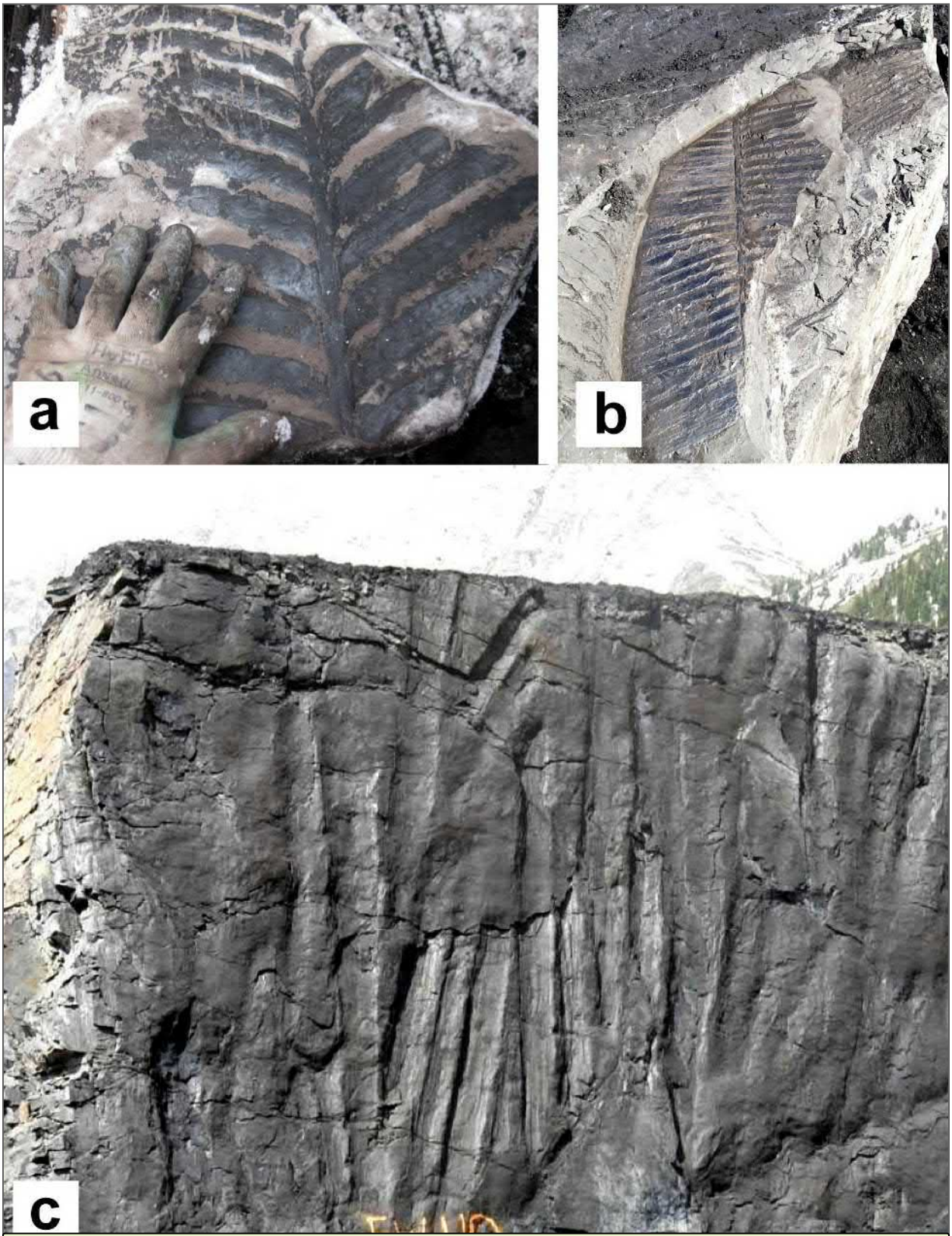

Figure 7. Plant fossils at LCO: (a, b) cycad fronds; (c) log impressions on the floor of the basal seam. Photographs by John Kinnear.

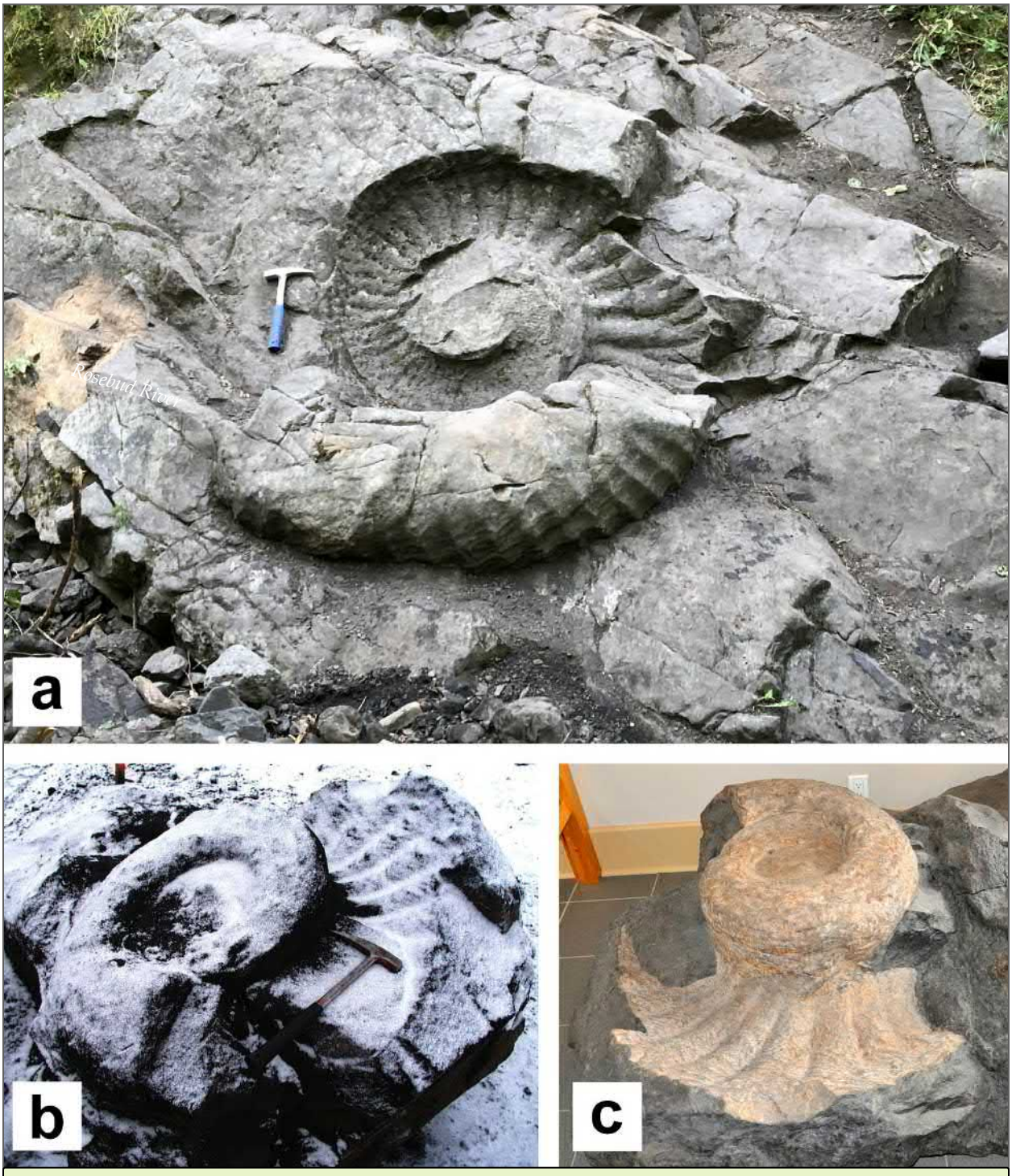

Figure 8. **A**mmonites from the Elk Valley Area: (a) the Coal Creek *Titanites*; (b) the Coal Mountain *Titanites* at the mine; (c) a fragment of the Coal Mountain *Titanites* on display in Sparwood. Photograph (a) by Keith Mychaluk; all others by John Kinnear.

Conclusions

1. Scattered fossils are known to be present in the Mist Mountain and Morrissey Formations and have been encountered at other mining operations in the Elk Valley Coal District. Mining activities at the Project, which would involve a high degree of disturbance to these formations, would therefore present a **High Risk** to fossils in the Mist Mountain and Morrissey Formations (Table 1).
2. Scattered fossils are known to be present in the Fernie Group along the Elk and Fording Rivers. Access road widening and construction of the conveyor system and rail loop would involve a moderate degree of disturbance to the Fernie Group and would therefore present a **Moderate Risk** to Fernie Group fossils.
3. Scattered fossils are known to be present in the pre-Jurassic units that flank part of the Grave Creek Road. These units could be exposed locally during road widening but typically are covered by unconsolidated sediments. The degree of disturbance would therefore be low, and the risk to pre-Jurassic fossils is assessed as **Low**.
4. Fossils can be present in unconsolidated sediments, but none have been reported from the Fernie–Elk Valley–Crowsnest region. Therefore, although there would be low to moderate disturbance to those sediments during road widening and construction of the rail loop, the risk to fossils in the unconsolidated sediments is assessed as **Low**.

Recommendations

1. Because the occurrence of fossils in the Elk Valley Coal District is unpredictable, it is recommended that a Chance Find Protocol be implemented, such as the example in Appendix A. This Protocol should set out procedures for:
    - diverting work away from the immediate area of a fossil find;
    - reporting the find to the site supervisor and designated paleontology specialist;
    - photographing the find and recording its location;
    - informing the BC Fossil Management Office or designated museum; and
    - developing a recovery or mitigation plan.

2. Workers should be made aware of the importance of fossils and should be provided with copies of the Chance Find Protocol, which should include photographs of the kinds of fossils that might be found during work.

3. A systematic paleontological field survey by a qualified paleontologist and assistants is also recommended to further assess the potential for fossil occurrences in the Project area. It should involve:
    - examining natural outcrops and roadcuts on Crown Mountain, along the site access and Grave Creek roads, and in the rail loop area, to better establish the frequency and types of fossil occurrences;
    - determining, where possible, the thickness of cover over the bedrock along the roads and in the rail loop area; and
    - preparing a report of findings and submitting all fossils to the designated museum or repository.

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*Disclaimer: Any recommendations made in this report are not necessarily consistent with requirements of the BC Fossil Management Office.

References

Anonymous 2010. Another giant ammonite! Everything Fernie, November 3, 2010. Downloaded from https://fernie.com/blog/another-giant-ammonite/

Bell, W.A. 1956. Lower Cretaceous floras of western Canada. Geological Survey of Canada Memoir 285.

Frebold, H. 1957. Jurassic Fernie Group in the Canadian Rocky Mountains and Foothills. Geological Survey of Canada Memoir 287.

Gibson, D.W. 1985. Stratigraphy, sedimentology and depositional environments of the coal-bearing Jurassic-Cretaceous Kootenay Group, Alberta and British Columbia. Geological Survey of Canada Bulletin 357.

Hamblin, A.P. and Walker, R.G. 1979. Storm-dominated shallow marine deposits: the Fernie-Kootenay (Jurassic) transition, southern Rocky Mountains. Canadian Journal of Earth Sciences 16: 1673-1690.

Kinnear, J. 2012. Stepping back in time. Heritage News 22: 3-4, February 17, 2012. Downloaded from www.crowsnestheritage.ca/wp-content/uploads/2010/08/February-20121.pdf.

McCrae, R.T. and Buckley, L.G. 2005. A dinosaur track site from the Elk Valley Coal District. Marrella 20: 19-20.

McCrae, R.T., Buckley, L.G., Plint, A.G., Currie, P.J., Haggart, J.W., Helm, C.W. and Pemberton, S.G. 2014. A review of vertebrate track-bearing formations from the Mesozoic and earliest Cenozoic of western Canada with a description of a new theropod ichnospecies and reassignment of an avian ichnogenus. In: M.G. Lockley and S.G. Lucas (eds.), Fossil footprints of western North America, NMMNHS Bulletin 62.

Newmarch, C.B. 1953. Geology of the Crowsnest coal basin with special reference to the Fernie area. British Columbia Department of Mines Bulletin 33.

Price, R.A. 1962. Fernie map-area (east half), British Columbia and Alberta, 82G1/2. Geological Survey of Canada Paper 61-24.

Price, R.A. 2013. Geology, Fernie, British Columbia–Alberta. Geological Survey of Canada Map 2200A, doi: 10.4095/292659.

Province of British Columbia. 1996. Heritage Conservation Act, R.S.B.C. 1996, c 187. Queen's Printer, Victoria, British Columbia, Canada.

Province of British Columbia. 1996. Land Act, R.S.B.C. 1996, c 245. Queen's Printer, Victoria, British Columbia, Canada.

Westermann, G.E.G. 1966. The holotype (plastotype) of ?*Titanites occidentalis* Frebold from the Kootenay sandstone (upper Jurassic) of southern British Columbia. Canadian Journal of Earth Sciences 3: 623-625.

Appendix A:

Proposed Chance Find Protocol for the Crown Mountain Project

Why are fossils important?

Fossils are the preserved remains, traces, or imprints of organisms from the geological past. They provide opportunities for education and scientific discovery, and are essential to understanding British Columbia's natural history and geology. British Columbia's coal mines have played an important role in uncovering and reporting fossils so they can be documented, studied, and displayed for people to enjoy.

Regulations concerning fossils

Fossils are part of BC's natural heritage and all fossils on Crown Land are the property of the province. They may not be sold or removed from the province. Collecting of fossils is prohibited without a permit, except for recreational collecting of some common types of fossils. Mines and developers are asked to report any fossils unearthed on their sites to the British Columbia Fossil Management Office (Heritage Branch) or the Royal British Columbia Museum.

What kinds of fossils might be found at Crown Mountain?

Open pit areas: The rock formations that will be exposed in the open pits are known to host plant fossils, trackways (footprints) of dinosaurs and other animals, and ammonites. Some of these fossils could be exposed during mining. Many fossils, like isolated footprints, plant fossils, and ammonites, will be relatively small (less than 1 m^2). Larger fossils would include long trackways, beds with abundant plant remains, and impressions of logs. [include photos of examples at end]

Other areas: Fossils could also be present along the conveyor route, the roadways, or in the rail loop area but they are less likely to be exposed there because of the lower levels of ground disturbance. The shales along the conveyor route and site access road could contain marine fossils such as ammonites and shells, and could even have bones of marine animals. Bedrock along the Grave Creek Road could also contain marine fossils. Unconsolidated sediments can contain bones of Ice Age animals, although these are very rare.

What should you do if you discover a fossil?

1. Suspend all forms of ground disturbance in the immediate vicinity of the fossil and divert traffic away from it.

2. Establish a protective buffer of at least 50 m around the fossil. Demarcate the buffer in a highly visible way (e.g., with "No Work" flagging).

3. Report the fossil to the site supervisor and designated site paleontology specialist or geologist.

4. Make sure that you've found all of it. What appears to be an isolated footprint may turn out to be part of a longer trackway. Similarly, what appears to be isolated bone or plant fossil may prove to be part of a larger assemblage.

5. Photograph the site and fossil material, preferably with a scale in the photo, and record its GPS location, including, if possible, the elevation. Note the finder's name, the type of fossil found and, if possible, its stratigraphic position (e.g., "a few metres above Seam 9", or "between Seams 10M and 10L").

6. The designated paleontology specialist [insert name here] will determine the significance of the find and contact the BC Fossil Management Office or designated museum.

7. If the find is small (less than about 1 m^2) and robust, the paleontologist may determine that it is safe to remove it from the site and transport it to a safe location for shipment to the designated museum.

8. If the find is large or fragile, or if it is judged by the paleontologist to be very rare, the paleontologist will consult with the British Columbia Fossil Management Office to develop a recovery or mitigation plan.