BC Geological Survey
Coal Assessment Report
993

COAL ASSESSMENT REPORT TITLE PAGE AND SUMMARY

TITLE OF REPORT: Coal Assessment Report for the Dillon lease, British Columbia, Canada

TOTAL COST: $30,000

AUTHOR(S): **C.G. Cathyl-Huhn, P.Geo., F. Eshun, P.Geo., M. Tuters EIT, and M. Brown EIT**

SIGNATURE(S):

NOTICE OF WORK PERMIT NUMBER(S)/DATE(S):

YEAR OF WORK: **2014 and 2015**

PROPERTY NAME**: Dillon**

COAL LICENSE(S) AND/OR LEASES ON WHICH PHYSICAL WORK WAS DONE: **none**

MINERAL INVENTORY MINFILE NUMBER(S), IF KNOWN: **93P.007**

MINING DIVISION: **Liard**

NTS / BCGS**: NTS 93P/5 / BCGS 93P.031 and 93P.041** NATO zone **10U** digraph **EG**

LATITUDE (NAD83): **55°23' 59.84" North**; LONGITUDE (NAD83): **121° 49' 35.38" West**

UTM Zone: **10N** EASTING: **574317** NORTHING: **6139926**

OWNER(S): **Walter Canadian Coal Partnership**

MAILING ADDRESS: **200-235 Front St. (P.O. Box 2140), Tumbler Ridge, BC, V0C 2W0**

OPERATOR(S) [who paid for the work]: **0541237 B.C. Ltd. On Behalf of Brule Coal Partnership**

MAILING ADDRESS: **200-235 Front St. (P.O. Box 2140), Tumbler Ridge, BC, V0C 2W0**

REPORT KEYWORDS (lithology, age, stratigraphy, structure, alteration, mineralisation, size and attitude). **Bituminous coal, Early Cretaceous, Bullhead Group, Gething Formation, Gaylard Member, marker beds, imbricate faults, thrust faults, thin-skinned tectonics, anticlines, synclines, Owl Creek Syncline, deposit modelling**

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS: **Coal Assessment Report 957**

SUMMARY OF TYPES OF WORK IN THIS REPORT		EXTENT OF WORK (in metric units)	ON WHICH TENURES
GEOLOGICAL (scale, area)			
	Ground, mapping	**nil**	**n/a**
	Photo interpretation	**nil**	**n/a**
GEOPHYSICAL (line-kilometres)			
	Ground (Specify types)	**nil**	**n/a**
	Airborne (Specify types)	**nil**	**n/a**
	Borehole		
	Gamma-density	**nil**	**n/a**
	Resistivity	**nil**	**n/a**
	Caliper	**nil**	**n/a**
	Deviation	**nil**	**n/a**
	Dip	**nil**	**n/a**
	Others	**nil**	**n/a**
	Core drilling	**nil**	**n/a**
	Non-core (rotary) drilling	**nil**	**n/a**
SAMPLING AND ANALYSES			
Total number of samples		**nil**	**n/a**
	Proximate	**nil**	**n/a**
	Ultimate	**nil**	**n/a**
	Petrographic	**nil**	**n/a**
	Vitrinite reflectance	**nil**	**n/a**
	Coking	**nil**	**n/a**
	Wash tests	**nil**	**n/a**
PROSPECTING (scale/area)		**nil**	**n/a**
PREPARATORY/PHYSICAL		**nil**	**n/a**
Line/grid (km)		**nil**	**n/a**
Trench (number, metres)		**nil**	**n/a**
Bulk sample(s):		**nil**	**n/a**

Section 4, part of Section 8, and Appendix A remain confidential under the terms of the Coal Act Regulation, and have been removed from the public version.

http://www.bclaws.ca/civix/document/id/complete/statreg/251_2004

1 Table of contents

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2 Introduction, situation, and details of work

This report, titled *Coal Assessment Report for the Dillon lease, British Columbia, Canada*, incorporates and comments upon results of a year-2015 coal-reserve study (Eshun, Avery, and Snodsmith, 2015), as concerns a larger area within the Burnt River coal deposit, part of which is covered by the Dillon coal lease (tenure 412964). Findings specific to tenures other than the Dillon lease are beyond the scope of the present coal-assessment report, and shall be reported separately.

The present report does not provide new coal-quality information, as no such work was done during the period of time since the submission of CAR-957.

Assessment work here-reported comprises office-based geological and computational studies conducted in the latter part of 2014 and the beginning of 2015, culminating with the preparation of the present report in August of 2015.

This work was undertaken in support of Walter Canadian Coal Partnership's (WCCP's) ongoing mine-planning concerning the Brule open-pit mine within the Dillon property, in keeping with WCCP's obligations under the *Coal Act.*

Mining commenced within the Dillon property in December of 2004, beginning with the development of the Dillon Pit, and continuing mining operations within the Blind and Brule pits. Total production of coal as of the end of year-2011 was 6.24 million tonnes, with an additional 1.8 million tonnes in year-2012 (Riddell, 2013). **Table 2-3,** given below, presents production statistics for Brule Mine, whose open-pit workings have spanned the border between the Dillon and Brule tenures. Production from the two tenures has been commingled, and cannot readily be broken-out separately.

Active mining of coal from Brule Mine was suspended in July of 2014; however, previously-stockpiled coal was hauled, for several months thereafter, from Brule to the coal-washery and coal-loading facilities at Willow Creek.

The formerly-worked Dillon and Blind open-pit mines (also covered by the Dillon tenure) are not discussed within the present report; for information upon those mines, the interested reader may consult Coal Assessment Report No. 957 (CAR-957), submitted previously (here referred as Cathyl-Huhn, Avery, and Singh, 2014).

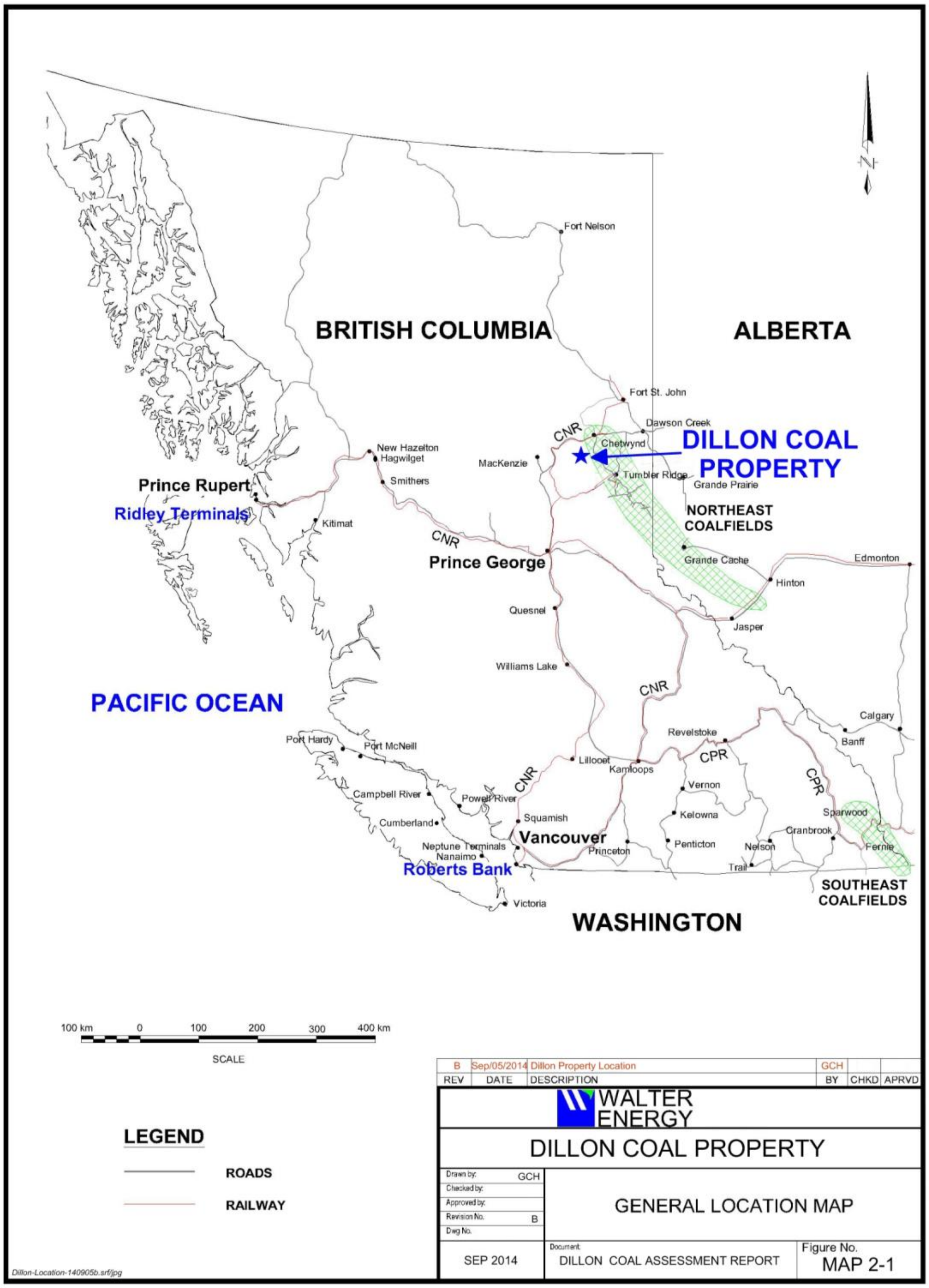
2.1 Location, tenure, access and infrastructure

General location of the Dillon coal property, within the Brazion coalfield of northeastern British Columbia, is depicted in **Map 2-1**, and access routes are shown in **Map 2-2**. The Brazion coalfield comprises the outcrop area of Jurassic and Early Cretaceous coal-measures, lying between the valleys of the Pine and Sukunka rivers, north of Pine River through to the west bank of the Sukunka River. The coalfield name has no formal standing as a toponymic entity, and it is used within this report for purposes of convenience. In detail, the Dillon coal property comprises a single coal lease (Tenure 412964), covering a total area of 1,176 hectares, more or less, as shown by **Map 2-2**. The entire extent of this tenure is contiguous, with no detached or offsetting segments.

Road access is via two routes, of which the most convenient route passes through the Sukunka River valley, and an alternative is overland from the Pine River Valley, via the Falling Creek Connector Road, Hasler Creek Forest Service Road, and the Brule Connector Road. These roads are well-signposted for wayfinding, with kilometre-posts (for radio calling) clearly-marked.

To reach the Dillon property via road from the Sukunka River valley, access commences from the junction of highway BC-29 and the Sukunka Forest Service Road (FSR), which is maintained by the Sukunka Road Users Committee (a group of industrial users of the road). After travelling southward along the Sukunka FSR, following the eastern bank of Sukunka River, the junction with the Blind Creek Road is reached at kilometre 16.5 of the Sukunka FSR. Walter Energy holds tenure to the Blind Creek Road under a *Special Use Permit* (SUP) from MFLNRO.

The Blind Creek Road crosses Sukunka River on a multi-span, wood-floored, steel deck-girder bridge suitable for highway loads, and then winds steeply uphill atop the southern canyon wall of Blind Creek. Several smaller wooden bridges provide crossings of smaller streams along the Blind Creek Road. A number of spur roads and trails branch from the Blind Creek Road, most of which serve current or historic logging or natural-gas operations.



The eastern edge of the Dillon lease is very poorly-served by roads, and is best accessed on foot via seismic lines which extend outward from the central developed area. Road access to Dillon requires passing through the security gates of Brule Mine. One gate is situated on the Blind Creek Road, whilst another gate is situated atop the drainage divide between the valleys of Mink Creek and Blind Creek.

The municipal airport at Chetwynd is the closest operating fixed-wing airfield to the Dillon coal property. Helicopters may be chartered from the Chetwynd airport, or alternatively they may be hired from the Tumbler Ridge airport. With prior permission from the mine's management, helicopters may be landed at Brule Mine. The closest railway service to Dillon is at Walter Energy's Willow Creek coal-loading facility, situated on the southern bank of Pine River, west of Chetwynd. The most direct coal-haulage route to the railway is via the Falling Creek, Hasler Creek and Brule roads.

The Dillon property contains facilities and equipment necessary for open-pit mining, including a warehouse, offices, fuel tanks, and on-site repair shops for machinery and rolling-stock. Electrical power was formerly available from B.C. Hydro at the Sukunka substation, which fed a wood-pole sub-transmission line to a transformer-station at Brule Mine, situated within the boundaries of the Dillon coal property. At date of writing, the Brule Mine electrical distribution system is served by a portable generator, situated at the mine's shop complex. Telecommunications, including Internet access, are available via satellite and cellular telephone systems. Satellite access is excellent in within the deforested parts of the Dillon property, but unreliable in the heavily-wooded hillsides and riparian areas. Cellular coverage is inconsistent, owing to distance from transmitters, and to interruptions of line-of-sight to transmitters.

Base-mapping for the Dillon area is freely available from the provincial government's Base Map Online Store, which affords a facility for downloading representational shaded-relief topographic maps. Map-sheet 093P/5 (at 1:50,000) of the National Topographic System, and provincial base map sheets 093P.031 and 093P.041 (at 1:20,000) cover the property.

2.2 Physiography, climate and vegetation

Terrain is generally mountainous, with very steep hill slopes, capped by rounded, rolling, densely-forested plateaux whose sides have been deeply-dissected by steep gullies and ravines. Ground elevations range from 940 metres at Blind Creek, in the extreme southeastern corner of the Dillon lease, to 1,385 metres atop Camp Ridge, within the lease's southwestern corner. The Dillon area has a continental alpine climate, characterised by long, moderately cold, snowy winters and short, rainy summers. Snow and frost may occur in any month of the year. Winds are generally gusty and ongoing, with rare calm periods. Convective thunderstorms frequently occur during summer months, bringing intense rain-showers and occasional hail.

A mosaic of overmature and immature second-growth (previously logged or burned by wildfires) coniferous forest covers most upland areas of the property, with more-abundant broadleaf trees along streams and creeks. The Dillon coal lease lies within Canfor's Tree Farm Licence (TFL) No.48, with numerous cut-blocks. Most of the readily-accessible parts of the Dillon property are covered by juvenile second-growth trees. Soil cover at Dillon is patchy, consisting mainly, of till, colluvium and alluvium, with pockets of peat and silt within poorly-drained upland areas. Exploratory drilling has encountered, and partially outlined, localised areas of very thick soil cover, locally exceeding 50 metres' thickness.

2.3 Property description

The Dillon coal property consists of one coal lease (**Map 2-2**), established within coal licences originally held by Teck Corporation (Teck), and sold by that firm to Western Canadian Coal

Corp. (a predecessor company of Walter Energy) in 1999. To maintain good status, coal leases require the payment of an area-based annual rental fee as prescribed by the provincial *Coal Act Regulation*. **Table 2-1** presents tenure details for the Dillon property, whose total area is 1176 hectares and whose annual rental cost is $11,760.

Table 2-1: Coal tenure at Dillon

Tenure Numbers		Land description		Area in hectares (ha)	Dates		Annual rental
Current	Historic	Blocks	Units		Issued	Renew by	at $10 or $15/ha
412964	CL 3079, 3080, 3084 and 3085	93P/5 Block F	65, 66, 67, 68, 75, 76, 77, 78, 85, 86, 87, 88, 95, 96, 97, 98	1,176 ha	Sept. 9, 2004	Sept. 9, 2015	$11,760 (at $10)
Totals		1 coal lease / 16 units		1,176 ha			$11, 760

2.3.1 Regulatory setting

Surface access for drilling and other exploratory works is regulated by the provincial government, under the *Coal Act Regulations* and the *Mines Act*. The Dillon coal property is situated within the Dawson Creek TSA (Timber Supply Area). Cutting of timber for mining purposes is subject to the terms of a *Free Use Permit* issued by the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO).

2.4 Coal production statistics

Table 2-2 (below) presents annual summaries of commingled production from the Dillon and Brule coal leases, from year-2010 onward to suspension of Brule Mine's coal production in July of 2014.

Table 2-2: Annual production statistics for Brule Mine, commingled from Dillon and Brule coal leases

Year	Run-of-mine (ROM) coal in tonnes	Bank cubic metres (BCM) of waste	Strip ratio (BCM/ROM)
2010	1,150,503	10,106,951	8.78:1
2011	1,726,201	19,742,969	11.44:1
2012	2,124,098	19,668,561	9.26:1
2013	1,757,326	14,103,360	8.03:1
2014	909,453	7,434,230	8.17:1
2015 (to date of this report)	nil	nil	n/a
totals	7,667,581	71,056,070	9.27:1

Note: table compiled by Matt Brown, EIT.

Coal from the Dillon lease has historically been sold into world markets as a low-volatile, low-ash Pulverised Coal Injection (PCI) product, used for steel-making purposes.

2.5 Current work

'Current work' in the context of this report comprises:

- a limited study of borehole geophysical logs to ascertain the extent of thrust-faulting,
- subsurface correlation and tracing of various marker beds within the Gething Formation,
- geological modelling of the Brule coal deposit, and
- the calculation of coal volumes (Eshun and others, 2015), as outlined in **Appendix A** and **Appendix B** of this report.

That portion of the Brule deposit's coal volume which lies specifically within the bounds of the Dillon Lease has been determined by Francis Eshun P.Geo., and is discussed in detail in **Section 5** of the present report.

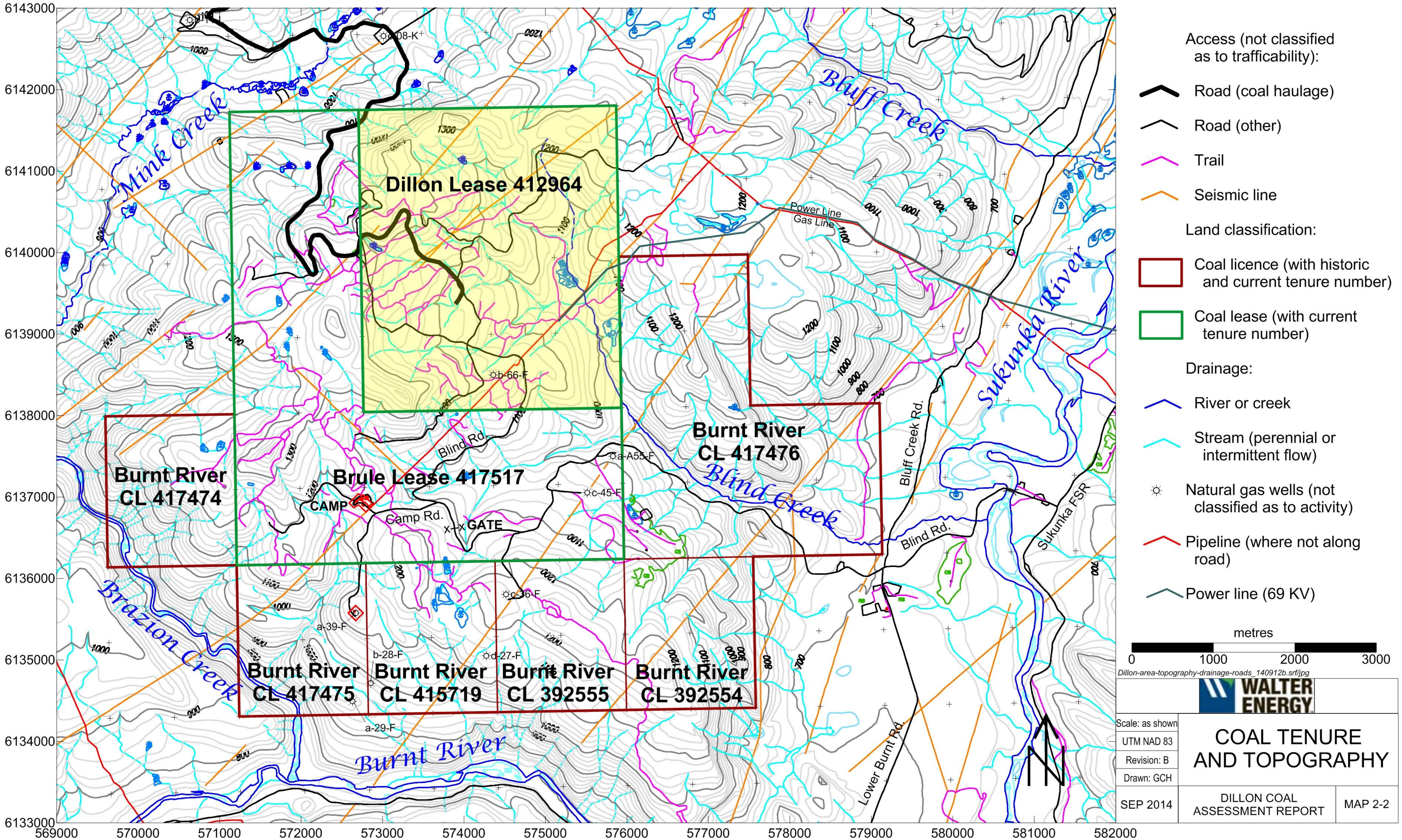
Current geological modelling is adequate to define the gross fold structure of the Brule Mine segment of the Dillon Lease, although as the creators of the 3D block model have noted (Eshun and others, 2015, page 11), "the current model does not incorporate a sufficient amount of coal quality data to provide reliable predictions of product quality and should not be relied upon for such." The modelling study did not incorporate many faults, and its authors noted few overlapping intersections of major coal beds within the boreholes used to construct the model.

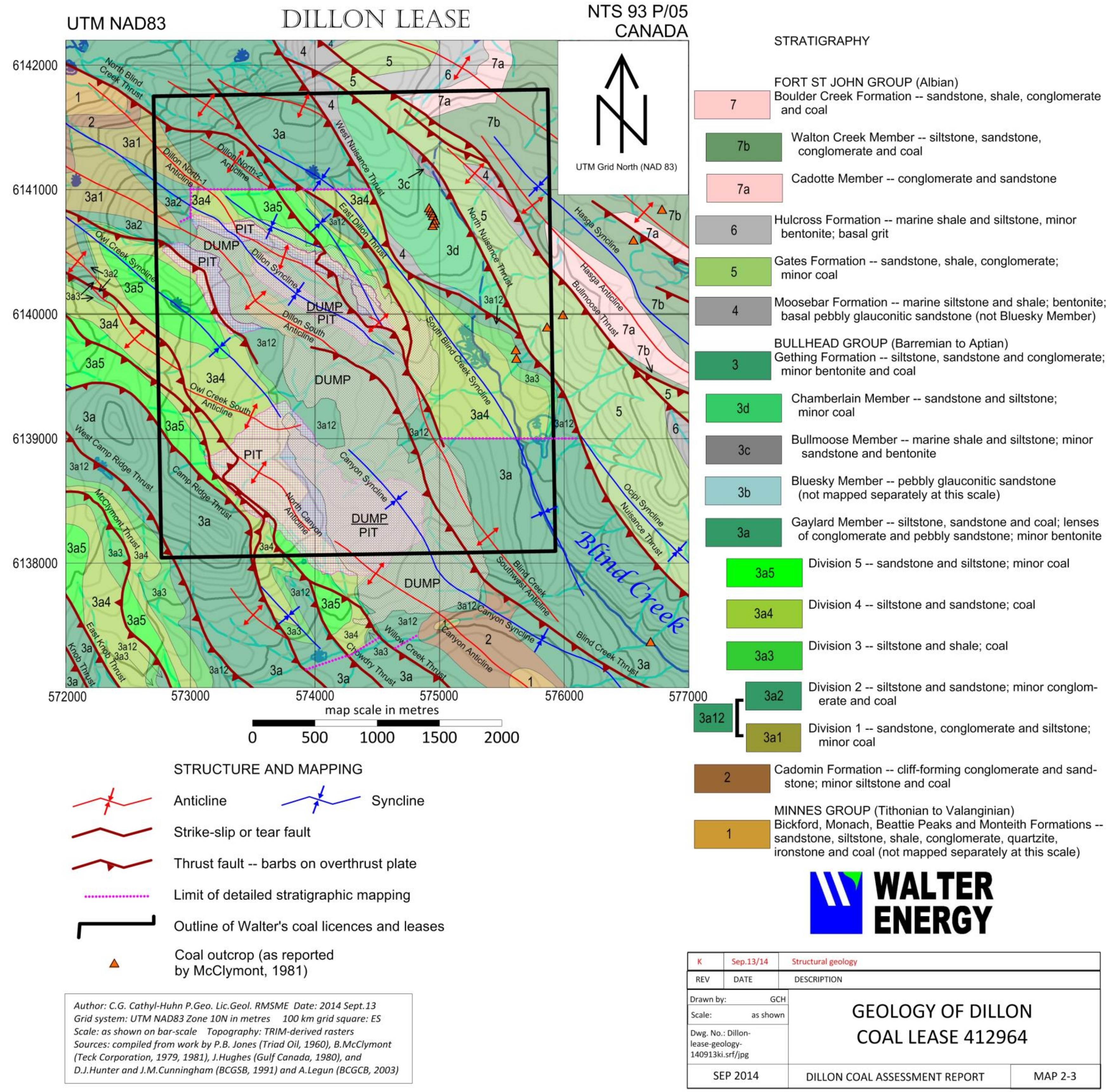
The coal-measures within the Dillon area have not yet been completely tested by drilling, and ample scope remains for the extensions of the already-identified coal deposits (e.g. Brule, Dillon and Blind), with potential for increase of the coal-resource base. The Dillon property merits further work.

2.6 Acknowledgements and statement of professional responsibility

Mine geologist Francis Eshun P.Geo. provided a copy of the January 2015 modelling memorandum (here presented as **Appendices A** and **B**), which incorporates his work along with that of other Walter Energy staff (cited in **Section 7** as Eshun and others, 2015). Mine engineers Matt Brown EIT and Michael Tuters EIT provided Brule Mine's production figures and base-mapping, respectively. Thanks are due to data analyst Preetpal Singh, who has continued to collect drilling and geophysical records from their storage locations at minesites and other outlying locations.

Senior colliery geologist Gwyneth Cathyl-Huhn P.Geo. accepts professional responsibility for this report.


Dillon Lease 412964
Brule Lease 417517
Burnt River
CL 417474
Burnt River
CL 417476
Burnt River
CL 417475
Burnt River
CL 415719
Burnt River
CL 392555
Burnt River
CL 392554
Mink Creek
Bluff Creek
Sukunka River
Blind Creek
Brazion Creek
Burnt River
Blind Rd.
Camp Rd.
CAMP
GATE
Power Line
Gas Line
Bluff Creek Rd.
Sukunka FSR
Lower Burnt Rd.
Access (not classified as to trafficability):
Road (coal haulage)
Road (other)
Trail
Seismic line
Land classification:
Coal licence (with historic and current tenure number)
Coal lease (with current tenure number)
Drainage:
River or creek
Stream (perennial or intermittent flow)
Natural gas wells (not classified as to activity)
Pipeline (where not along road)
Power line (69 KV)
metres
0 1000 2000 3000
Dillon-area-topography-drainage-roads_140912b.srf/jpg
WALTER ENERGY
Scale: as shown
UTM NAD 83
Revision: B
Drawn: GCH
COAL TENURE AND TOPOGRAPHY
SEP 2014
DILLON COAL ASSESSMENT REPORT
MAP 2-2


UTM NAD83
DILLON LEASE
NTS 93 P/05
CANADA
UTM Grid North (NAD 83)
6142000
6141000
6140000
6139000
6138000
572000
573000
574000
575000
576000
577000
map scale in metres
0 500 1000 1500 2000
Blind Creek
North Blind Creek Thrust
Dillon North-1 Anticline
Dillon North-2 Anticline
West Nuisance Thrust
East Dillon Thrust
North Nuisance Thrust
Hasga Syncline
Hasga Anticline
Bullmoose Thrust
Owl Creek Syncline
Dillon Syncline
Dillon South Anticline
South Blind Creek Syncline
Owl Creek South Anticline
West Camp Ridge Thrust
Camp Ridge Thrust
McClymont Thrust
North Canyon Anticline
Canyon Syncline
Blind Creek Southwest Anticline
Ocipi Syncline
Nuisance Thrust
Blind Creek Thrust
Canyon Anticline
Willow Creek Thrust
Chowdry Thrust
East Knob Thrust
Knob Thrust
PIT
DUMP
DUMP PIT
STRATIGRAPHY
FORT ST JOHN GROUP (Albian)
7 Boulder Creek Formation -- sandstone, shale, conglomerate and coal
7b Walton Creek Member -- siltstone, sandstone, conglomerate and coal
7a Cadotte Member -- conglomerate and sandstone
6 Hulcross Formation -- marine shale and siltstone, minor bentonite; basal grit
5 Gates Formation -- sandstone, shale, conglomerate; minor coal
4 Moosebar Formation -- marine siltstone and shale; bentonite; basal pebbly glauconitic sandstone (not Bluesky Member)
BULLHEAD GROUP (Barremian to Aptian)
3 Gething Formation -- siltstone, sandstone and conglomerate; minor bentonite and coal
3d Chamberlain Member -- sandstone and siltstone; minor coal
3c Bullmoose Member -- marine shale and siltstone; minor sandstone and bentonite
3b Bluesky Member -- pebbly glauconitic sandstone (not mapped separately at this scale)
3a Gaylard Member -- siltstone, sandstone and coal; lenses of conglomerate and pebbly sandstone; minor bentonite
3a5 Division 5 -- sandstone and siltstone; minor coal
3a4 Division 4 -- siltstone and sandstone; coal
3a3 Division 3 -- siltstone and shale; coal
3a12
3a2 Division 2 -- siltstone and sandstone; minor conglomerate and coal
3a1 Division 1 -- sandstone, conglomerate and siltstone; minor coal
2 Cadomin Formation -- cliff-forming conglomerate and sandstone; minor siltstone and coal
MINNES GROUP (Tithonian to Valanginian)
1 Bickford, Monach, Beattie Peaks and Monteith Formations -- sandstone, siltstone, shale, conglomerate, quartzite, ironstone and coal (not mapped separately at this scale)
STRUCTURE AND MAPPING
Anticline
Syncline
Strike-slip or tear fault
Thrust fault -- barbs on overthrust plate
Limit of detailed stratigraphic mapping
Outline of Walter's coal licences and leases
Coal outcrop (as reported by McClymont, 1981)
Author: C.G. Cathyl-Huhn P.Geo. Lic.Geol. RMSME Date: 2014 Sept.13
Grid system: UTM NAD83 Zone 10N in metres 100 km grid square: ES
Scale: as shown on bar-scale Topography: TRIM-derived rasters
Sources: compiled from work by P.B. Jones (Triad Oil, 1960), B.McClymont (Teck Corporation, 1979, 1981), J.Hughes (Gulf Canada, 1980), and D.J.Hunter and J.M.Cunningham (BCGSB, 1991) and A.Legun (BCGCB, 2003)
WALTER ENERGY
K Sep.13/14 Structural geology
REV DATE DESCRIPTION
Drawn by: GCH
Scale: as shown
Dwg. No.: Dillon-lease-geology-140913ki.srf/jpg
GEOLOGY OF DILLON COAL LEASE 412964
SEP 2014
DILLON COAL ASSESSMENT REPORT
MAP 2-3

3 Geology

Regional and local geology of the Dillon coal property (**Map 2-3**) is known mainly from the extensive work of D.F. Stott (1960; 1963; 1968; 1973; 1974; 1981; 1998) and D. Gibson (1992a; 1992b), both from the Geological Survey of Canada. Industrially-focussed work has also been done by the oil industry (Jones, 1960, focussing on structural geology) and the coal industry (chiefly by Teck Corporation).

As well, numerous other relevant coal-company reports are available as Coal Assessment Reports from the British Columbia Geological Survey Branch, as cited in **Section 7** of this report. The most useful of these reports (available as Coal Assessment Report No.490) was written by B.I. McClymont (1981) for a joint-venture of Teck and Brameda Resources Ltd.

The most recent relevant coal-assessment report for the nearby Brule Lease (whose principal coal-resource area adjoins the Dillon Lease to the west) is Coal Assessment Report No.936, written by C.G. Cathyl-Huhn and L.R. Avery (2014). The most immediately-precedent coal-assessment report for the Dillon Lease *per se* is Coal Assessment Report No.957, written by C.G. Cathyl-Huhn, L.R. Avery and P. Singh (2014).

3.1 Regional geological context

The Dillon coal property lies within the Brazion coalfield of northeastern British Columbia, part of the Foothills structural province of the Canadian Cordillera. All rocks exposed at the ground surface are of latest Jurassic to Early Cretaceous age, belonging to the Minnes (Tithonian to Valanginian stages), Bullhead (Barremian to Aptian stages) and Fort St. John (Albian stage) groups. Where not subsequently eroded, the total undeformed thickness of these rocks is 2200 to 2350 metres. Depth to Precambrian continental basement, including both Mesozoic and Palaeozoic rocks, is more substantial, in the range of 10 to 12 kilometres (McMechan, 1984), although some of this thickness is attributable to thrust-induced tectonic stacking of the strata, and to associated shortening across folds.

The majority of sedimentary rocks within the Brazion coalfield are clastic in origin, ranging in grain-size from claystones and mudstones through pebble-conglomerates. Lesser amounts of biologically- and chemically-derived sedimentary rocks are present, comprising coals, banded and nodular ironstones, glauconite-rich sandstones and gritstones, and impure dolomites.

Volcanic rocks constitute a very small component of the Jurassic and Early Cretaceous strata, comprising very fine- to fine-grained tuffs, interpreted to have originated as wind-borne distal ash-fall deposits from contemporaneous volcanoes situated within the Coast Plutonic Complex, far to the southwest of the property. The volcanic rocks characteristically occur as very thin (at most a few decimetres) yet regionally-extensive bands, which are of use as markers for structural and stratigraphic correlations. No intrusive rocks are known to occur at Dillon.

3.1.1 Regional sedimentology and stratigraphy

During much of the Early Cretaceous period, the Western Interior of North America was occupied by a shallow seaway, variably-designated by different authors as the Western Interior Sea, the Boreal Sea, or by various analogues of formation names, such as the Clearwater Sea, Hulcross Sea or Moosebar Sea. Depths of the seaway, magnitude of accommodation space for sediments, and overall shoreline trends, were largely controlled by vertical movements within a block-faulted crystalline basement terrane of Precambrian age, the Peace River Arch.

During the latest Jurassic and earliest Cretaceous periods, sediments of the Minnes Group and the basal part of the Bullhead Group were derived from actively-eroding upland areas within the North American craton, particularly from the Peace River Arch. The receiving basin during this early time period lay to the west of the craton, within an actively-subsiding continental shelf which prograded westwards into the ancestral Pacific Ocean. Subsequently, slightly later within the Early Cretaceous period, sediments of the upper Bullhead Group and the Fort St. John Group were derived from actively-rising thrust-faulted tectonic forelands situated to the west and southwest of the seaway, synchronous with the docking of allochthonous tectonic terranes against the western margin of the North American craton.

Kalkreuth and Leckie (1989) recognised the close association between actively-subsiding shoreface sandstone deposits and the overlying presence of thick coal beds; this association is well-established within the upper part of the Gething Formation within the Brazion and Sukunka-Quintette coalfields, and less well-so within the lower part of the Gething Formation.

3.1.2 Regional tectonics

The Dillon property's structural geology is complex and thin-skinned (Barss and Montandon, 1981), characterised by cylindrical-conical tight folds, and by doubly-arcuate folded thrust-faults, locally producing very complex imbricate *schuppen*-structures with the Gething Formation coal-measures. Thrust faults are northeast-verging, and generally southwest-dipping, where not overturned by refolding. Thrusts characteristically overlap in *en echelon* manner, with displacement gradually transferring from one fault to another via trains of folds.

Age relationships amongst the thrusts are inferred to be as are generally-observed within the Cordilleran fold-thrust belts of northwestern North America, with the oldest thrusts occupying stratigraphically-higher positions (generally to the southwest) of the stratigraphically-lower and younger thrusts.

3.2 Structural geology at local scale

In detail (**Map 2-3**), the Dillon property occupies a series of tightly-compressed structural slices (which may be informally referred to as structural 'plates', following general regional practice) bounded and stacked-up by folded, arcuate, northeastward-verging thrust-faults. *En-echelon* folds occur within displacement-transfer zones situated between major thrust-faults. Folds are concentric and cylindrical to conical in form.

Positional confidence of faults, folds and associated geological-unit contacts ranges from 'approximate' to 'defined' within the Dillon coal property, with the highest confidence being associated with mined-areas within the existing open-pit workings.

Some of the geological structures' names were first assigned in the late 1950s by Triad Oil's geologists (Jones, 1960), or in the 1970s by Teck Corporation's workers. Additional structures were subsequently recognised by Western Coal staff and consultants making more detailed studies of the Dillon lease and the adjoining Brule lease, while yet others are here newlycoined for the purposes of the regional geological study which underpins the present report.

3.2.1 Thrust faults

Most of the Dillon coal property lies between two regionally-significant faults: the Willow Creek Thrust in the southwest, and the Bullmoose Thrust in the northeast of the property.

Thrust faults, as inferred from landforms and from limited ground-surface observations, in general display sinuous map traces. Furthermore, thrust faults curve vertically, in consequence of ‘ramp-flat’ structural refraction between weak and strong beds, and also as a consequence of passive folding above later-formed structural ramps along deeper, younger thrusts.

Thrusts range in scale from outcrop-scale mesoscopic *schuppen*-structures comprised of many closely-associated micro- and meso-faults whose stratigraphic displacements are a few decimetres to a few metres, to regionally-throughgoing faults and fault zones (such as the Bullmoose, Nuisance, and Willow Creek thrust faults and associated splays), whose stratigraphic offsets may exceed several hundred metres. **Table C-1**, in **Appendix C** of this report, presents a (likely-incomplete) selection of drilled intersections of thrust faults within the Brule Mine area, as observed in a selection of boreholes situated within both the Dillon Lease and the Brule Lease.

*To reiterate, the listing of thrust faults in **Table C-1** is likely to be incomplete, on the dual grounds of incomplete examination of borehole records (this is a work-in-progress) and of difficulty in identifying thrust faults whose course is layer-parallel with respect to underlying <u>and</u> overlying strata.*

Thrust faults locally follow bedding within coal beds, as evidenced by intense shearing and micro- to meso-scale imbricate structures within coal beds and also within nearby mechanically-weak roof and floor rocks. The most noteworthy horizons of bedding-parallel thrusting are the Marker D coal bed (close below coal C60) and the Marker B coal bed (close below the Lower Seam). Some of the faults identified within **Table C-1** are denoted as 'flat'; these faults are inferred to be bedding-parallel, effectively functioning as décollement horizons.

Some exploratory boreholes have encountered multiple structural ‘horses’ of overthrust coal, particularly along the keel and the near-axial region of the northeast limb of the Owl Creek Syncline. Seam C60 appears to be more-commonly involved in such structures than the Upper Seam or the Lower Seam. Given current drilling and geophysical data, it is not yet clear whether this differential involvement is due to mechanical contrasts in rock strength, or perhaps an artefact of increased difficulty in drilling through tectonically-complex zones at greater depth.

Thrust faulting within the Dillon Lease (and within the immediately-adjoining portion of the Brule Lease) is inferred, on regional grounds, to have a northeastward primary vergence (sense of tectonic transport). Meso-scale thrust-faults with opposing (southwestward) vergence have been locally observed within the workings of Brule Mine, but southwestward vergence is inferred to be of secondary extent. Thus far, thrusting has not been considered to achieve the deformational intensity of that seen within the triangle zone at Willow Creek, although such intensities are conceivable within the cores of the folds within the Dillon Lease, particularly within the near-isoclinal structures associated with the Dillon Syncline (**Map 2-3**).

Despite the pervasive faulting of the coal-measures, normal stratigraphic facing of the rocks is generally preserved, and overturned beds are uncommon except for within the Dillon Syncline.

3.2.2 Folds

As noted above, folds at Dillon are concentric to conical in form. Folds locally die out as closely-associated *en-echelon* couplets, interpreted as accommodating displacement transfer between thrust faults. Layer-parallel slip is characteristic within the deformed coal-measures. As well, cataclastic ‘podding’ may occur within axial culminations and keels of the folds; this is particularly likely to have occurred along the keel of the Dillon Syncline, which is locally near-isoclinal in form. Anomalously-thick borehole intersections may reflect podding of coal.

3.3 Stratigraphic review of the Dillon Lease and its coal beds

A generalised stratigraphic profile of the Jurassic and Cretaceous coal-measures of the Dillon area is presented as **Table 3-1**. The following discussion provides a systematic description of the major rock-units, drawing heavily upon the detailed results of drilling within the western half of the Dillon lease. For convenience, the discussion is broken into the headings of ‘Younger rocks’ (**Section 3.3.1**), ‘Gething Formation coal-measures’ (**Section 3.3.2**) and ‘Older rocks’ (**Section 3.3.3**).

3.3.1 Younger rocks (map-units 4 through 7b)

‘Younger rocks’ within the Dillon coal property comprise Albian (Early Cretaceous) sedimentary rocks of the Boulder Creek, Hulcross, Gates and Moosebar formations, all of them being within the Fort St. John Group. The Boulder Creek Formation is the youngest of these rocks within the Dillon property, underlying a very small portion of the property’s northeastern corner. The following discussion proceeds downward in order of increasing geological age, from youngest to oldest.

Boulder Creek Formation (map-units 7b and 7a)

The Boulder Creek Formation, of late Middle Albian age (Gibson, 1992b) forms prominent cliffs in the upland area between Blind Creek and Sukunka River, immediately northeast of Dillon. Boulder Creek rocks are inferred to extend into the northeastern corner of the Dillon coal property, within the Hasga anticline-syncline system, and beneath the Bullmoose Thrust.

Regionally, conglomerate and sandstone are the predominant lithologies of the Boulder Creek Formation, but the formation also contains fine-grained rocks including siltstone, root-penetrated, variably-carbonaceous mudstone, and coal. Conglomerate and sandstone are concentrated in the basal Cadotte Member (map-unit 7a) of the formation, while fine-grained rocks are concentrated in the overlying Walton Creek Member (map-unit 7b). The uppermost regional division of the Boulder Creek Formation, comprising the conglomerate of the Paddy Member, is not recognised at Dillon.

The overall thickness of the Boulder Creek Formation is inferred to be 80 to 110 metres at Dillon, of which the basal 30 metres comprises the Cadotte Member and the overlying 50 to 80 metres comprises the Walton Creek Member. The basal contact of the Boulder Creek Formation with the underlying Hulcross Formation is abrupt to erosional at local scale, and likely to be interfingering at regional scale.

Hulcross Formation (map-unit 6)

The Hulcross Formation, of middle Albian age within the Early Cretaceous (Stelck and Leckie, 1988) comprises thinly-interbedded, locally-concretionary grey siltstone, fine-grained sandstone and dark grey mudstone with occasional very thin but extremely-persistent interbeds of soft, light grey to white tuff (Kilby, 1985; Gibson, 1992b) and rare thin stringers of coal. Sideritic concretions are commonly found in isolated, laterally-persistent bands. At Dillon, the Hulcross Formation is inferred to only occur within an extremely limited area within the far northeastern extremity of the property, underlying the Bullmoose Thrust.

The thickness of the Hulcross Formation in the Dillon area is estimated to be 130 metres. The formation's immediate base is characteristically marked by a thin (generally less than a metre thick) erosive-based bed of pebbly sandstone or gritstone, lying erosionally upon the underlying strata of the Gates Formation. At Dillon, the fine-grained rocks of the Hulcross Formation, Moosebar Formation, and the Bullmoose Member of the Gething Formation are lithologically similar and therefore difficult to distinguish in isolated outcrop sections.

Gates Formation (map-unit 5)

The Gates Formation, of late Early Albian age within the Early Cretaceous (Stott, 1982), comprises thin to thick interbeds of sandstone, siltstone, conglomerate, and shale, locally accompanied by coal beds. The Gates Formation was formerly considered as a member within the Commotion Formation, and that usage prevailed in earlier governmental surveys and coal-industry exploration reports (Stott, 1968). Coals of the Gates Formation, and their enclosing sedimentary rocks, were deposited on the shoreline of the Clearwater Sea (part of the Western Interior Seaway) between 108.7 and 111.0 million years ago, as part of an extensive complex of coastal plains, deltas and estuaries collectively known as the Gates Delta.

Within the Dillon property, the Gates coal-measures are exposed within the northeastern limb of the Ocipi Syncline (beneath the North Nuisance Thrust) and likely also present at depth within the Hasga fold belt (beneath the Bullmoose Thrust). No drilling has been done within the Gates Formation at Dillon.

At Dillon, the Gates Formation is inferred to be 70 to 100 metres thick. The nature of its contact with the underlying Moosebar Formation is unknown at local scale, but likely to be interfingering at the regional scale.

Moosebar Formation (map-unit 4)

The Moosebar Formation, of Early Albian age (Stott, 1968) comprises approximately 190 metres of marine siltstone and shale, with minor interbeds of sandstone and very thin but extremely-persistent bands of tuff (generically named as 'bentonites' by local geologists). Within the Dillon property, the Moosebar Formation is inferred to form bedrock within a two narrow structural slices lying between the West Nuisance, North Nuisance, and Bullmoose thrust faults. Insufficient lithological detail is available in this area, to support the usual subdivision of the formation into an upper siltstone/sandstone unit (the Spieker Member), and a lower mudstone/tuff member.

Table 3-1: Table of lithostratigraphic units

Group/Formation/ Member			Map-		Lithology and thickness	Coal bed details
Fort St. John Group	Boulder Creek Fm.	Walton Creek Mb.	7b		siltstone, sandstone, conglomerate and coal; 50 to 85 m thick.	coal present but not yet drilled
		Cadotte Mb.	7a		conglomerate and sandstone; 30 m thick.	
	Hulcross Fm.		6		marine shale, siltstone and sandstone; minor tuff and sideritic concretions; thin basal grit; 130 m thick.	
	Gates Fm.		5		sandstone, shale, conglomerate; minor coal; 70 to 100 m thick?	coal present but not yet drilled
	Moosebar Fm.		4		marine siltstone and shale; minor tuff; basal pebbly glauconitic sandstone; 190 m thick?	
Bullhead Group	Gething Fm.	Chamberlain Mb.	3d		sandstone and siltstone; minor conglomerate and coal; 60 m thick?	coal present but not yet drilled
		Bullmoose Mb.	3c		marine shale and siltstone; minor sandstone and tuff; 105 m thick.	
		Bluesky Mb.	3b		glauconitic pebbly sandstone, pebbly mudstone and conglomerate; 2 to 21 m thick.	stringers of detrital coal
		Gaylard Mb.	3a	3a5	Division 5 (beds above Seam 60): sandstone and siltstone, minor coal; 95 to 105 m thick.	minor coals: Markers G, F, and E.
				3a4	Division 4 (beds above Upper Seam): siltstone and sandstone; coal; 45 to 75 m thick.	major coal: Seam 60 (at top); minor coals: Markers D, C.
				3a3	Division 3: siltstone and shale; coal; 8 to 35 m thick.	major coals: Upper Seam (at top) and Lower Seam (at base).
				3a2	Division 2 (beds below Lower Seam): siltstone and sandstone; minor conglomerate and coal; 105 m thick?	minor coals: Markers B (near top), AA, and A (near base).
				3a1	Division 1: sandstone, conglomerate and siltstone; minor coal near base; 35 to 70 m thick.	basal section potentially contains coal; not yet drilled within property.
	Cadomin Fm.		2		gritty sandstone and conglomerate; minor siltstone; 25 to 35 m thick?	
Minnes Group	Bickford Fm. (formerly known as the Brenot Fm.)		1	1d	sandstone, siltstone, mudstone and coal; 285 to 300 m thick.	not yet drilled within property.
	Monach Fm.			1c	sandstone and quartzite; minor siltstone and conglomerate; 50 m thick.	
	Beattie Peaks Fm.			1b	sandstone, siltstone and shale; minor ironstone and coal; 300 m thick.	not yet drilled within property.
	Monteith Fm.			1a	sandstone, shale and conglomerate; quartzite; 600 m thick?	

The basal contact of the Moosebar Formation with the underlying Chamberlain Member of the Gething Formation is marked by a thin but laterally-persistent, formally-unnamed zone of erosive-based pebbly, glauconitic sandstone, siltstone and mudstone.

3.3.2 Gething Formation coal-measures (map-unit 3)

The Gething Formation, of early Aptian to early Albian age within the Early Cretaceous (Gibson, 1992a), comprises thin to thick interbeds of siltstone, sandstone, mudstone and coal, with lesser amounts of gritstone, pebble-conglomerate, ironstone and tuff. The Gething

Formation includes beds formerly designated as the Dresser Formation by Hughes (1964); its current stratigraphic extent was established by Stott (1968).

Following upon suggestions made by coal-company geologists (Wallis and Jordan, 1974) and subsequent work by the British Columbia Geological Survey (Duff and Gilchrist, 1981), Gibson divided the Gething into three members: the non-marine to transitional Chamberlain Member, the shallow-marine Bullmoose Member, and the non-marine to transitional Gaylard Member. A fourth member of the Gething Formation, the Bluesky Member, is also inferred to be present between the base of the Bullmoose Member and the top of the Gaylard Member.

The Gething Formation originated as a complex of non-marine to shallow-marine sedimentary deposits, laid down by meandering and braided streams and rivers within a widely-extensive belt of coastal deltas, of which two (the Gaylard and Chamberlain paleodeltas) extended into the Dillon area. Deltaic deposits were occasionally interrupted and at times extensively overrun by transgressive, shallow-marine deposits of the Western Interior Seaway. A thick central tongue of marine rocks (the Bullmoose Member) separates the non-marine and paralic deposits of the Gaylard and Chamberlain paleodeltas.

Coals of the Gething Formation at Dillon, and their enclosing sedimentary rocks, were deposited between 111 and 123 million years ago (Gibson, *ibid.*), on the basis of regional plant-fossil and foraminiferal zonations.

Chamberlain Member (map-unit 3d)

The Chamberlain Member of the Gething Formation is inferred to be exposed only in a small area within the Dillon property, situated between the two strands of the Nuisance Thrust.

The Chamberlain Member comprises interbedded sandstone and siltstone, with minor conglomerate, grading northward and northeastward to sandy siltstone (Gibson, 1992a). Regionally, the Chamberlain Member is well-known to contain several coal beds within the Sukunka-Quintette coalfield (Wallis and Jordan, 1974). Locally, coals interpreted to belong to the Chamberlain are known to outcrop between the West and North strands of the Nuisance Fault, within the northeastern corner of the Dillon property. However, the Chamberlain Member has not yet been tested by coal-exploration boreholes at Dillon. The Chamberlain Member is inferred to be approximately 60 metres thick within the area bounded by the two strands of the Nuisance Thrust, with an abrupt to interfingering basal contact above the underlying Bullmoose Member.

Bullmoose Member (map-unit 3c)

Within the Dillon coal property, the Bullmoose Member of the Gething Formation is inferred to only be present between the two strands of the Nuisance Thrust, where it is largely-covered by the overlying Chamberlain Member. Regionally, the Bullmoose Member comprises thinly-interbedded marine shale and siltstone, with an overall turbiditic aspect, accompanied by minor sandstone and tuff. Similar lithologies would be expected to exist within the poorly-exposed Bullmoose rocks at Dillon. Where a complete section of the Bullmoose Member has been drilled (within the Rocky Creek coal property, south of Dillon), its thickness is 83 metres, and its basal contact with the underlying Bluesky Member is gradational to abrupt. A similar contact relationship is expected at Dillon, although upon the evidence of widely-spaced natural-gas boreholes situated to the east and north of Dillon, the Bullmoose Member is inferred to be slightly thicker, at 105 metres.

Bluesky Member (map-unit 3b)

As with the Bullmoose Member, the Bluesky Member of the Gething Formation is inferred to only be present between the strands of the Nuisance Thrust, where it has no yet been located at outcrop, nor drilled. Regionally, the Bluesky Member comprises pebbly sandstone, pebbly mudstone and cherty pebble-conglomerate, often containing sparse to abundant glauconite, correlated on the basis of its stratigraphic position and distinctive glauconitic content with the Bluesky Formation of the Dawson Creek area (Kilby, 1984; Legun, 1990; Gibson, 1992a). Again on a regional basis, the Bluesky ranges in thickness from 2 to 21 metres, with at least part of its thickness variation being occasioned by its erosion basal contact with the underlying Gaylard Member of the Gething Formation. Similar thickness and contact relationships are likely for the Bluesky Member at Dillon.

Gaylard Member (map-unit 3a)

The Gaylard Member of the Gething Formation is inferred to be represented at Dillon by approximately 330 metres of siltstone, sandstone, mudstone and minor ironstone, tuff, gritstone and conglomerate, accompanied by three thick coal beds (from top down, Seam C60, the Upper Seam, and the Lower Seam), locally several metres thick, and at least nine thinner coal beds (collectively termed the ‘Marker’ coals) which seldom exceed a metre.

At Dillon, the Gaylard coal-measures may be usefully subdivided into five informal ‘divisions’, based mainly upon gross lithology and the presence of major coal beds. Stratigraphic details of these informal divisions are presented in **Tables 3-1** and **3-2**.

<u>Gaylard lithologies</u>

Siltstone is by far the predominant lithology within the Gaylard Member, characterised by variable levels of bioturbation from patchy to intense, occasionally with bands of nodular or massive (rarely mosaic-textured) ironstone, and ranging in texture from muddy to very sandy. Where they closely underlie coal beds, Gaylard Member siltstones are often rooty and somewhat carbonaceous, although immediate floors of coals generally grade upward to variably-carbonaceous mudstones.

Sandstones within the Gaylard Member range in texture from fine- to coarse-grained, rarely very coarse-grained to gritty or pebbly, and they are frequently cross-bedded. Channel-scours are characteristically found at the base of thicker sandstone units. The immediate basal portions of some channel-filling sandstones are sparsely- to moderately-bioturbated, suggesting the presence of basal salt-water wedges within their associated stream channels. Closely-spaced drilling demonstrates that the Gaylard sandstones vary rapidly in thickness between boreholes. Some of this variation may be due to channel-filling morphologies, whilst in other cases the tops of the sandstones may be bar-forms, draped in a variable thickness of fine-grained sedimentary rocks.

Mudstones within the Gaylard Member are generally silty, at times very much so, and variably-carbonaceous. Nodular ironstone is occasionally present within mudstone units, but the nodules appear to be randomly-disposed rather than concentrated into specific horizons. Glauconite is rarely, but notably, present within the finer mudstones, suggesting that such mudstones may host higher-order maximum flooding surfaces.

Coaly mudstones are characteristically present as thin (centimetre to decimetre-scale) partings within coal beds, or as lenses immediately overlying the tops of coal beds. Coaly mudstones are occasionally associated with elevated fusain contents in the immediately-underlying coals, suggestive of origin as fire splays.

Tuff bands (colloquially termed as 'ash bands') are occasionally present within the well-exposed sections of the Gaylard Member at Brule Mine's Camp Pit. These bands of pyroclastic volcanic rock appear as distinctively white to very light grey, clay-rich, soft layers, ranging from a few millimetres to a decimetre thick, within their otherwise-unremarkable bounding strata.

<u>Gaylard coals</u>

Coals and associated coaly mudstones form 5% to 10% of the Gaylard Member's thickness within the Dillon coal property. Where observed in working-faces at Brule Mine's Camp Pit, the Gaylard Member coals range in texture from blocky and well-cleated to intensely-sheared and pulverised, locally forming finely-imbricate masses of 'cornflakes'.

Three major coals are recognised at Dillon: coal C60 (at the top of Division 4), the Upper Seam (at the top of Division 3) and the Lower Seam (at the base of Division 3).

The Gaylard coals at Dillon range in visual brightness from 'dull' and 'dull banded' to 'dull and bright', rarely to 'bright banded' within the Diessel/CSIRO visual coal classification generally used in Canadian coalfields. Some of the dull coal has an anomalous sub-metallic lustre, verging upon 'grey durain' as is more characteristic of Carboniferous coals rather than Cretaceous coals. Banding is generally coarse, although it is often obscured by shearing. Within the Stopes macroscopic classification system (Stopes, 1935), the Gaylard coals range from 'durains' to 'clarains'. The Gaylard coals occasionally grade into black coaly mudstone at their upper contacts. Where shearing is pervasive within such contact horizons, it is difficult to visually distinguish sheared coal from sheared coaly rock, although coals are more likely to have a black streak and coaly rock a dark brown to brownish-black streak when abraded.

Gaylard coals tend to pinch-out or split laterally. The pattern of splitting is rendered more difficult to decipher in those areas where faults travel along bedding within or adjacent to coal zones. Individual leaves of split coals sometimes retain a distinctive log response, increasing confidence in their correlation away from areas of conjoint coal. Drilling is sufficiently closely-spaced to allow mapping of splits within the western third of the Dillon lease (and to approximately map their morphology and internal topology), but insufficiently-so within the southeastern part of the property, which is as yet relatively underexplored.

<u>Marine bands</u>

The Gaylard coal-measures are punctuated by bands of shallow-marine rocks. The thickest and most readily-recognised of these 'marine bands' at Dillon comprises 2 to 9 metres of interbedded mudstone and siltstone with minor very thin bands of sandstone and tuff, designated as 'Marker CD,' within Division 4 of the Gaylard Member.

Table 3-2: Stratigraphic setting of Gaylard Member coals at Dillon

Gaylard divisions	**Coal beds**	Lithology	**Typical thickness of coal bed /** Typical thickness of intervening strata
Division 5		fine- to coarse-grained sandstone and siltstone; minor gritstone and coal	65 metres?
	Marker G	**coal** – dull and bright, clean to dirty; numerous thin partings of carbonaceous to coaly mudstone; locally grades laterally into mudstone with coal streaks.	**0.5 to 1.5 metres**
		variably-carbonaceous mudstone, siltstone and sandstone.	4 to 10 metres
	Marker F	**coal** – bright banded, clean; high gamma-ray response in immediate roof.	**0.5 to 0.8 metres**
		fine- to coarse-grained sandstone, variably-carbonaceous siltstone and mudstone.	20 to 25 metres
	Marker E	**coal** – dull and bright to bright banded; occasional bands of carbonaceous mudstone and mudstone/sandstone laminite; often a doublet of coals.	**0.5 to 1.5 metres**
		fine- to medium-grained sandstone, mudstone and carbonaceous mudstone; occasional ironstone bands near base.	10 to 15 metres
Division 4	**Seam C60**	**coal** – dull to bright banded, with numerous thin bands of carbonaceous to coaly mudstone and siltstone.	**2.7 to 7.0 metres;** splits to northeast
		carbonaceous mudstone; minor siltstone; locally thickens due to presence of sandstone.	0.1 to 20 metres; thickens northward
	Marker D	**coal** – dull to dull and bright, generally sheared; locally intensely-sheared and therefore inferred to host a bedding-parallel tectonic detachment zone.	**0.5 to 2.0 metres;** thickens to north
		siltstone; fine- to medium-grained sandstone, mudstone, minor carbonaceous mudstone and tuff.; includes **Marker CD** (possible marine band)	15 to 25 metres
	Marker C	**coal** – dull lustrous to bright, locally sheared.	**0.5 to 1.0 metres;** thins northward
		fine- to medium-grained sandstone; mudstone, minor siltstone; occasional bioturbated zones; with high gamma-log response in floor – *marine band*?	10 to 11 metres
	(unnamed)	**coal** – bright, with numerous thin bands of carbonaceous mudstone and siltstone.	**0.4 metres**
		fine- to medium-grained sandstone, mudstone; minor carbonaceous mudstone and siltstone, mainly as thin interbeds (point-bar structure?).	10 to 21metres
Division 3	**Upper Seam**	**coal** – dull and bright to bright banded, hard, locally containing 0.3 to 1.2 m parting of variably-carbonaceous mudstone. Where split, the upper ply is **Upper A**, and the lower ply is **Upper B.**	**0.5 to 4.0 metres ;** thins and splits northward
		fine-grained sandstone and siltstone; carbonaceous mudstone.	nil to 25 metres; thickens northward
	Marker M	**coal** – dull and bright to bright banded.	**0.5 metres;** Z-split geometry: rising southward from Lower to Upper Seam
		fine-grained sandstone and siltstone; carbonaceous mudstone.	nil to 3 metres; thickens southward
	Lower Seam	**coal** – bright banded, moderately hard to hard, with well-developed cleat; locally containing parting of siltstone or variably-carbonaceous mudstone. Where split, the upper ply is **Lower A**, and the lower ply is **Lower B**.	**2.0 to 11.0 metres;** thins and splits southward
Division 2		soft, variably-carbonaceous mudstone; minor siltstone.	0.2 to 1.8 metres
	Marker B	**coal and dirty coal** -- dull and bright, soft to very soft; typically contains many very thin partings of carbonaceous mudstone; moderately to intensely sheared; therefore inferred to host a bedding-parallel tectonic detachment zone.	**0.45 to 1.0 metres**
		fine-grained sandstone, mudstone, minor siltstone.	10 to 15 metres
	Marker AA	**coal** – dull and bright to bright banded, typically dirty, hard.	**0.5 to 1.5 metres**
		mudstone, siltstone and channel-filling sandstone with lenses of gritstone and pebble-conglomerate; minor carbonaceous to coaly mudstone.	45 to 75 metres
	Marker A	**coal** – dull and bright to bright banded, hard, typically a doublet of coals, with a central parting of carbonaceous to coaly mudstone.	**0.9 to 1.5 metres**
Division 1		very fine- to medium-grained sandstone, mudstone and siltstone; minor carbonaceous mudstone; coals are locally present near base; sandstones are locally cross-bedded, with channel-filling morphology.	35 to ?70 metres

Marker CD is of practical concern as being the most-extensive zone of potentially acid-generating (PAG) rocks recognised thus far within the Dillon mining lease. Marker CD can be readily recognised by its elevated natural gamma-radiation response on geophysical logs.

Gaylard-Cadomin contact

The basal contact of the Gaylard Member with the underlying Cadomin Formation is abrupt to possibly-erosional at the local scale (Cant, 1996), and interfingering at regional scale (Stott, 1968; Gibson, 1992a), being drawn at the top of a coarse-grained, locally-pebbly, often-gritty bed of sandstone.

3.3.3 Older rocks (map-units 1 through 3)

Along anticlinal crests, and also within the overthrust strata above and to the southwest of the Mt. Chamberlain Fault, rocks older than the Gething Formation are locally exposed within the Dillon coal property. These rocks remain virtually-unexplored at the local scale. Most of what is known of these formations' coal content comes from drilling within the Rocky Creek coal property (Chowdry, 1980; Bowler, 1981) situated about ten kilometres south of Dillon, with which the senior author of the present report was extensively involved.

In order from top down, these older formations comprise the Cadomin Formation (the basal unit within the Bullhead Group), and the Bickford, Monach, Beattie Peaks and Monteith Formations (within the Minnes Group), ranging in age from Late Jurassic to Early Cretaceous. At regional and property scale, all four of constituent formations within the Minnes Group are mapped together as a single unit (map-unit 1). Within the present detailed discussion and within **Table 3-1**, however, these formations are treated individually (as map-units 1d, 1c, 1b and 1a).

Cadomin Formation (map-unit 2)

The Cadomin Formation immediately underlies the Gething Formation, forming the basal part of the Bullhead Group (Stott, 1968). As such, the Cadomin Formation includes strata previously assigned to the Dresser Formation of the Crassier Group by Hughes (1964). The stratonym 'Dresser' is now formally superseded.

The Cadomin Formation comprises one or more thick beds of coarse-grained, gritty to pebbly sandstone and pebble-conglomerate (McLean, 1981) with occasional lenses of siltstone and pebbly gritstone, and rare thin lenses of dirty coal. The Cadomin Formation thus resembles the basal sandstone unit (Division 1) of the Gaylard Member, and its distinction from the overlying Gaylard sandstones rests mainly upon the Cadomin Formation's greater lateral continuity.

At Dillon, the Cadomin Formation is estimated to be 25 to 35 metres thick. Its basal contact with the underlying Bickford Formation is erosional, with considerable local scour into the older sediments. Regionally, the base of the Cadomin marks a northeastward-deepening angular unconformity, cutting down into successively-older rocks of the Minnes Group (Stott, 1973).

Bickford Formation (map-unit 1d)

The Bickford Formation is the stratigraphically-highest and therefore youngest of the four formations which comprise the Minnes Group (Stott, 1981; 1998). The formation was previously designated by Hughes (1964) as the Brenot Formation, being the basal part of his now-superseded Crassier Group. The name 'Brenot' remained in local use by coal-industry workers until the earliest 1980s (Hughes, 1980; Stott, 1981).

The Bickford Formation (named for Mt. Bickford near Pine Pass) consists of non-marine sandstone, siltstone, mudstone and coal, with a total thickness of 285 to 300 metres (Chowdry, 1980). Within the Dillon property, channel-filling conglomerates, up to 11 metres thick, occur near the top of the formation (Stott, 1998).The uppermost few metres of the formation, immediately beneath the base of the Cadomin Formation, is typically bleached and altered to a distinctively-soft, very light grey to white layer of clay-rich sediment.

Coals of potentially-mineable thickness were reported from the Bickford Formation within the Rocky Creek coal property (south of Dillon), on the basis of extensive drilling during the early 1980s, but the formation has yet to be drilled at Dillon, and its local coal potential is therefore unknown.

The basal contact of the Bickford Formation with the underlying Monach Formation is generally abrupt at local scale although interfingering on a regional scale, being drawn at the top of the Monach's distinctive quartzitic sandstones.

Monach Formation (map-unit 1c)

The Monach Formation comprises cliff-forming sandstone and quartzite, with lesser amounts of interbedded siltstone and conglomerate, and occasional thin coals, part of the Minnes Group (Chowdry, 1980; Stott, 1998); Hughes (1964) previously considered the Monach Formation to be the uppermost unit within his Beaudette Group, along with the underlying Beattie Peaks and Monteith formations. The coal content of the Monach Formation appears to be minimal, on a regional basis, and the formation's principal economic significance is as a marker bed in drilling and geological mapping.

The thickness of the Monach Formation at Rocky Creek is approximately 50 metres (Bowler, 1981); a similar thickness appears plausible for the Dillon area. The basal contact of the Monach Formation with the underlying Beattie Peaks Formation is gradational at local scale, and likely to be interfingering on a regional scale (Stott, 1998).

Beattie Peaks Formation (map-unit 1b)

The Beattie Peaks Formation comprises sandstone, siltstone and shale, locally accompanied by minor ironstone and coal, originating as a regionally-extensive shallow-marine to deep-marine turbidite system (Stott, 1998). Chowdry (1980) recognised the existence of thin coals and one thick coal (up to 2.5 metres) within the Beattie Peaks Formation at Rocky Creek, but these coals have not yet been traced into the Dillon area, where the formation remains unexplored.

The thickness of the Beattie Peaks Formation at Rocky Creek is approximately 300 metres, comprised mainly of sandstone, siltstone and shale, with minor ironstone and coal. A similar thickness of strata is inferred to be present within the Dillon property. The basal contact of the Beattie Peaks Formation upon the underlying Monteith Formation is abrupt (Hughes, 1964), and possibly interfingering on a regional scale.

Monteith Formation (map-unit 1a)

The Monteith Formation forms the basal unit of the Minnes Group (Stott, 1968) and as such it also formerly constituted the basal formation within Hughes' (1964) Beaudette Group. As with the other formations the Monteith Formation remains unexplored at Dillon Mine. Within the Rocky Creek coal property, however, Chowdry (1980) recognised interbedded sandstone, shale and conglomerate, with lesser amounts of quartzite and occasional thin coals.

The thickness of the Monteith Formation at Rocky Creek was estimated to be very approximately 600 metres (Chowdry, *ibid.*); a similar thickness appears reasonable for Dillon.

5 Reclamation

Since the submission of the preceding report on the Dillon Lease (CAR-957, by Cathyl-Huhn and others, 2014), no additional disturbant exploration work has been done, and no reclamation work has been specifically devoted to exploration-induced disturbances.

Diamond-drill cores from the two year-2013 geotechnical boreholes (BR 13-01C and BR 13-02C) are stored on-site within a shed, to protect them from the weather.

6 Statement of costs

No new disturbant exploratory work has been conducted within the Dillon Lease since the end of year-2013 (up to which date CAR-957 provided a tabulation of exploratory work).

However, during the latter part of year-2014, and the first half of January 2015, non-disturbant work was done concerning the Dillon Lease: to wit, the construction of a geological deposit model for the Brule Mine area, and the determination of coal reserves (as presented in **Appendices A** and **B** of the present report).

Staff involved in this work included:

- Francis Eshun, P.Geo. -- Mine geologist at Brule Mine
- Laura Avery, B.Sc. -- Technical services coordinator at Brule Mine
- Blake Snodsmith -- Senior geologist at Walter Energy, Alabama

No detailed costing is available for this work, which was undertaken by Walter Energy employees based in British Columbia and Alabama. An overall work effort of 100 person-days at $500/day is here assumed to have been required, based on the senior author's appreciation of the extent and complexity of work involved. 95 person-days are assumed to have been devoted to this work in year-2014, and 15 person-days in year-2015, resulting in estimated overall year-2014 cost of $47,500 and overall year-2015 cost of $2,500.

The Dillon Lease is assumed by the senior author to have required half the working time, despite its having markedly more than half the area of the overall project. This division is founded upon the apparent increase of geological complexity of the adjoining portion of the Brule Lease, as compared with the Brule Mine area within the Dillon Lease. Apportioned costs are therefore assumed to be:

- Year-2014: $23,750 within Dillon Lease
- Year-2015: $1,250 within Dillon Lease

A further $5,000 (ten person-days at $500/day) is assumed to have been devoted on the senior author's part, to preparation of the present report, including collation of geological and geophysical records, a preliminary survey of thrust-faulted boreholes, and the subsurface mapping of additional marker beds as had been recommended by Eshun, Avery and Snodsmith (2015) in their coal-reserve modelling report.

Total 2014-2015 assessable expenditure on the Dillon Lease is therefore estimated to be $30,000 (Canadian funds), as broken out below in **Table 6-1**.

Table 6-1: Cost breakdown by activity

Item	Cost of work	Percentage attributable to Dillon Lease
Personnel (year-2014)	$47,500	50%, thus $23,750 in Tenure 412964
Personnel (year-2015)	$2,500	50%, thus $1,250 in Tenure 412964
Consultants	nil	nil
Food/accommodation	nil	nil
Mobe/demob within BC	nil	nil
Aircraft support	nil	nil
Vehicle rentals	nil	nil
Equipment/supplies	nil	nil
Instrument rentals	nil	nil
Laboratory analysis	nil	nil
Contract jobs -- unit costs	nil	nil
Report preparation (2015)	$5,000	100%, thus $5,000 in Tenure 412964
TOTALS:	$55,000	$30,000 of which $23,750 in year-2014 and $6,250 in year-2015

Note: in this table, the cost of the geological modelling and coal-reserve reporting is allocated as 'personnel', as distinct from the 'report preparation' attribution of the present coal-assessment report.

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8 Conclusions

The Dillon Lease contains coal-measures of latest Jurassic to Early Cretaceous age, within the Minnes, Bullhead and Fort St. John groups of sedimentary rocks. These rocks are deformed by numerous northeast-verging, imbricate thrust faults and associated tight concentric folds, consistent with the overall thin-skinned structural style of the Rocky Mountain Foothills of northeastern British Columbia.

Historic (pre-2001) exploration work at Dillon was done by Teck Corporation, as reported in Coal Assessment Reports Nos. 486, 487, 488, 489 and 490. Considerable current exploratory work has subsequently been done from year-2001 onward to year-2013, by Walter Energy, Walter Canadian Coal Partnership, associated firms, and preceding firms. This work has previously been reported in Coal Assessment Report No. 957, submitted in September of 2014.

The current (year-2014 and year-2015) work within the Dillon Lease comprises a geological-modelling exercise and the calculation of coal resources and coal reserves (derived by Francis Eshun P.Geo. from the geological model, guided by the findings of a January 2015 model-validation report here-presented as **Appendix A** and **Appendix B**), together with the compilation of the current report, incorporating the generation of level-of-assurance polygons for the three major coal zones within the property, and a preliminary survey of the extent of thrust-faulting as interpreted from downhole geophysical logs of existing exploratory boreholes.

[redacted]

[redacted]

Rounded to the nearest whole dollar, the current work at Dillon is estimated to have cost $30,000 (in Canadian funds).

This work has met its immediate objectives of providing a better understanding of the property’s structural and stratigraphic geology, and of its coal-resource base and coal reserves.

The Dillon property merits further work.

9 Statements of qualifications

I, Michael Tuters B.A.Sc. EIT, do hereby certify that:

a) I am currently employed on a full-time basis by Walter Canadian Coal Partnership, a subsidiary of Walter Energy, in their Northeast British Columbia office in Tumbler Ridge, British Columbia.

b) This certificate applies to the current report, titled *Coal Assessment Report for the Dillon lease, British Columbia, Canada*, dated August 17, 2015

c) I am registered as an Engineer in Training with the Association of Professional Engineers and Geoscientists of British Columbia.

d) I received my Bachelor of Applied Science in mining engineering from Queens University in Kingston in 2010.

e) I have worked for Walter Energy since January 2012; my current title is Mine Engineer 1.

f) I am a contributing author of this report, titled *Coal Assessment Report for the Dillon lease, British Columbia, Canada*, dated August 17, 2015, concerning the Dillon coal property.

I, Matt Brown B.A.Sc. EIT, do hereby certify that:

a) I am currently employed on a full-time basis by Walter Canadian Coal Partnership, a subsidiary of Walter Energy, in their Northeast British Columbia office in Tumbler Ridge, British Columbia.

b) This certificate applies to the current report, titled *Coal Assessment Report for the Dillon lease, British Columbia, Canada*, dated August 17, 2015

c) I am registered as an Engineer in Training with the Association of Professional Engineers and Geoscientists of British Columbia.

d) I received my Bachelor of Applied Science in mining engineering from Queens University in Kingston in 2010.

e) I have worked for Walter Energy since May 2011; my current title is Mine Engineer 1.

f) I am a contributing author of this report, titled *Coal Assessment Report for the Dillon lease, British Columbia, Canada*, dated August 17, 2015, concerning the Dillon coal property.

I, Francis Eshun, M.Sc. P.Geo, do hereby certify that:

a) I am currently employed on a full-time basis by Walter Energy Ltd. in their Northeast British Columbia office in Chetwynd, British Columbia.

b) This certificate applies to the current report, titled *Coal Assessment Report for the Dillon lease, British Columbia, Canada*, dated August 17, 2015

c) I am registered as a Professional Geoscientist with the Association of Professional Engineers and Geoscientists of British Columbia.

d) I received my Bachelor's degree in geological engineering from Kwame Nkrumah University of Science & Technology in Kumase, Ghana in 1998. I received my M.Sc. degree in civil and environmental engineering from North Carolina A&T State University in 2005.

e) I have worked for Walter Energy since September 2011; my current title is Pit Geologist.

f) I am a contributing author of this report, titled Coal Assessment Report for the Dillon lease, British Columbia, Canada, dated August 17, 2015, concerning the Dillon coal property.

I, C.G. Cathyl-Huhn P.Geo.(BC) Lic.Geol.(WA) RMSME, do hereby certify that:

a) I am currently employed on a full-time basis by Walter Canadian Coal Partnership, a subsidiary of Walter Energy Inc., in their Canadian head office in Tumbler Ridge, British Columbia.

b) This certificate applies to the current report, titled *Coal Assessment Report for the Dillon lease, British Columbia, Canada*, dated August 17, 2015.

c) I am a member (Professional Geoscientist, Licence No. 20550) of the Association of Professional Engineers and Geoscientists of British Columbia, licenced as a geologist (Licence No. 2089) in Washington State, a member (No.152081) of the Association for Iron & Steel Technology, and a founding Registered Member of the Society for Mining, Metallurgy and Exploration (SME, Member No. 518350). I have worked as a colliery geologist in four countries for over 37 years since my graduation from university.

d) I certify that by reason of my education, affiliation with professional associations, and past relevant work experience, having written numerous published and private geological reports and technical papers concerning coalfield geology, coal-mining geology and coal-resource estimation, that I am qualified as a Qualified Person as defined by Canadian *National Instrument 43-101* and a Competent Person as defined by the Australian *JORC Code*.

e) I have worked as senior colliery geologist for Walter Canadian Coal Partnership's Canadian operations since November of 2011.

f) My most recent visit to the Dillon coal property was in August of 2015.

g) I am principal author of this report, titled *Coal Assessment Report for the Dillon lease, British Columbia, Canada*, dated August 17, 2015, concerning the Dillon coal property.

h) I accept professional responsibility for this report.

i) As of the date of this report, I am not independent of Walter Canadian Coal Partnership and Walter Energy, pursuant to the tests in Section 1.4 of *National Instrument 43-101*, for the reason that I am a full-time employee of Walter Canadian Coal Partnership.

j) The effective date of this report is August 17, 2015.

"original signed and sealed by"
Dated this 17th day of August, 2015. C.G. Cathyl-Huhn P.Geo. Lic.Geol. RMSME

Appendix B:

Common cross section lines in both MineSight and Mincom from same plane

Francis Eshun P.Geo., Laura Avery, and Blake Snodsmith, January 14, 2015

[Following is a suite of cross-sections drawn by Walter Energy staff, originally presented as an appendix to the January 2015 technical memorandum which is here-presented as **Appendix A**, above. Locations of section lines are shown above in **Figure A-1**. Serial ('figure') numbers have been added to cross-section captions.]

Common cross section lines in both MineSight and Mincom from same plane (see drillhole map for location).

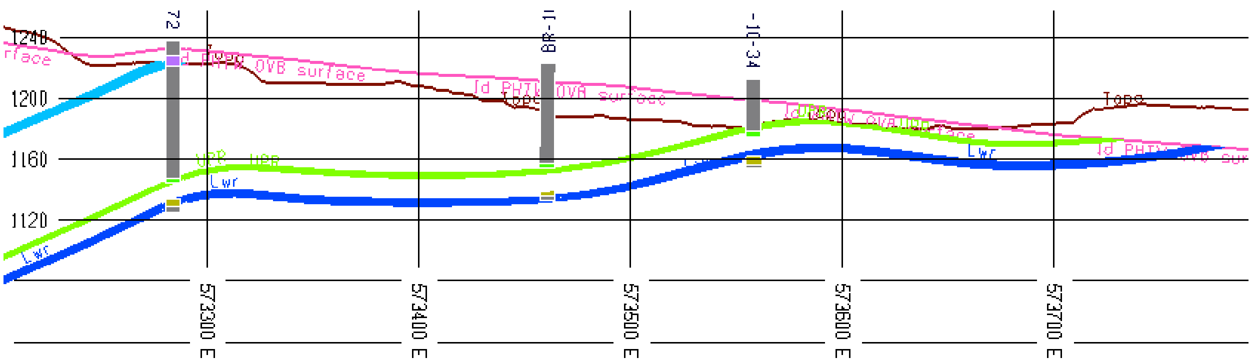


Figure B-1: MineSight: Section 32

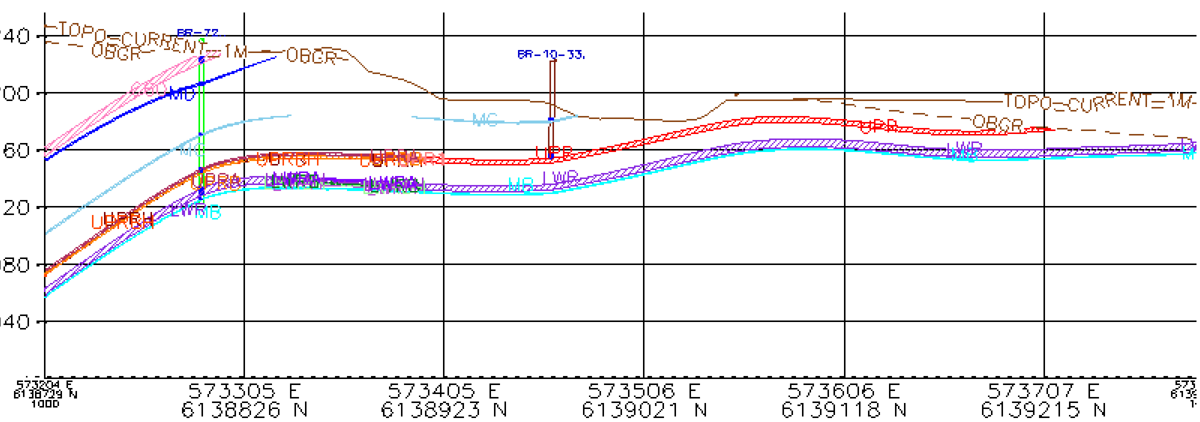


Figure B-2: Mincom: Section 32

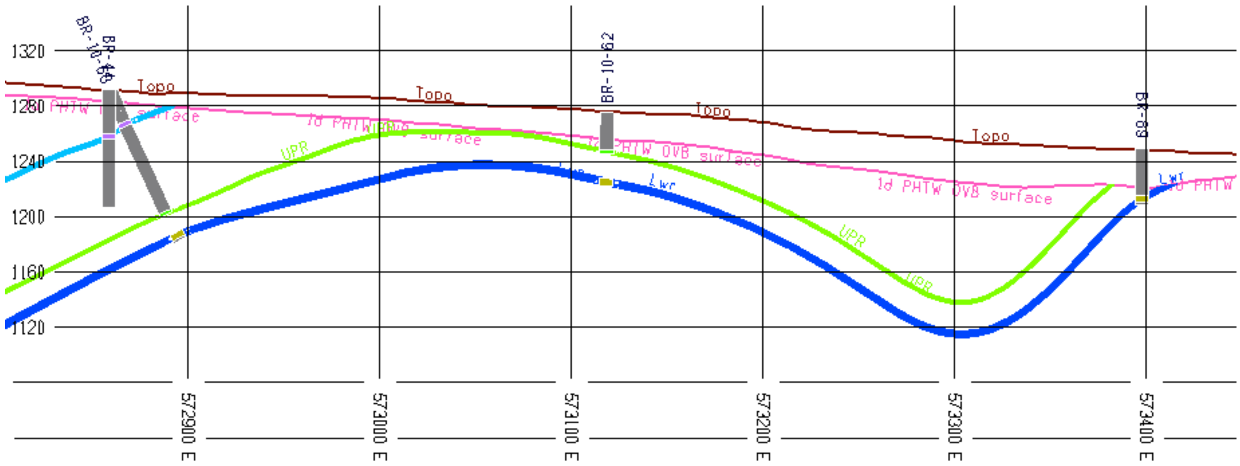


Figure B-3: MineSight: Section 44

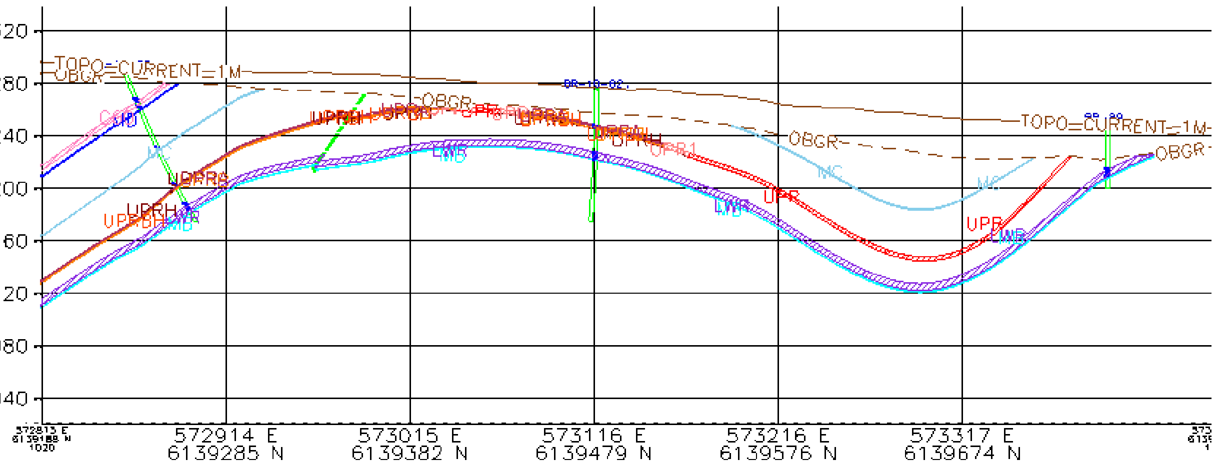


Figure B-4: Mincom: Section 44

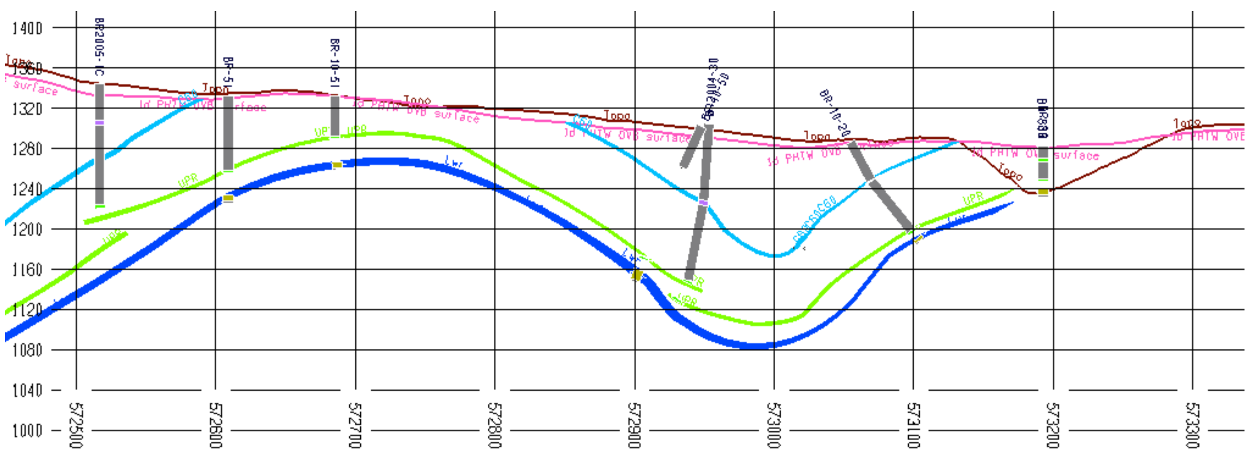


Figure B-5: MineSight: Section 53

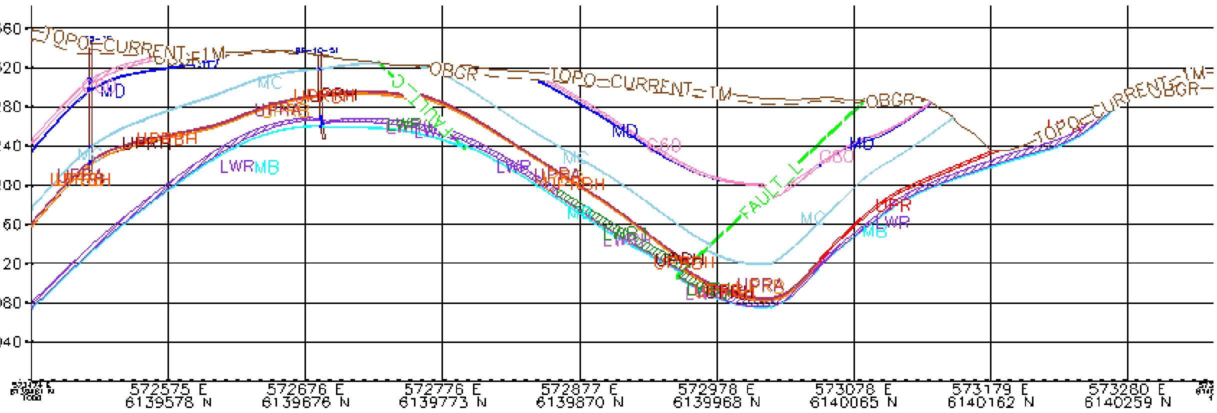


Figure B-6: Mincom: Section 53

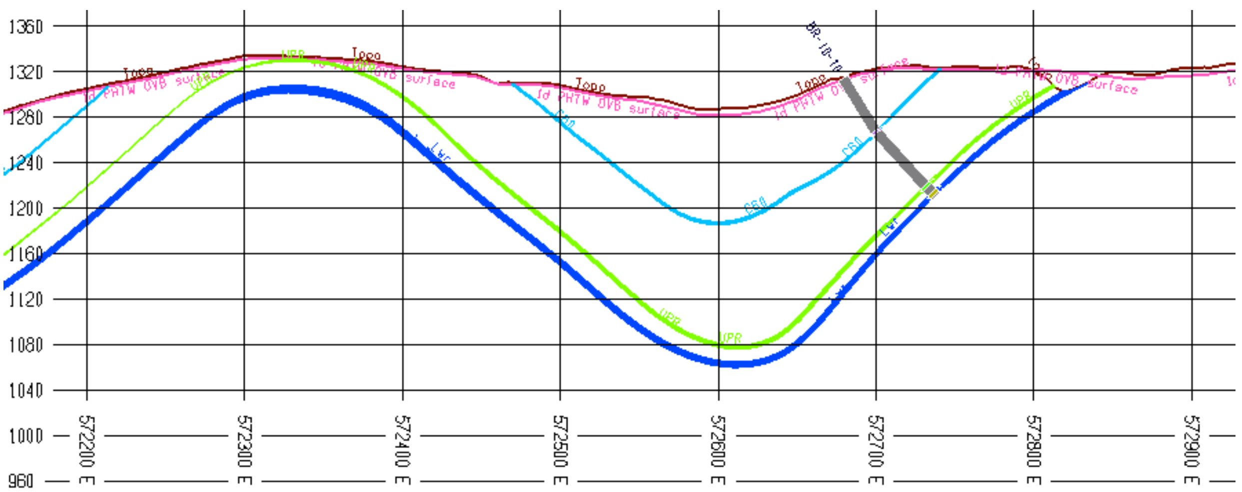


Figure B-7: MineSight: Section 63

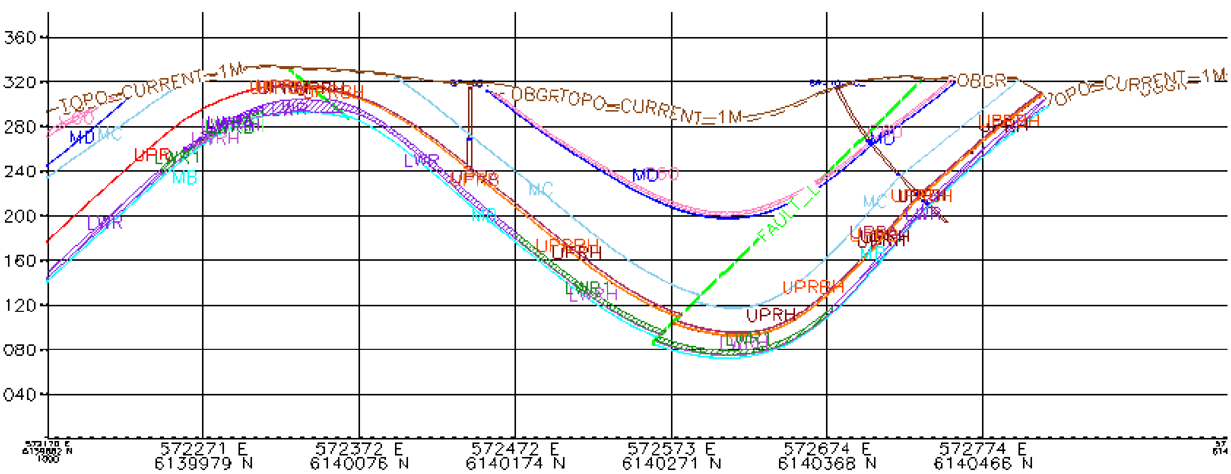


Figure B-8: Mincom: Section 63

Appendix C: Structural data survey

C.G. Cathyl-Huhn, P.Geo., August 16, 2015

Following review of the findings of the Brule 3D block model report (as presented in **Appendix A** and **Appendix B**, above), a survey of downhole geophysical data was undertaken, covering the south-central portion of the Dillon Lease, and (at a lower level of intensity), the adjoining portion of the Brule Lease. A non-random sampling of borehole geophysical logs were examined, concentrating mainly on deeper boreholes of more recent (year-2009 and later) vintage, situated in areas where the bedrock geological compilation map (**Map 2-3** of this report) indicated the presence of a through-going thrust-fault. Gamma-density logs were used wherever available, as they are more readily interpreted for the presence and depositional structure of coal beds; where need be, gamma-neutron logs were used to elucidate the possible presence of thrust-faults within non-carbonaceous strata. Four types of information were sought:

- Presence of thrust faults within coal beds or demonstrably repeating coal beds
- Presence of thrust-faults within non-carbonaceous strata (a more challenging exercise)
- Possible existence of panels of overturned strata, or of recumbent folds (not found)
- Presence of minor marker beds (in this study, Markers G, F, E, D, C, B, and A)

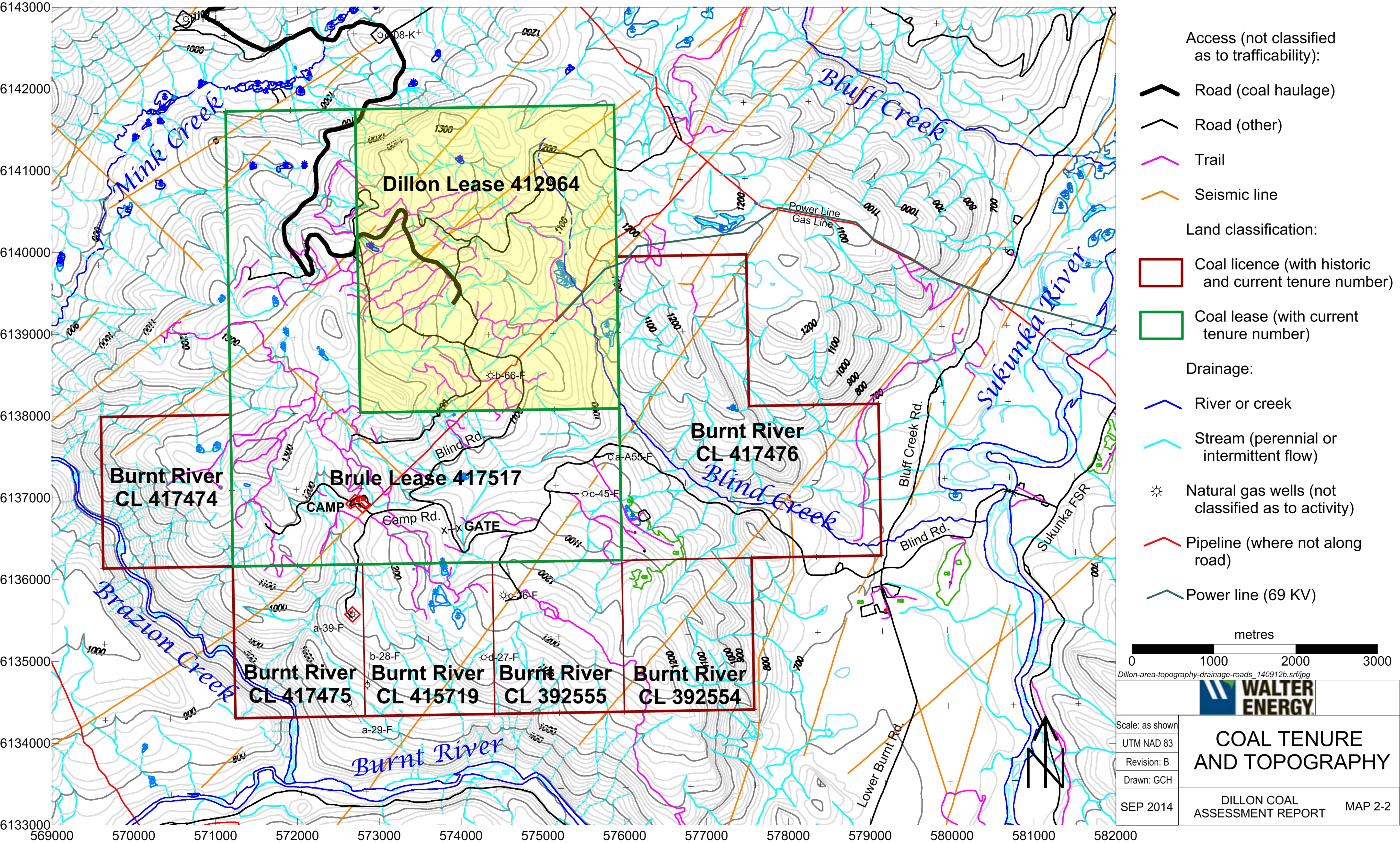
Markers G and F had not been previously studied within the Dillon Lease, nor adjoining areas within the Brule Lease. Markers M and AA had been reported in previous stratigraphic studies, but were not here examined owing to limited time. As well, a series of thin coals and carbonaceous beds are known to occur between Markers D and C, but these known or potential marker beds were not studied during the present exercise.

Table C-1, presented in hard-copy as a pair of broadsheets (sized to be printed at ANSI D size in landscape format), and given in digital form as a single data-table in XLS (BIFF-97) format, sets forth the results of this study.

- Numerous boreholes, as listed within the table, encountered one or more thrust-faults.
- However, many boreholes appear to be unfaulted.
- The coverage of boreholes is not complete, owing to the aforementioned time constraints, but most of the recent-vintage boreholes adjacent to mapped traces of major thrust-faults have been examined, and are here-reported.
- All depths in **Table C-1** are given in metres, derived from geophysical-log depths except in those rare cases where only core logs are available for examination.

Confidence in the mappability of the marker beds is high, on account of their characteristic geophysical-log responses. Although the marker beds seldom consist of coals which are thick enough and clean enough to be considered mineable in their own right, their subsurface mapping does afford the means to trace thrust-faults through sections of the coal-measures which otherwise lack distinctive geophysical indicators of thrust-faulted or drag-folded strata.

The as-yet-unexamined series of thin coals between Marker C and Marker D may be particularly useful in elucidating the trajectories of faults which transgress the less well-known strata between the roof of the Upper Seam and the floor of Seam C60.

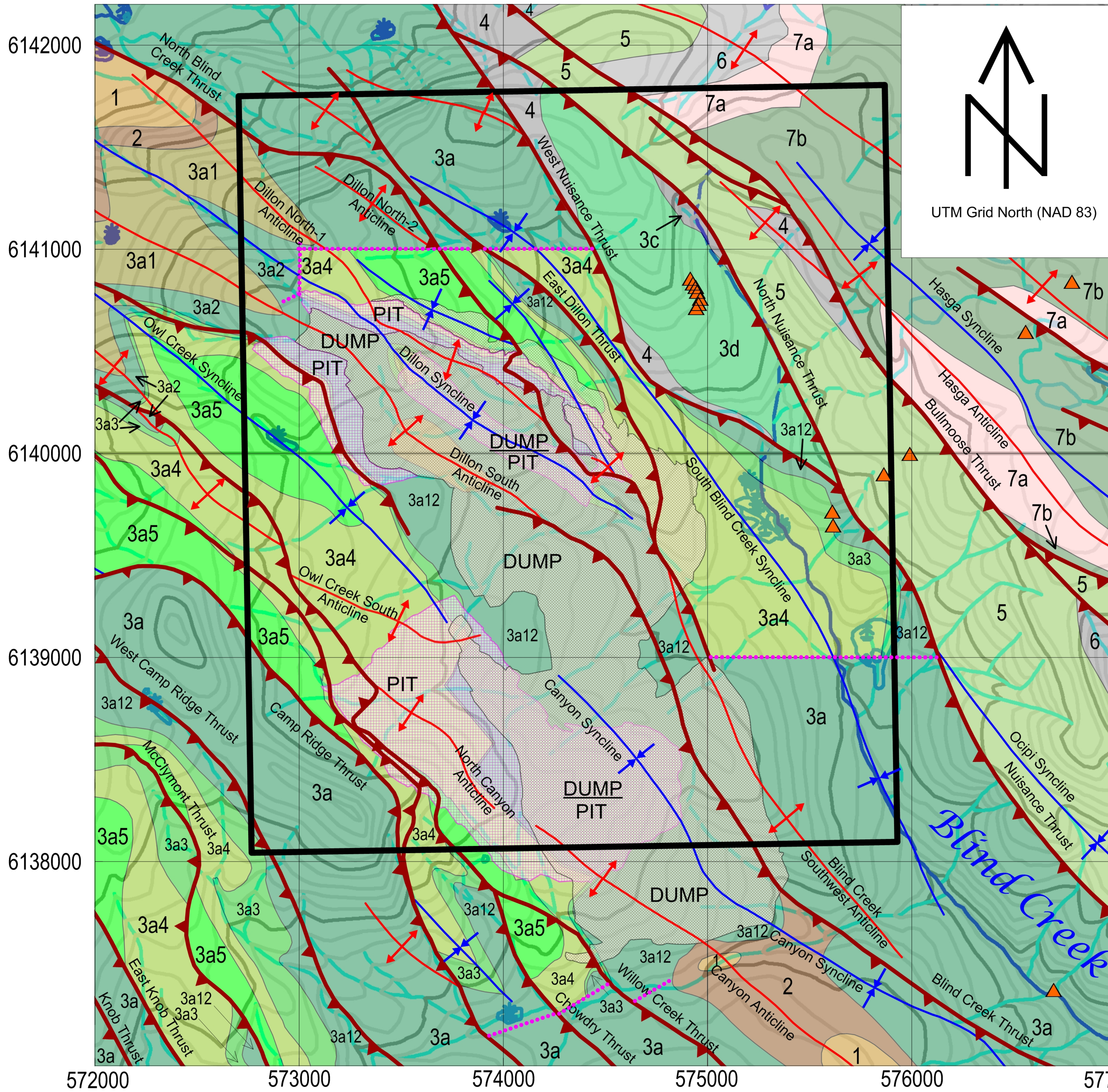


Dillon Lease 412964
Brule Lease 417517
Burnt River CL 417474
Burnt River CL 417476
Burnt River CL 417475
Burnt River CL 415719
Burnt River CL 392555
Burnt River CL 392554
Mink Creek
Bluff Creek
Blind Creek
Sukunka River
Brazion Creek
Burnt River
CAMP
Camp Rd.
GATE
Blind Rd.
Bluff Creek Rd.
Sukunka FSR
Lower Burnt Rd.
Power Line
Gas Line
Access (not classified as to trafficability):
Road (coal haulage)
Road (other)
Trail
Seismic line
Land classification:
Coal licence (with historic and current tenure number)
Coal lease (with current tenure number)
Drainage:
River or creek
Stream (perennial or intermittent flow)
Natural gas wells (not classified as to activity)
Pipeline (where not along road)
Power line (69 KV)
metres
0 1000 2000 3000
Dillon-area-topography-drainage-roads_140912b.srf/jpg
WALTER ENERGY
Scale: as shown
UTM NAD 83
Revision: B
Drawn: GCH
COAL TENURE AND TOPOGRAPHY
SEP 2014
DILLON COAL ASSESSMENT REPORT
MAP 2-2

UTM NAD83

DILLON LEASE

NTS 93 P/05
CANADA



map scale in metres

0 500 1000 1500 2000

STRUCTURE AND MAPPING

Anticline

Syncline

Strike-slip or tear fault

Thrust fault -- barbs on overthrust plate

Limit of detailed stratigraphic mapping

Outline of Walter's coal licences and leases

Coal outcrop (as reported by McClymont, 1981)

Author: C.G. Cathyl-Huhn P.Geo. Lic.Geol. RMSME Date: 2014 Sept.13
Grid system: UTM NAD83 Zone 10N in metres 100 km grid square: ES
Scale: as shown on bar-scale Topography: TRIM-derived rasters
Sources: compiled from work by P.B. Jones (Triad Oil, 1960), B.McClymont (Teck Corporation, 1979, 1981), J.Hughes (Gulf Canada, 1980), and D.J.Hunter and J.M.Cunningham (BCGSB, 1991) and A.Legun (BCGCB, 2003)

STRATIGRAPHY

FORT ST JOHN GROUP (Albian)

- 7 — Boulder Creek Formation -- sandstone, shale, conglomerate and coal
- 7b — Walton Creek Member -- siltstone, sandstone, conglomerate and coal
- 7a — Cadotte Member -- conglomerate and sandstone
- 6 — Hulcross Formation -- marine shale and siltstone, minor bentonite; basal grit
- 5 — Gates Formation -- sandstone, shale, conglomerate; minor coal
- 4 — Moosebar Formation -- marine siltstone and shale; bentonite; basal pebbly glauconitic sandstone (not Bluesky Member)

BULLHEAD GROUP (Barremian to Aptian)

- 3 — Gething Formation -- siltstone, sandstone and conglomerate; minor bentonite and coal
- 3d — Chamberlain Member -- sandstone and siltstone; minor coal
- 3c — Bullmoose Member -- marine shale and siltstone; minor sandstone and bentonite
- 3b — Bluesky Member -- pebbly glauconitic sandstone (not mapped separately at this scale)
- 3a — Gaylard Member -- siltstone, sandstone and coal; lenses of conglomerate and pebbly sandstone; minor bentonite
- 3a5 — Division 5 -- sandstone and siltstone; minor coal
- 3a4 — Division 4 -- siltstone and sandstone; coal
- 3a3 — Division 3 -- siltstone and shale; coal
- 3a12 [3a2 — Division 2 -- siltstone and sandstone; minor conglomerate and coal; 3a1 — Division 1 -- sandstone, conglomerate and siltstone; minor coal]
- 2 — Cadomin Formation -- cliff-forming conglomerate and sandstone; minor siltstone and coal

MINNES GROUP (Tithonian to Valanginian)

- 1 — Bickford, Monach, Beattie Peaks and Monteith Formations -- sandstone, siltstone, shale, conglomerate, quartzite, ironstone and coal (not mapped separately at this scale)

WALTER ENERGY

REV	DATE	DESCRIPTION
K	Sep.13/14	Structural geology

Drawn by: GCH	GEOLOGY OF DILLON COAL LEASE 412964
Scale: as shown	
Dwg. No.: Dillon-lease-geology-140913ki.srf/jpg	
SEP 2014	DILLON COAL ASSESSMENT REPORT — MAP 2-3