Valley Ridge Country Estates

Phase 3

Area Structure Plan

Prepared For

Richard and Kathleen Koentges
in
Potions of the NW and NE 31 7 3 W5

August 20, 2006

Prepared by: Brown Okamura & Associates Ltd. and Golden Municipal Planning

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1.0 Background

1.1 Introduction

It is the practice of the Council of the Municipality of the Crowsnest Pass (CNP) to have an area structure plan prepared and to accompany an application for the re-designation of properties to grouped country residential use. This Plan supports the Valley Ridge Country Estates Phase 3 development and facilitates the development of the remainder of the lands owned by Dick Koentges. The Valley Ridge Country Estates Phase 3 Area Structure Plan (ASP) is located in parts of the North ½ of Sec. 31 Twp. 7 Rge. 3 W5M in the Municipality of the Crowsnest Pass (CNP). The ASP outlines a residential subdivision complementing Mr. Koentges's 1998 and 1999 approvals for grouped residential use located to the north and east of the subject lands and the results of the development will be similar in nature.

Council's approval of an area structure and a re-designation bylaw are the first steps in the construction of this residential parcel and add to the existing neighborhood in this portion of the municipality.

1.2 The Site

This area structure plan concerns lands in the Municipality of the Crowsnest Pass and contains 64.20 ha of land. Map 1 indicates the location of the ASP in the CNP. A title for the property in Appendix 1 describes the land as:

First
Meridian 5 Range 3 Township 7
North West Quarter Section 31
Containing 64.7 ha more or less
Excepting thereout:

Plan	9813686	1.056 ha

Second
Meridian 5 Range 3 Township 7
Section 31
Legal Subdivision 15 in the North East Quarter
Containing 16.21 ha (40 Acres) more or less
Excepting thereout:

Area 'A'	9011565	1.12 ha
Road	9813686	1.13 ha
Plan	0010584	1.68 ha

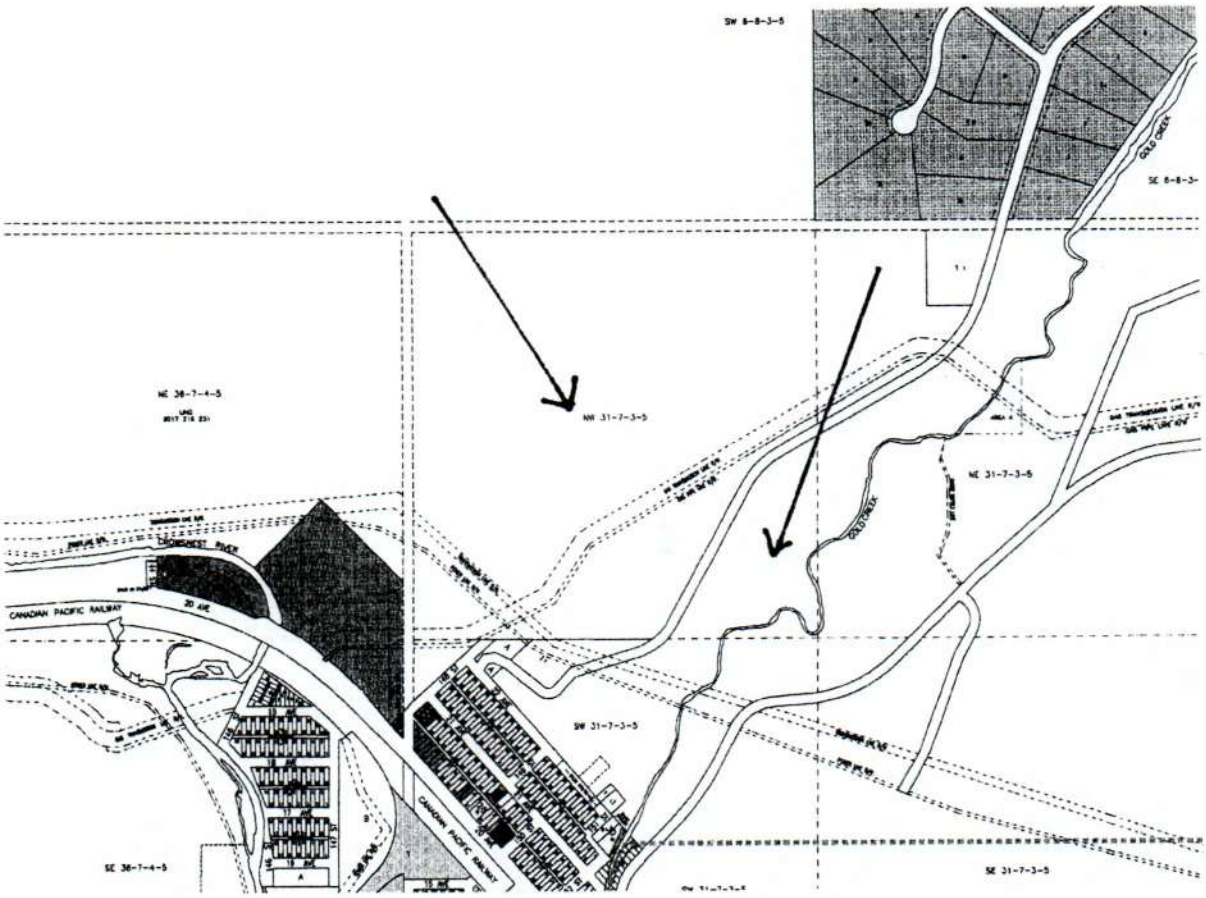
The property is made up of table land generally north of Frank and below the easterly face of Goat Mountain. Access to the site is provided by a well developed municipal roadway which comes from Frank and serves development further north.

1.3 Municipal Bylaws

Two main municipal planning bylaws apply to the land and this proposal and outline the municipal guidelines for subdivision and development in the Crowsnest Pass. Firstly the Land Use Bylaw # 632-2004 (LUB) currently designates the land as Non Urban, also shown in Map 1, which in general provides only for agricultural uses. In order to implement this ASP the land use designation in the Land Use Bylaw would have to be changed to the Grouped Country Residential District which allows for subdivision into smaller residential lots. Standards of development are provided in the Land Use Bylaw and are used as the framework of this plan.

A special schedule of the Land Use Bylaw is Schedule 14 Fire Smart Regulations intended to take pre-emptive measures to prevent damage from wild fire.

A second bylaw with an affect on this ASP is the Municipal Development Plan which is also a statutory plan and provides standards for country residential use particularly in part 8 of the (MDP). These standards are also used to prepare this ASP.



Map 1 - Location (north of Frank)

1.4 Existing Land Use

Currently this land is part of an agricultural operation and is largely grazed by cattle. Some portions are very steep and remain in a natural state. No structures exist on the site aside from some works associated with the pipeline that traverses the site and is protected by several easements.

Land uses in the immediate area include:

- vacant and un-developable lands to the west and east
- country residential uses on parcels similar to those being proposed to the north
- urban uses below the bench to the south in Frank

Further country residential uses proposed in this ASP would be compatible with existing uses in the surrounding area.

1.5 Site Opportunities

One is immediately struck by the beauty of the site with the varied topography vegetation and views. Vistas of the CNP are available from most points and will provide residents with superior look outs. The site is well drained, stable serviceable and easily accessed with no investment required from the Municipality. Lots created on this site will be highly desirable and saleable. A high quality residential development can occur on this site

1.6 Site Constraints

Although the site provides excellent building sites not all of the land can be constructed on as existing constraints include:

- Major gas pipeline traversing the property.
- Extreme slopes in the east, south and west portions of the land.
- An area of wet land and drainage course.

These constraints are accommodated in the design provided but impact on the total amount of lots that can be created.

2.0 Development Plan

2.1 Objectives of Plan

This development is providing rural country living in high quality housing located within the CNP a full service, stable and desirable urban municipality. Valley Ridge Country Estates Phase 3 will give an option of residential living that is largely unavailable in southern Alberta. Opportunities and constraints of the site, as well as the standards of the municipality have been used to develop a plan for the Koentges lands. This concept is intended to provide future residents a high quality living environment making use of the natural beauty of the site and the panoramic view of the Municipality.

Future land owners and rate payers will live in a residential community that:

- Takes advantage of the natural attributes of the site
- Is complementary to adjacent residential areas
- Contains efficient roadways, services and access to the greater community and
- Has a low impact on sensitive areas of the property.

The terrain allows for a choice of lots that display different characteristics of size topography and natural vegetation. In the long term this subdivision will add to the overall residential quality and financial stability of the municipality. Initially there is no cost to the municipality and the development agreement ensures a quality of infrastructure that will not burden the municipality in the future.

2.2 Land Use and Population

All lots will be country residential properties with the exception of the roadways and any public utility lots needed by utility providers. Parcels are of various sizes but all will accommodate single family dwellings. There is proposed to be 30 lots in Phase 3.

Assuming the dwellings are occupied by families that meet the CNP average household size, the development should hold a total of approximately 96 to 102 persons.

2.3 Phasing

Development of this property will be in one phase which will include all the land in the ASP. The development will consist of 30 lots of 3.2 to 12 acres in size as will be discussed further.

Infrastructure construction land sales and housing construction are proposed to commence immediately after receiving the appropriate approvals.

2.4 Municipal and School Reserve

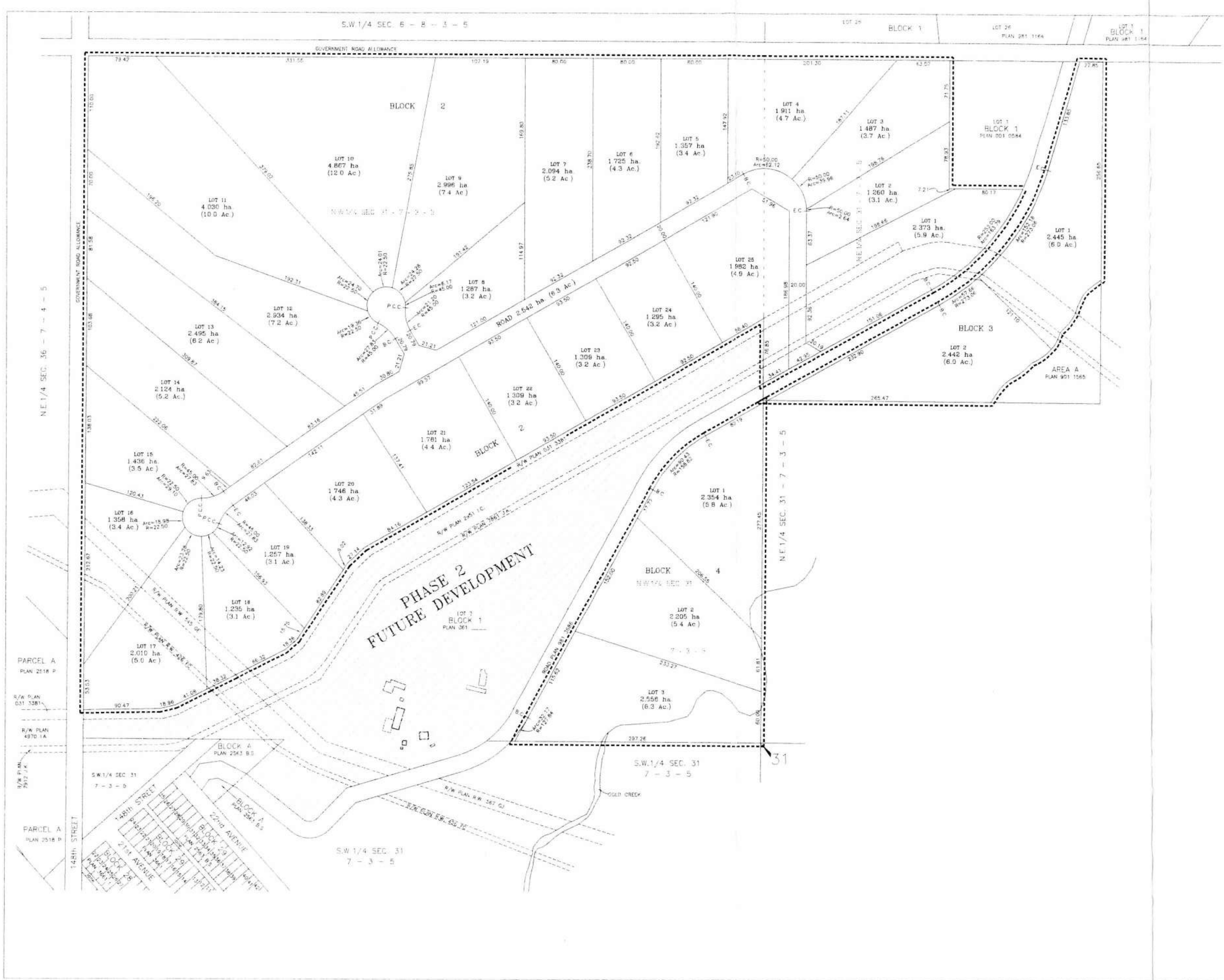
Municipal and school reserve will be provided as a payment to the municipalities municipal reserve fund in lieu of the provision of land. This will assist the CNP in providing recreational facilities to the public in general.

2.5 The Conceptual Plan

Subject to minor amendments after a final survey map 2 is the conceptual plan for this area structure plan. It includes:

- All lots in excess of the required 3 acres.
- A variety of lot sizes and advantages.
- A minimum amount of roadway to provide access to the various sights.
- No development on unsuitable portions of the land.

MAP 2
CONCEPTUAL PLAN



NOTES:
Portion to be approved is outlined thus
and contains approximately 64.204 ha.
Distances are in metres and decimal parts thereof.

Distances and areas are approximate and are subject to change upon final survey.

NO	REVISION	DATE	BY
2	Revised Lots	Aug.23/06	cjb
1	Revised Lots	Jun.28/06	cjb

brown okamura & associates ltd.
Professional Surveyors
314 Stafford Drive, Lethbridge, Alberta

DICK KOENTGES

TENTATIVE PLAN SHOWING SUBDIVISION
of all of
N.W.1/4 SEC. 31 & PART OF N.E.1/4 SEC. 31
all within
TWP. 7, RGE. 3, W.5 M.
MUNICIPALITY OF CROWSNEST PASS

APPROVED		
	DRAWN CJB	DATE JUNE 8/06
	CHECKED RFB	JOB 06-8532
	DESIGN	SHEET
	TRACED	DRAWING 06-853219
	SCALE 1:2000	ISSUE
R. F. Bower, A.L.S.		

3 Municipal Services

3.1 Water Supply

The water system for the subdivision will be individual wells licensed by each owner although at this time a communal system based on wells is being investigated. A hydrology study is required on the project by the Water Act and copied in Appendix 2. In part the study concluded:

"..EBA is of the opinion that there is adequate ground water supply to meet the needs of existing development and the domestic requirements of the proposed 35 lot residential development:"

It should be noted that the study was based on the initial estimate of 35 lots when on more detail review the lot yield will be 30.

In the case of a communal water system it is proposed that the lot containing the wells and associate equipment will be a public utility lot and that under an agreement the users of the system will be responsible for the systems operation and maintenance. Potable water would then be piped directly to each dwelling.

Additional approvals will be required at the provincial level and these processes are being reviewed at this time.

3.2 Waste Water System

Each lot will be responsible for the disposal of waste water on the site. Individual septic tanks will be installed be certified contractors in accordance with Alberta Environment standards. The soils analysis conducted by EBA Engineering is contained in Appendix 3. The study in part concludes:

"*The results of percolation testing indicate that although borderline , in most areas of the property appear to be suitable for septic disposal fields ...*"

A number of follow up recommendations are made two ensure proper waste water treatment occurs. It appears that this site has soil conditions acceptable to this form of waste water treatment but each site will be tested to finalize the location of each septic tank installation.

3.3 Storm Water Control

Roadways are the main conveyance that directs water into the natural drain on the land. Water proceeds to Gold Creek which will be subject to Provincial approvals. Run off standards are provided by the province and the construction will comply with the requirements. Engineering firms will be engaged to design the required systems.

3.4 Roadways

In the development agreement to be signed with the municipality, usually as a result of a subdivision approval condition, the developer agrees to construct to the CNP standards the:

- Internal roadways,
- approaches from the internal roads and
- approach to the existing CNP road

3.5 Shallow Utilities

- Fortis Alberta provides power in the CNP and the developers engineering staff is in contact with the service provider to address their requirements in delivering electricity. Lines are proposed to be underground and any easements that may be needed by Fortis will be provided.
- Atco provides natural gas in the CNP and the developers engineering staff is in contact with the service provider to address their requirements in delivering gas. Pipelines are proposed to be located in easements that may be needed by Atco.
- Telus provides communication services in the CNP and the developers engineering staff is in contact with the service provider to address their requirements in delivering phone and other services. Lines are proposed to be underground and any easements that may be needed by Telus will be provided.

3.6 Policing

The RCMP is responsible for police protection service and it is expected that the area will be patrolled within the schedule established for the Municipality.

3.7 Fire Protection and Fire-Smart

Fire protection is largely provided by the Municipality and at times with the assistance of Alberta Sustainable Recourses in the case of forest fire. To reduce the risk of wildfire danger it is important to implement the policies of schedule 14 of the Land use Bylaw 632-2004 Fire-Smart Regulations. In part it is important for our future residents and the developer to:

- Choose suitable building material
- Control fuel load on the individual sites
- Control fire sources such as fire and barbeque pits
- Provide a water source for fire protection

Wildfire protection will be an ongoing discussion among the residents of this subdivision and the residents of the greater CNP.

4) Implementation / Conclusion

4.1 Area Structure Plan and Re-designation

This area structure plan is submitted to council at the same time as the application for land use bylaw re-designation. It acts as a support document indicating the developer's full plan for the lands under his ownership. Note the parcel where the applicant resides is omitted from the re-designation process as the plan is that this site will remain as a small scale agricultural use for sometime.

This first approval is an agreement between the developer and the CNP about the general nature of the future development. Subsequent approvals and more detail analysis will require development of further detailed agreements as part of conditions on approvals.

4.2 Subdivision Process

The next step in municipal approvals is the subdivision application which begins with a tentative survey plan of the conceptual plan adopted in the ASP. As part of the approval many conditions will firm the details of the subdivision for example a development agreement will ensure the developers responsibility in providing infrastructure and costs. Other conditions will deal with other issues identified in the circulation of the application to various stakeholder groups.

4.3 Development Approval

The last major step in the process is the approval of the individual dwelling units again giving the opportunity for implementation of conditions.

4.4 Project timing

It is the developer's intent to proceed with the approval process and have lots for sale as soon as the process allows. Potentially the lots could be ready for sale early 2007 as infrastructure development is completed.

4.5 Conclusion

Mr. Koentges has with this Area Structure Plan proposed a quality development that will reflect well on the Municipality of the Crowsnest Pass. Agreements will ensure the Municipality achieves the quality without the costs. We look forward to continued co operation with the municipality leading to the development of these lands.

Appendix 1
Land Title

ALBERTA REGISTRIES

LAND TITLE CERTIFICATE

S

LINC	SHORT LEGAL	TITLE NUMBER
0027 796 200	5;3;7;31;NW	001 071 034 +1
0028 334 811	5;3;7;31;NE	

LEGAL DESCRIPTION

FIRST

MERIDIAN 5 RANGE 3 TOWNSHIP 7
SECTION 31
QUARTER NORTH WEST
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES	(ACRES)	MORE OR LESS
ROAD	9813686	1.056	2.61	

EXCEPTING THEREOUT ALL MINES AND MINERALS
AND THE RIGHT TO WORK THE SAME

SECOND

MERIDIAN 5 RANGE 3 TOWNSHIP 7
SECTION 31
LEGAL SUBDIVISION 15 IN THE NORTH EAST QUARTER
CONTAINING 16.2 HECTARES (40 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES	(ACRES)	MORE OR LESS
AREA 'A'	9011565	1.12	2.77	
ROAD	9813686	1.131	2.79	
SUBDIVISION	0010584	1.68	4.15	

EXCEPTING THEREOUT ALL MINES AND MINERALS
AND THE RIGHT TO WORK THE SAME

ESTATE: FEE SIMPLE

MUNICIPALITY: MUNICIPALITY OF CROWSNEST PASS

REFERENCE NUMBER: 981 405 172

(CONTINUED)

REGISTERED OWNER(S)

REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
001 071 034	16/03/2000	SUBDIVISION PLAN		

OWNERS

RICHARD KOENTGES
OF MUNICIPALITY OF CROWSNEST PASS
ALBERTA T0K 0E0
AS TO AN UNDIVIDED 1/2 INTEREST

KATHLEEN A KOENTGES
OF MUNICIPALITY OF CROWSNEST PASS
ALBERTA T0K 0E0
AS TO AN UNDIVIDED 1/2 INTEREST

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
1964AC .	31/05/1910	INSTRUMENT CANADIAN AMERICAN COAL AND COKE CO. LTD. "LICENCE OF OCCUPATION (SEE INSTRUMENT)"
7378GE .	23/10/1950	CAVEAT CAVEATOR - ALTALINK MANAGEMENT LTD.. ATTN: TRANSMISSION LAND DEPT PO BOX 20, STATION M CALGARY ALBERTA T2P2G9 AFFECTED LAND: 5;3;7;31;NW AFFECTED PLAN: RW545 (DATA UPDATED BY: TRANSFER OF CAVEAT 021217706)
8252JL .	20/04/1966	PUBLIC UTILITIES BOARD ORDER IN FAVOUR OF - THE ALBERTA GAS TRUNK LINE CO LTD.

(CONTINUED)

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
		AFFECTED PLAN: 2951IC ORDER 27445
937JT .	20/12/1966	MORTGAGE OF UTILITY RIGHT OF WAY MORTGAGEE - MONTREAL TRUST COMPANY. AFFECTS INSTRUMENT: 8252JL .
1232JY .	23/05/1967	MORTGAGE OF UTILITY RIGHT OF WAY MORTGAGEE - THE ROYAL TRUST COMPANY. AFFECTS INSTRUMENT: 8252JL .
731 002 456	10/04/1973	SURFACE RIGHTS BOARD ORDER IN FAVOUR OF - THE ALBERTA GAS TRUNK LINE CO LTD. AS TO PORTION OR PLAN:7861JK
741 051 223	29/05/1974	MORTGAGE OF UTILITY RIGHT OF WAY MORTGAGEE - MONTREAL TRUST COMPANY. AFFECTS INSTRUMENT: 731002456
741 084 188	05/09/1974	MORTGAGE OF UTILITY RIGHT OF WAY MORTGAGEE - THE ROYAL TRUST COMPANY. AFFECTS INSTRUMENT: 731002456
771 003 253	11/01/1977	UTILITY RIGHT OF WAY GRANTEE - ALTALINK MANAGEMENT LTD.. ATTN: TRANSMISSION LAND DEPT PO BOX 20, STATION M CALGARY ALBERTA T2P2G9 "PORTION DESCRIBED" (DATA UPDATED BY: TRANSFER OF UTILITY RIGHT OF WAY 021177874)
841 120 078	13/07/1984	UTILITY RIGHT OF WAY GRANTEE - NOVA AN ALBERTA CORPORATION. AS TO PORTION OR PLAN:2951IC 7861JK
881 226 226	09/12/1988	CAVEAT RE : SALES AGREEMENT CAVEATOR - HER MAJESTY THE QUEEN IN RIGHT OF ALBERTA AS REPRESENTED BY MINISTER OF PUBLIC WORKS, SUPPLY AND SERVICES C/O GARRY R. SUMMERS DIRECTOR OF LAND ACQUISITION BRANCH 2 FLOOR, COLLEGE PLAZA

(CONTINUED)

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
		8215-112 ST EDMONTON ALBERTA T6G5A9 AGENT - GARRY R SUMMERS AFFECTED LAND: 5;3;7;31;NW 5;3;7;31;NE
901 298 144	04/12/1990	DISCHARGE OF CAVEAT 881226226 AFFECTED LAND: 5;3;7;31;NW
921 035 556	19/02/1992	CAVEAT RE : LEASE CAVEATOR - NOVA CORPORATION OF ALBERTA. 801 - 7TH AVENUE,S.W. CALGARY ALBERTA T2P3P7 AGENT - JOSEPHINE HOMULOS
931 032 446	11/02/1993	CAVEAT RE : AMENDING AGREEMENT CAVEATOR - NOVA CORPORATION OF ALBERTA. P.O. BOX 2535, STATION M 801-7 AVENUE, SW, CALGARY ALBERTA T2P2N6 AGENT - JOSEPHINE HOMULOS
931 044 275	01/03/1993	CAVEAT RE : RIGHT OF WAY AGREEMENT CAVEATOR - NOVA CORPORATION OF ALBERTA. 801-7 AVE SW P.O. BOX 2535, STN M CALGARY ALBERTA T2P2N6 AGENT - JOSEPHINE HOMULOS
931 044 529	01/03/1993	CAVEAT RE : AMENDING AGREEMENT CAVEATOR - NOVA CORPORATION OF ALBERTA. 801 - 7TH AVENUE,S.W. CALGARY ALBERTA T2P3P7 AGENT - JOSEPHINE HOMULOS AFFECTED LAND: 5;3;7;31;NE
931 052 209	09/03/1993	CAVEAT RE : RIGHT OF WAY AGREEMENT CAVEATOR - NOVA CORPORATION OF ALBERTA.

(CONTINUED)

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
		801 - 7TH AVENUE,S.W. CALGARY ALBERTA T2P3P7 AGENT - JOSEPHINE HOMULOS AFFECTED LAND: 5;3;7;31;NE
951 172 616	02/08/1995	CAVEAT RE : UTILITY RIGHT OF WAY CAVEATOR - FORTISALBERTA INC.. 320-17 AVE SW CALGARY ALBERTA T2S2V1 AFFECTED LAND: 5;3;7;31;NE (DATA UPDATED BY: TRANSFER OF CAVEAT 011167136) (DATA UPDATED BY: CHANGE OF NAME 041454555)
981 197 063	06/07/1998	UTILITY RIGHT OF WAY GRANTEE - CANADIAN WESTERN NATURAL GAS COMPANY LIMITED.
981 326 662	20/10/1998	UTILITY RIGHT OF WAY GRANTEE - CANADIAN WESTERN NATURAL GAS COMPANY LIMITED. AFFECTED LAND: 5;3;7;31;NE
001 071 035	16/03/2000	CAVEAT RE : DEFERRED RESERVE CAVEATOR - THE MUNICIPALITY OF CROWSNEST PASS. OLDMAN RIVER INTERMUNICIPAL SERVICE AGENCY #B1, 905-4 AVENUE SOUTH LETHBRIDGE ALBERTA T1J0P4 AGENT - TOM GOLDEN.
001 120 452	08/05/2000	MORTGAGE MORTGAGEE - ALBERTA TREASURY BRANCHES. BOX 671 BLAIMORE ALBERTA T0K0E0 ORIGINAL PRINCIPAL AMOUNT: $228,000
001 180 415	30/06/2000	AMENDING AGREEMENT AMOUNT: $303,000 AFFECTS INSTRUMENT: 001120452
031 286 142	25/08/2003	CAVEAT

(CONTINUED)

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
		RE : AMENDING AGREEMENT CAVEATOR - NOVA GAS TRANSMISSION LTD. 450-1 ST SW P O BOX 1000, STN. M CALGARY ALBERTA T2P4K5 AGENT - SHELLEY HENDERSON
031 286 143	25/08/2003	CAVEAT RE : AMENDING AGREEMENT CAVEATOR - NOVA GAS TRANSMISSION LTD. 450-1 ST SW P O BOX 1000, STN. M CALGARY ALBERTA T2P4K5 AGENT - SHELLEY HENDERSON

TOTAL INSTRUMENTS: 025

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 28 DAY OF AUGUST, 2006 AT 11:22 A.M.

ORDER NUMBER:6160738

CUSTOMER FILE NUMBER:

REGISTRAR OF LAND TITLES

END OF CERTIFICATE

Appendix 2
Groundwater Supply Feasibility Evaluation
(Hydrology)

Mr. Richard Koentges

PRELIMINARY GROUNDWATER SUPPLY FEASABILITY EVALUATION FOR PROPOSED 35 LOT COUNTRY RESIDENTIAL SUBDIVISION: VALLEY RIDGE COUNTRY ESTATES, PHASE 2 W½ 31-007-03 W5M IN THE MUNICIPAL DISTRICT OF CROWSNEST PASS

4401178

August 2006

EBA Engineering Consultants Ltd.
p. 403.329.9009 • f. 403.328.8817
442 - 10 Street N • Lethbridge, Alberta T1H 2C7 • CANADA

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FIGURES

APPENDICES

1.0 INTRODUCTION

This report summarizes the results of a Preliminary Groundwater Supply Feasibility Evaluation of the proposed 35 lot country residential subdivision in W ½ 31-007-03 W5M in the Municipal District (MD) of Crowsnest Pass (Figure 1). EBA Engineering Consultants Ltd. (EBA) was retained by Mr. Richard Koentges to conduct this investigation, and prepare this report. The report was required to assess whether an adequate groundwater supply was potentially available to meet the needs of existing groundwater users and the proposed development. Potential aquifer yield, aquifer continuity, and aquifer susceptibility to potential contamination at the proposed subdivision have been considered.

The evaluation was conducted in accordance with the "Environmental Guidelines for the Review of Subdivisions in Alberta, Chapter 2: Guidelines for the Evaluation of Groundwater Supply for Unserviced Residential Subdivisions" [Alberta Environment (AENV), 1998], the Water Act (AENV, 1996), and through consultation with AENV personnel.

The Groundwater Feasibility Assessment consisted of three tasks as follows:

- a review of available site documentation, including drillers reports, pumping and recovery test data, and hydrogeological reports;
- data analysis including: analysis of existing pumping test data, analysis of aquifer potential, and computation of theoretical impact on nearby wells; and
- preparation of a report summarizing the findings.

2.0 PROJECT SCOPE AND AREA

This groundwater feasibility assessment report is limited to the evaluation of potential water supply for the proposed development. The evaluation area includes the proposed development and a 1.6 km radius.

This report addresses an assessment of the feasibility of finding sufficient volumes of groundwater to sustain the proposed development. A groundwater feasibility assessment report, as outlined by AENV (1998) should evaluate the following criteria:

1. The potential of one or more aquifers to provide a sufficient supply of groundwater to meet the needs of existing users and the needs of the proposed development.
2. The extent to which each aquifer is continuous beneath the proposed development.
3. The potability of aquifer water and potential existing anthropogenic contamination.
4. The feasibility of treating groundwater, if required.
5. The susceptibility of each aquifer to potential contamination (e.g., septic tile fields).

It should be noted that Criteria 3 and Criteria 4 can be more adequately addressed once a well has been drilled and water samples have been analyzed.

To protect water resources, AENV has implemented policies that govern the assessment and use of both surface water and groundwater in the province. Country residential subdivisions are regulated by Section 21(2) and Section 23(3) of the Water Act (AENV, 1996), which came into force January 1, 1999, and stated as follows:

Water Act – Section 21(2)

Subject to Subsection (3) and Section 23 and any exemptions specified in the regulations, a person who owns or occupies land under which groundwater exists:

(a) has the right to commence and continue the diversion of the groundwater for household purposes; and

(b) may not obtain a licence for the diversion of the groundwater for household purposes.

Note: As defined in the Water Act, "household purposes" means the use of a maximum of 1,250 m^3 of water per year per household for the purposes of human consumption, sanitation, fire prevention and watering animals, gardens, lawns, and trees.

Water Act – Section 23(3)

If, after this Act comes into force, a subdivision of land of a type or class of subdivision specified in the regulations is approved under the Municipal Government Act, a person residing within the subdivision or a parcel of land that adjoins or is above a source of water described in Section 21 has the right to commence and continue the diversion of water under Section 21 only if;

(a) a report certified by a professional engineer, professional geologist or professional geophysicist, as defined in the Engineering, Geological and Geophysical Professions Act, was submitted to the subdivision authority as part of the application for the subdivision under the Municipal Government Act, and the report states that the diversion of 1,250 m^3 of water per year for household purpose under Section 21 for each of the households within the subdivision will not interfere with any household users, licenses or traditional agricultural users who exist when the subdivision is approved; and

(b) the diversion of water for each of the households within the subdivision under Section 21 is not inconsistent with an applicable approved water management plan.

The Water Ministerial Regulation (AR 205/98) (AENV, 1999) states:

9(1) Subject to subsection (2), a type of subdivision of land for the purposes of Section 23(3) of the Act is a subdivision that results in six or more parcels in a quarter section or in a river lot.

Based upon the foregoing, to have the statutory right to obtain groundwater from a private water well system, AENV requires that the groundwater potential be evaluated according to specific protocols when the number of unserviced residential parcels per quarter section, both existing and proposed, using the underlying groundwater resources is six or more. As required by the Water Act and a letter of clarification regarding Section 23 of the Water Act to the MD of Foothills No. 31 (AENV, April 27, 1999), a

person residing within the subdivision on a parcel of land has the right to divert groundwater only if a report certified by a professional engineer, geologist, or geophysicist was submitted to the subdivision authority (the MD) as part of the application for the subdivision under the Municipal Government Act and the report states that the diversion of 1,250 m^3/year of water per household, for each of the houses within the subdivision, will not cause a significant adverse effect on existing water users in the area. In addition, the report must quantify the effect that household rights within the newly created subdivision may have on existing water users in the area. These required assessments were implemented by AENV so that groundwater resources are not overexploited in our province and existing groundwater users will not go short.

Based upon the foregoing, Section 21(2) and Section 23(3) of the Water Act ask two basic questions:

1. Is there sufficient water to supply the maximum requirement of 1,250 m^3/year for existing plus proposed uses within a quarter section?
2. Will the allocated volume of water result in a significant adverse effect on neighbouring wells and licensed users existing at the time of subdivision application?

The residential water allocation requirements have been estimated based on the Water Act (AENV, 1996).

The water allocation requirements for the proposed Valley Ridge Country Estates Subdivision Phase 2 were estimated using Subsection (3) and Section 23 of the Water Act (AENV, 1996), regarding the allowable use of 1250 m^3 of water per year per household for "household purposes". The total estimated requirements for the development are summarized in the following table.

Item	Water Requirement m^3/yr [Imperial Gallons per Minute (igpm)]
Houshold Purposes and Human Drinking Water: 35 residences x 1,250 m^3/year	43,750 m^3/year (18.3 igpm)

Based on the foregoing, the total water requirement is estimated at 43,750 m^3/year (18.3 igpm). In order to evaluate the groundwater potential, AENV requires that investigations and reporting should include the following:

- Review of available site documentation. This includes drillers' reports, pumping and recovery test data, hydrochemical data, and hydrogeological reports.
- Water well drilling and testing, including analysis of pumping and recovery test data, analysis of 20 year safe yield (Q_{20}), and computation of theoretical impact on nearby wells. Aquifer yield, aquifer continuity, groundwater potability (and feasibility of treatment, as required), and aquifer susceptibility to potential contamination at the proposed subdivision should be considered.

- Report preparation.

The investigations and reporting using this approach ensures that the owners will have the statutory right to use groundwater.

To assess potential aquifer yield for planning potential development density, preliminary assessments may be used as a guide in predicting potential aquifer yield in an area. This preliminary groundwater supply feasibility evaluation may be used at the initial stages of planning but should not replace the more rigorous investigations required by AENV when obtaining final development approval.

3.0 HYDROGEOLOGY

3.1 REGIONAL HYDROGEOLOGY

Surficial deposits in the area consist of quaternary glacial till deposits and alluvial sands and gravels. The till deposits may represent a significant groundwater resource in the area. The Alberta Research map NTS 82G-H (1974), indicates that the possible aquifers may be in shallow gravel deposits or underlying sandstone and shale. Groundwater wells in the area are completed in the gravel deposits and Belly River and Blairmore Formations. The Alberta Research Council Hydrogeology Report, (1974) indicates the regional groundwater is typically a bicarbonate + carbonate type and well yields of 5 igpm to 25 igpm are attainable in this region.

3.2 LOCAL HYDROGEOLOGY

A search of water well drilling reports filed with the Groundwater Information Center of AENV identified 19 groundwater wells within the evaluation area (see attached Table 1 and Figure 2). There is record information on a total of five wells currently located in the W½ 31-007-03 W5M. These are identified in Table 1 (Map Well ID 1-5).

Water wells drilled in the area are completed in the gravel deposits and Belly River and Blairmore Formations, and confirm that gravels and sandstones are the dominant aquifers used throughout the area. Available hydrochemical analysis data indicates that the local groundwater is predominantly a bicarbonate + carbonate type. Details regarding wells (where available) are provided in Table 1. Figure 2 depicts the well locations within the evaluation area.

Significant observations derived from available water well drillers reports are:

- Well depths vary significantly from 2.7 m to 103.6 m within W½ 31-007-03 W5M and the surrounding 1.6 km radius. The variability of well depth exceeds the topographic relief of approximately 30 m across the area indicating that the water bearing zones are not continuous across the area. As such, a conceptual aquifer model which entails a discontinuous "layer-cake" of hydrostratigraphic units is applicable.

- The apparent 20 year safe yields (Q_{20}) of wells within W½ 31-007-03 W5M and the surrounding 1.6 km radius of the proposed development, for wells which there is sufficient information available to compute aquifer parameters, ranges from 6,738 m^3/year (2.82 igpm) to 2,867,468 m^3/year (1,200.09 igpm). The mean apparent 20 year safe yields for these wells is 430,040 m^3/year (179.98 igpm). This computation is based upon the apparent transmissivity [i.e., Ta = 264Q(1+logt)/d] computed from data provided on the water well drillers reports.
- The variability of the well depths implies that water-bearing zones are multi-storey throughout the geologic section. The layer-cake hydrostratigraphic geology can be summarized based upon depth increments, using either the bottom of the perforated interval or the total depth of the well. The relationship between depth increments, flow estimates, and aquifer lithology are shown in the table below. Only wells containing adequate information were included.

LAYER-CAKE HYDROSTRATIGRAPHIC MODEL WITHIN W½ 31-007-03 W5M AND THE SURROUNDING 1.6 KM RADIUS

Depth Increment (m)	Number of Wells	Cumulative Flow Estimate (igpm; m^3/year)	Aquifer Lithology
10 to 20	3	1,444.60; 3,451,695	GRAVEL
30 to 50	2	75.62; 180,685	SS/SH
50 to 80	3	38.83; 92,780	SS/SH
80 to 104	1	57.93; 138,417	SS/SH

The three shallow wells between 10 m to 20 m are completed in gravel. The other six deeper wells are completed in sandstone/shale. There are two domestic use wells, two municipal use wells, and one unknown use well within W½ 31-007-03 W5M. There are eight domestic use wells, one municipal use well, one industrial use well, and three unknown use wells within the 1.6 km radius surrounding the proposed subdivision.

The data in the preceeding table indicates that the majority of wells are completed between 10 m and 80 m. Based upon layer-cake hydrostratigraphic geology, the wells located within W½ 31-007-03 W5M and the surrounding 1.6 km radius of the proposed subdivision have a cumulative minimum production potential of 3,725,160 m^3/year (1,559.05 igpm) to a depth of 80 m, based on the apparent 20 year safe yield of wells in the area.

There are five well records within W½ 31-007-03 W5M. The well records for two of these wells contain adequate information to determine flow estimates. These two wells are both completed in gravel aquifers between 10 m and 20 m. A layer-cake hydrostratigaphic model can be used for this preliminary assessment.

- There are five existing water wells located within W½ 31-007-03 W5M with the intent to create 35 additional lots. The Water Act, under Section 21(2) allocates a maximum of 1,250 m^3/year to each existing and proposed parcel of land for household use. The total

groundwater requirement is, therefore, 43,750 m^3/year (i.e., 35 lots x 1,250 m^3/year), which is less than the total cumulative production potential of 3,725,160 m^3/year within the upper 80 m of the geological section, based on 9 wells in the area. Therefore, sufficient water reserves should be available to service the additional thirty five lots, given that for 9 wells there is adequate water resources for a total of 2,980 users (i.e., 3,725,160 m^3/year/ 1,250 m^3/year = 2,980).

- It is recognized that the short-term pump tests given on the water well records may not be indicative of longer-term pumping tests and sustainable flow rates. Site specific well testing is required to confirm the groundwater supply potential.
- The water well data was also viewed to determine if a drop in regional groundwater table was evident with increased country residential subdivision development. The mean static water level (non-pumping) for wells within W½ 31-007-03 W5M and the surrounding 1.6 km radius of the proposed development was tabulated as shown in the table below.

AVERAGE STATIC WATER LEVEL DATA VERSUS TIME IN PROXIMITY TO W½ 31-007-03 W5M

Decade (m)	Number of Wells	Average Static Water Level (ft)
1970s	2	27.2
1980s	1	9.0
1990s	5	60.7
2000s	1	195.0

With the exception of the 1980s decade, the regional water level has decreased over a 22 year period from 1978 to 2000. This may be because the wells drilled in the 1990s and 2000s were deeper, and one well was completed in an aquifer with a lower piezometric head.

Based upon the evaluation criteria set out by AENV, 1994, there exists more than one water-bearing zone and the zones are likely not continuous beneath the quarter section. This conclusion is based upon the variability in well depth, completion interval, and preliminary flow estimates.

Water well records within W½ 31-007-03 W5M indicate overburden deposits that vary from 4.9 m (16 ft) to 7.9 m (26 ft) in thickness. The average overburden thickness is approximately 6.4 m (21 ft). When the overburden thickness exceeds 3 m, this depth of overburden is generally sufficient to accommodate septic fields. In accordance with subdivision regulations, site-specific percolation tests should be undertaken to confirm the suitability of the overburden material for septic field disposal.

4.0 SUMMARY OF FINDINGS

Based upon a review of potential aquifer yield, aquifer continuity, and aquifer susceptibility to potential contamination at the proposed subdivision, EBA concludes the following with regard to this evaluation:

- There are currently five existing water wells located within W½ 31-007-03 W5M that are registered with AENV. The proposed thirty five lot subdivision would bring the total number to forty and a total water requirement of 50,000 m^3/year (i.e., 40 lots x 1,250 m^3/year).
- Based upon existing water well flow test information, there is a minimum cumulative groundwater potential of 3,725,160 m^3/year (1,559.05 igpm) within the upper 80 m of the geological section, based on 9 well records in the area. The additional water requirements for the proposed development is less than the cumulative groundwater potential of the nine wells for which there is adequate information to compute aquifer parameters. Therefore, it is likely that there are sufficient groundwater reserves to serve the proposed additional thirty five lots of land in W½ 31-007-03 W5M based upon existing information.
- The groundwater supply for the proposed development may be obtained from wells completed within varying depth intervals up to 80 m. There is a lack of data to fully assess the aquifer potential below 80 m.
- Based upon the results of this groundwater feasibility assessment, EBA is of the opinion that there is an adequate groundwater supply potential to meet the needs of existing development and the domestic requirements of the proposed unserviced thirty five lot residential development. Water well drilling and testing is required to confirm this.
- Although all calculations and comments are based upon 1,250 m^3/year per household water use, as per the Water Act, it is important to note the seasonal and/or weekend use of the existing and proposed lots may result in a lower annual consumption. This further suggests there is an adequate groundwater supply potential to meet the needs of the existing developments and the domestic requirements of the proposed unserviced thirty five lot development.

5.0 RECOMMENDATIONS

Based upon the findings of this report, EBA recommends the following:

- Based upon this preliminary groundwater supply feasibility evaluation, the proposed subdivision has an adequate groundwater supply potential to meet the needs of existing development and the domestic requirements of the proposed unserviced residential subdivision. Thus, provisional approval for the development of the proposed thirty five lot subdivision should not be declined based upon groundwater supply issues.
- Based upon the results of investigations conducted at the site, it is concluded that the diversion of 1,250 m^3/year of water per household, for each of the houses within the proposed subdivision, are likely not to cause a significant adverse effect on existing water users in the area. Thus, provisional approval for the development of the proposed thirty five lot subdivision should not be declined based upon groundwater supply interference issues.

- Site specific testing of a new water well or existing wells would provide a more adequate assessment of water resources in the proposed development area.
- Groundwater from wells drilled at the proposed subdivision should be tested for potability parameters. Should parameters exceed Canadian Drinking Water Standards, the water may be treated.

6.0 DISCLAIMER

If you have any questions regarding the assumptions and conclusions drawn in this groundwater feasibility assessment, please contact the undersigned at your convenience. It should be noted that the assessment of potential groundwater availability is not a guarantee, but rather an indication of the probability of securing a sustainable groundwater supply. Site-specific well testing is required to confirm an adequate groundwater supply.

7.0 LIMITATIONS OF LIABILITY

The conclusions presented herein are based on the work scope as described in Section 1.0. This report has been prepared for the use of Mr. Richard Koentges for the specific application described above in accordance with generally accepted environmental engineering practices. No further warranty is made, either express or implied.

For further limitations, references should be made to EBA's Environmental Report – General Conditions (Appendix A)

8.0 CLOSURE

We trust the information herein satisfies your present requirements. Should you have any questions, please contact Mr. Stephen Mailath at our Calgary Riverbend office or Mr. Paul Cyganik at our Lethbridge office.

Respectfully submitted,
EBA Engineering Consultants Ltd.

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PROFESSIONAL ENGINEER ALBERTA
JAMES A. RYAN

PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature _____
Date August 10, 2006
PERMIT NUMBER: P245
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

REFERENCES

Alberta Environment. 1996. "Water Act". Queens Printer, Edmonton.

Alberta Environment. 1998. "Environmental Guidelines for the Review of Subdivisions in Alberta, Chapter 2: Guidelines for the Evaluation of Groundwater Supply for Unserviced Residential Subdivisions".

Alberta Environment. April 27, 1999. Letter from AENV to Mr. Harry Riva Cambrin of the MD of Foothills indicating how Section 23 of the Water Act may be addressed in reports by groundwater experts.

Tokarsky, O. 1974. Hydrogeology of the Lethbridge-Fernie Area, Alberta. Alberta Research Council, Report 74 – 1.

UMA Engineering Ltd. 1998. Subdivision Geotechnical Investigation. (File: 9721-036-00-07\L004\2.0).

UMA Engineering Ltd. 1998. Groundwater Supply Evaluation Report. (File No. 9721-036-03-02).

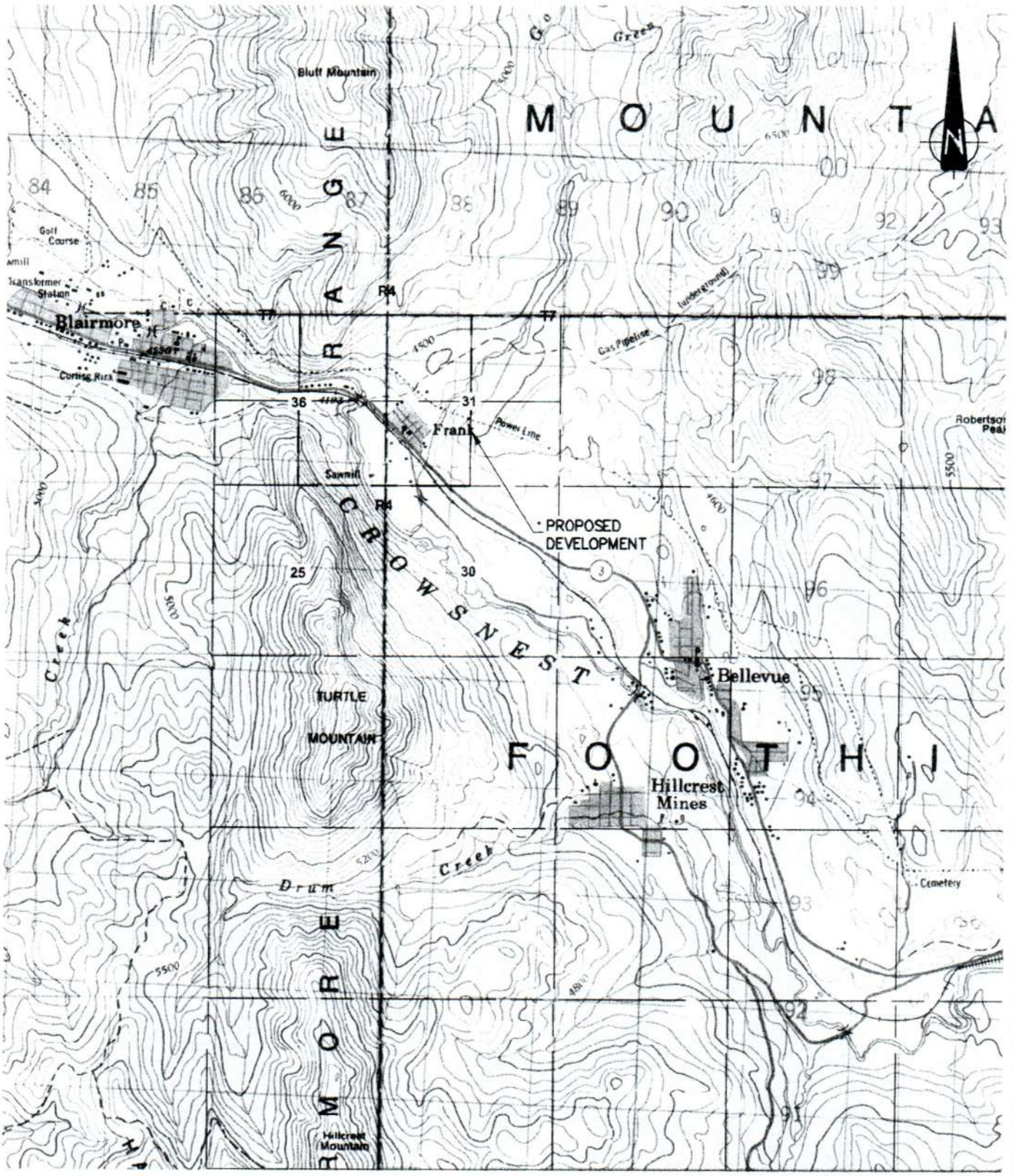
TABLES

TABLE 1: SUMMARY OF WELLS IN PROXIMITY TO THE PROPOSED DEVEL(

Map Well ID	AENV Well ID	Location	We	Transmissivity (gal/day/ft) Apparent	Q20 (lgpm) Apparent
31-07-03 W5M					
1	401896	31-07-03 W5M	FRANK, TOWN		
NW 31-07-03 W5M					
2	401895	NW 31-07-03 W5M	KOE		
SW 31-07-03 W5M					
3	401892	SW 31-07-03 W5M	FRIES		
4	401894	04 31-07-03 W5M	FRANK,	304,838.9	1,200.09
5	401893	04 31-07-03 W5M	FRANK,	46,451.6	244.51
SE 36-07-04 W5M					
6	374111	02 36-07-04 W5M	DEKA	198.3	7.30
7	401939	08 36-07-04 W5M	# TURTL		
8	401938	SE 36-07-04 W5M	SC		
NW 36-07-04 W5M					
9	401941	11 36-07-04 W5M	RESEARCH O		
NE 36-07-04 W5M					
10	401944	NE 36-07-04 W5M	CROWSNES		
11	401945	NE 36-07-04 W5M	KAYWC		
12	401940	10 36-07-04 W5M	TURTLE MTN		
SE 06-08-03 W5M					
13	495497	SE 06-08-03 W5M	KOENTGES P	704.5	13.56
14	495498	SE 06-08-03 W5M	KOENTGES	467.6	2.82
15	495499	SE 06-08-03 W5M	KOENT	103.4	6.51
16	499176	SE 06-08-03 W5M	KOENTGES	340.3	18.76
17	341023	SE 06-08-03 W5M	CLA	1,204.3	57.93
18	341559	SE 06-08-03 W5M	VALLEY RID	1,420.3	68.32
SW 30-07-03 W5M					
19	401891	12 30-07-03 W5M	TURTLE M		
				Total	1619.82
				Average	179.98

Notes:
SWL - Static water level.
PWL - Pumping water level.

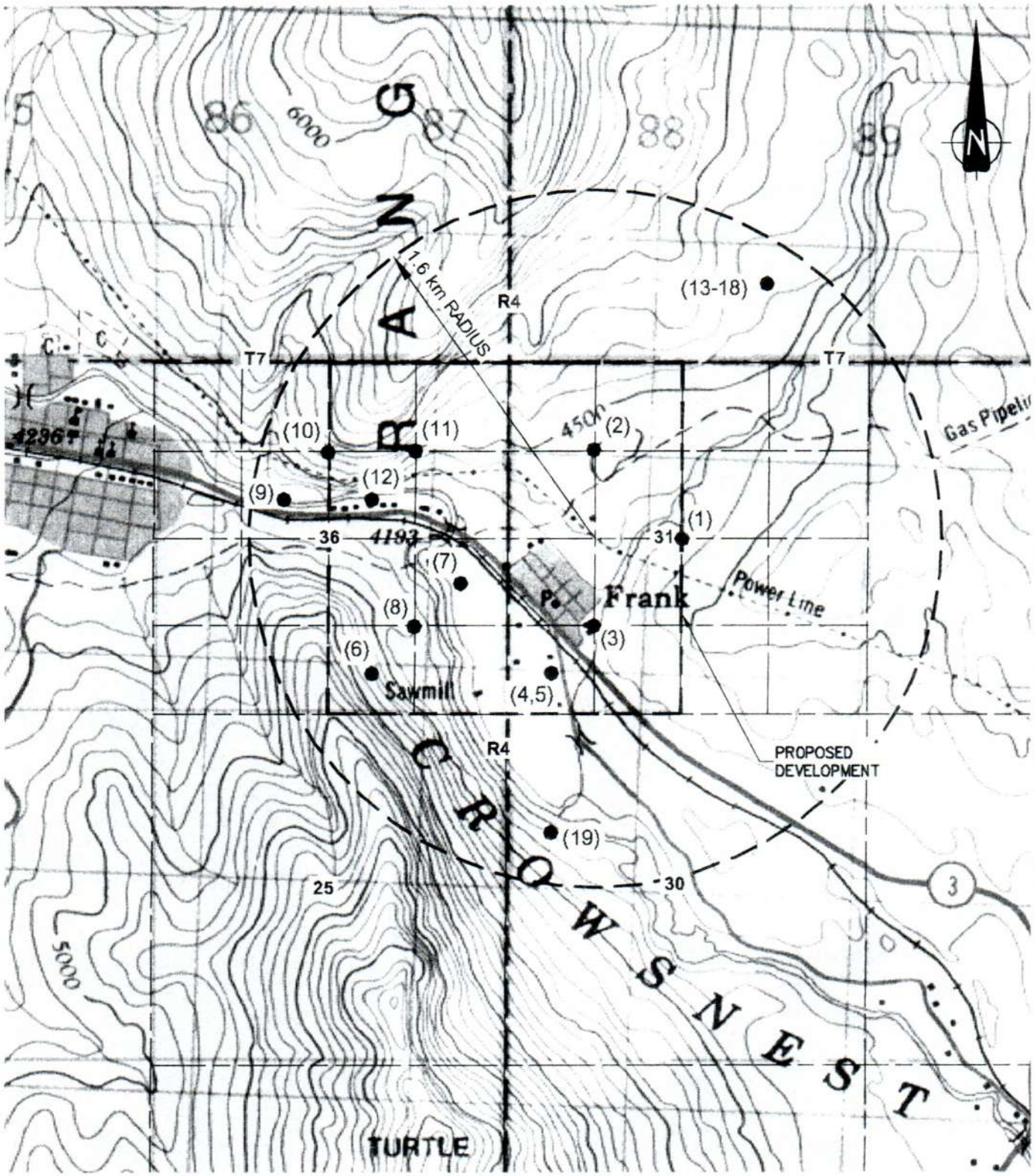
FIGURES



BASE REFERENCED FROM: NTS MAP 82G09.
*THIS DRAWING WAS ORIGINALLY PRODUCED IN COLOUR.

EBA Engineering Consultants Ltd.	CLIENT Mr. Richard Koentges	PROJECT VALLEY RIDGE COUNTRY ESTATES SUBDIVISION PHASE 2 W1/2-31-007-03 W5M	
DWN. KA / CHKD. PC		TITLE PROPOSED DEVELOPMENT PLAN	
EBA JOB NO. 4401178	FILE: 4401178-FIG1.dwg	REVISION NO.: 1	DATE: June 2006

Figure 1



0 250 500 750 1000 1250

Scale: 1:25,000 (metres)

LEGEND:

(##) ● – APPROXIMATE LOCATION OF WATER WELLS

BASE REFERENCED FROM: NTS MAP 82G09.

** THIS DRAWING WAS ORIGINALLY PRODUCED IN COLOUR.*

EBA Engineering Consultants Ltd.	CLIENT: Mr. Richard Koentges	PROJECT: VALLEY RIDGE COUNTRY ESTATES SUBDIVISION PHASE 2 W1/2-31-007-03 W5M	
DWN. KA / CHKD. PC		TITLE: PROPOSED DEVELOPMENT PLAN SHOWING SURROUNDING WATER WELLS	
EBA JOB NO. 4401178	FILE: 4401178-FIG2.dwg	REVISION NO.: 1	DATE: June 2006

Figure 2

APPENDIX

APPENDIX A ENVIRONMENTAL REPORT – GENERAL CONDITIONS

ENVIRONMENTAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of EBA's client. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 LIMITATIONS OF REPORT

This report is based solely on the conditions which existed on site at the time of EBA's investigation. The client, and any other parties using this report with the express written consent of the client and EBA, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive.

The client, and any other party using this report with the express written consent of the client and EBA, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made.

The client acknowledges that EBA is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

2.1 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of this report, EBA may have relied on information provided by persons other than the client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

3.0 LIMITATION OF LIABILITY

The client recognizes that property containing contaminants and hazardous wastes creates a high risk of claims brought by third parties arising out of the presence of those materials. In consideration of these risks, and in consideration of EBA providing the services requested, the client agrees that EBA's liability to the client, with respect to any issues relating to contaminants or other hazardous wastes located on the subject site shall be limited as follows:

1. With respect to any claims brought against EBA by the client arising out of the provision or failure to provide services hereunder shall be limited to the amount of fees paid by the client to EBA under this Agreement, whether the action is based on breach of contract or tort;
2. With respect to claims brought by third parties arising out of the presence of contaminants or hazardous wastes on the subject site, the client agrees to indemnify, defend and hold harmless EBA from and against any and all claim or claims, action or actions, demands, damages, penalties, fines, losses, costs and expenses of every nature and kind whatsoever, including solicitor-client costs, arising or alleged to arise either in whole or part out of services provided by EBA, whether the claim be brought against EBA for breach of contract or tort.

4.0 JOB SITE SAFETY

EBA is only responsible for the activities of its employees on the job site and is not responsible for the supervision of any other persons whatsoever. The presence of EBA personnel on site shall not be construed in any way to relieve the client or any other persons on site from their responsibility for job site safety.

5.0 DISCLOSURE OF INFORMATION BY CLIENT

The client agrees to fully cooperate with EBA with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The client acknowledges that in order for EBA to properly provide the service, EBA is relying upon the full disclosure and accuracy of any such information.

6.0 STANDARD OF CARE

Services performed by EBA for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

7.0 EMERGENCY PROCEDURES

The client undertakes to inform EBA of all hazardous conditions, or possible hazardous conditions which are known to it. The client recognizes that the activities of EBA may uncover previously unknown hazardous materials or conditions and that such discovery may result in the necessity to undertake emergency procedures to protect EBA employees, other persons and the environment. These procedures may involve additional costs outside of any budgets previously agreed upon. The client agrees to pay EBA for any expenses incurred as a result of such discoveries and to compensate EBA through payment of additional fees and expenses for time spent by EBA to deal with the consequences of such discoveries.

8.0 NOTIFICATION OF AUTHORITIES

The client acknowledges that in certain instances the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

9.0 OWNERSHIP OF INSTRUMENTS OF SERVICE

The client acknowledges that all reports, plans, and data generated by EBA during the performance of the work and other documents prepared by EBA are considered its professional work product and shall remain the copyright property of EBA.

10.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by EBA shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by EBA shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA's instruments of professional service will be used only and exactly as submitted by EBA.

The Client recognizes and agrees that electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

Appendix 3
Geotechnical Evaluation

Mr. Richard Koentges

GEOTECHNICAL EVALUATION
VALLEY RIDGE RESIDENTIAL SUBDIVISION, PHASE 2
FRANK, ALBERTA

4401178

August 2006

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APPENDICES

1.0 INTRODUCTION

This report presents the results of a geotechnical evaluation conducted by EBA Engineering Consultants Ltd. (EBA) for the proposed Valley Ridge Country Subdivision (Phase 2) to be located north of Frank, Alberta. The scope of work for this evaluation was described in a proposal issued to Brown Okamura & Associates Ltd., on behalf of the owner, Mr. Koentges, on April 17, 2006.

The objective of this geotechnical evaluation was to determine the general subsurface conditions in the area of the proposed development and to develop recommendations for the geotechnical aspects of design and construction for the country residential subdivision. The second component of this evaluation included an assessment of the stability of the existing slopes adjacent to the proposed residential development and to recommend development restrictions, as appropriate. It is noted that a hydrogeological assessment for the feasibility of a potable well water supply for this development was also completed by EBA and will be issued under separate cover. Environmental issues were not included in EBA's scope of geotechnical work and as such, are not discussed in this report.

Authorization to proceed with the evaluation was provided by Mr. Koentges.

2.0 PROJECT DETAILS

EBA's understanding of the development was derived from a project review meeting with Mr. Koentges on April 6, 2006 and is summarized as follows.

- The project site is located several hundred metres northwest of the outskirts of Frank, Alberta. The proposed development area is shown on Figure 1 (NW ¼ and part of the NE ¼ Section 31-7-3-W5M). The general land area is bisected by an existing gravel surfaced road, as well as a high pressure gas utility right-of-way. The western portion of the property (west of the existing road) has undulating topography and is bounded to the west and northwest by a significant upgradient slope. To the east of the road, the property footprint is relatively narrow, with a relatively level topography, and is bounded on the east by a downgradient slope, approximately 20 m to 30 m in height, above Gold Creek (water course).
- The project concept of a country residential subdivision (Valley Ridge Country Estates, Phase 2), is at the Area Structure Plan (Plan) stage, with the intent to submit this Plan to the Municipality of Crowsnest Pass for rezoning to country residential.
- EBA understands that the preliminary development concept would include approximately 35 residential lots, each in the order of approximately 4 acres in size (may vary between 3 and 5 acres). The possibility of smaller lots is also under consideration. The foundation system for the housing will likely be shallow spread footings and grade supported lower level floor slabs.

- The scope of work for this evaluation is intended to confirm the feasibility of the site soils for subdivision grading and utility installations, as well as shallow footing foundation systems.
- A new access road will be required, particularly for the west area of the site. It should be noted that, although EBA will provide recommendations for design and construction of the roadway, a stormwater management plan and design are outside of EBA's scope of work.
- The development will require consideration of safe development setback distances from the toe of the upper slope, as well as from the crest of the lower slope, for subdivision planning and design. The scope of this evaluation includes an evaluation of slope stability and development setback recommendations.
- Septic field disposal is proposed for handling of wastewater. As such, the scope of EBA's services includes an assessment of the feasibility of septic field disposal, through the completion of percolation testing at select locations across the property.
- With respect to groundwater issues, it is understood that the first concept is a municipal well supply, with the water capacity for each well suitable for a number of houses. A hydrogeological assessment has been completed as part of EBA's services, in order to assess the feasibility of additional water supply from the underlying aquifer(s), and has been reported separately.
- Previous geotechnical evaluations for Phase 1 of the subdivision (to the northeast of the subject Phase 2) (SE ¼ 6-8-3-W5M) was completed by UMA Engineering Ltd. (UMA) in October 1997 and in January 1998. The existing reporting by UMA has been reviewed and given consideration in the development of recommendations contained in this geotechnical evaluation report.

3.0 SCOPE OF WORK

3.1 BACKGROUND REVIEW

The first phase for the geotechnical evaluation for this project included a review of available information on the geology of the site and surrounding area, including an historical aerial photograph review. This review was also completed in conjunction with the hydrogeological assessment, reported separately. The primary information provided to EBA included the UMA geotechnical reporting, as well as site elevation contours from a topographic survey completed by Brown Okamura & Associates Ltd. (BOA). Water well records were also reviewed as part of the hydrogeological assessment, with relevant information also included in this geotechnical evaluation.

EBA's geotechnical engineer also conducted a detailed site reconnaissance to assess current conditions in comparison to historic conditions. Specifically, during the site reconnaissance by our geotechnical engineer, the 'Bottom of Bank' for the upper slope and the 'Top of

Bank' for the lower slope were established for the toe and crest of the slopes respectively. As noted further in this report, recommendations are provided for a development setback distance from the bottom of bank line and from the top of bank line, in consideration of the geometry and stability of the adjacent slopes. It is recommended that the development setback lines be located by survey, as required for final development planning.

3.2 GEOTECHNICAL PROGRAM

The work scope for the geotechnical evaluation included a total of 22 boreholes installed within the footprint of the development area to depths varying between approximately 1.0 m to 13.6 m (Boreholes (BH)001 through BH022). The majority of the boreholes encountered refusal in either shallow bedrock or within dense cobbly gravel deposit.

Four of these twenty-two boreholes (BH001 through BH004) were installed to address the slope stability assessment along the crest of the lower slope and were drilled to practical refusal to depths of 5.5 m to 13.6 m.

An additional 8 percolation testholes (P01 through P08), at representative development locations around the property, were installed to depths of 0.9 m to obtain the required subsurface information to address regulatory guidelines for design and construction of septic disposal fields.

Prior to borehole drilling, EBA completed verification of the location of buried utilities through Alberta One-Call. Furthermore, due to the gas pipeline right-of-way through the property (shown on Figure 1), it was necessary for EBA to obtain a crossing agreement with Nova Gas Transmission Limited, prior to accessing the site with drilling equipment.

The fieldwork for this evaluation was carried out on June 5, June 21, and July 18, 2006 using a truck mounted drill rig contracted from Chilako Drilling Services Ltd. of Coaldale, Alberta. The rig was equipped with 150 mm diameter solid stem continuous flight augers. EBA's field representatives were Mr. John Christensen and Mr. Paul Cyganik.

In all of the boreholes, disturbed grab samples were obtained at 600 mm intervals. All soil samples were visually classified in the field and the individual soil strata and the interfaces between them were noted. The borehole logs are presented in Appendix B. An explanation of the terms and symbols used on the borehole logs is also included in Appendix B.

Slotted 25 mm diameter PVC standpipe was installed BH001 through BH006, BH008, BH011, and BH016 in order to monitor the groundwater level at each location. Auger cuttings were used to backfill around the standpipes and they were sealed at the ground surface with bentonite chips.

The percolation test procedure included half filling the percolation testhole with water and allowing the testhole to saturate for a period of approximately 24 hours. On July 19, 2006, the percolation holes (P01 through P08) were refilled with water to approximately 0.45 m

below existing ground surface and the subsidence of the water was measured versus time (refilling to the same level every 30 minutes and measuring the drop in water level).

The locations of the boreholes were initially selected based on the property survey plan shown on Figure 1 (provided by BOA). The Geodetic Elevations (Elevation) of the existing ground surface at the borehole locations were obtained by referencing the elevation contours from the topographic survey. The borehole elevations are indicated on the borehole logs.

Classification tests, including natural moisture content, grain size analysis, and soluble sulphate content were subsequently performed in the laboratory on samples collected from the boreholes, to aid in the determination of engineering properties. The results of the laboratory tests are presented on the borehole logs in Appendix B and in Appendix D.

4.0 SITE DESCRIPTION

EBA personnel (Mr. Jim Ryan, P.Eng.) conducted a visual reconnaissance of the site. The reconnaissance included reviewing the existing condition of the slopes, including the areas at the tops of bank and toes of the slope. The following site description is derived from this reconnaissance.

The project site is located to the northeast of Frank, Alberta, as shown on Figure 1, encompassing a large portion of North ½ Section 31-7-3 W5M. Access to the property is via an existing gravel surfaced road up a hill slope from Frank. The gravel road runs through the property as shown on Figure 1 and on Photo 1, running approximately southwest to northeast. The northwest and southeast portions of the property are described as follows.

- To the northwest of the road (the largest portion of the property), as shown on Photo 2, the ground surface has an undulating topography. The ground surface rises from the road location (Elevation of 1330 m to 1350 m) towards the toe of what is termed the upper slope (approximately Elevation 1350 to 1360 m). Ground surface elevation contours are shown on Figure 1. Cross elevation sections of the northwest property are shown on Figure 2. The toe area of the upper west slope consists of a talus deposit (at a slope of approximately 2 to 3 horizontal to 1 vertical) from the mountain shown in the background of Photo 2 (near vertical rock face). The west property is generally open and grass covered, with the exception of isolated areas of tree growth, particularly along the toe of the upper slope. The west property is very well drained towards the south and west. There are no signs of recent instability within the upper slope.
- To the northwest of the road is a Nova Gas Transmission Limited pipeline right-of-way, as shown on Figure 1.

- To the southeast of the road is the smaller portion of the property, as shown on Photo 3. The topography in this area is only slightly undulating, in comparison to the northwest portion, and the southeast property is moderately well drained. Ground surface elevations within the level portion vary between approximately Elevation 1330 m and Elevation 1350 m, draining from north to south. The level portion of the property is open and grass surfaced and generally free of tree cover. There is what appears to be a small gravel extraction area at the south terminus of this southeast property.
- The southeast property is bounded on the southeast by the valley slope of Gold Creek. The typical top of bank area of the slope is shown on Photo 4, with the top of bank line delineated on Figure 1. The adjacent lower slope appears to be approximately 30 m to 40 m in height (visual estimation), with a slope gradient varying between approximately 1.5 and 2.0 horizontal to 1.0 vertical, steepening within the lower portion. Virtually the entire slope face is tree surfaced, with a mixed and mature tree growth. Although a select number of the trees are leaning somewhat, virtually all of the trees are near vertical. There are no signs of recent instabilities within this southeast lower slope. Based on visual observations, the subsurface conditions of the approximate lower half of the slope appears to be comprised of bedrock.

As part of this evaluation, EBA reviewed aerial photographs taken of the project area between circa 1950 and 2004. Based on these air photos, it is apparent that the slopes adjacent to the property have not changed significantly in the past 50 years. In recent photos from 2004, the existing road as well as the pipeline right-of-way are clearly visible and the property is shown in its current condition. On the photos from 1995, the access road had not yet been constructed, although the pipeline right-of-way is evident, with no other relevant differences noted. There is no evidence of any slope instabilities on these photos.

From photos taken in 1986, the pipeline right-of-way is evident. There appears to be some evidence of tree clearing along the base of the upper slope of the northwest property area. Further upgradient of the upper slope (within the lower portion of the talus deposit), there appears to be localized near surface slumping of the slope and disturbance of the tree cover. The majority of the northern portion of the southeast property had a heavy tree cover in 1986. Therefore, the trees from the level portion of the southeast property must have been removed between 1986 and 1995. There is no other evidence of slope instabilities in these photos.

The photos from 1965 and 1970 are similar to those noted in 1986, with the gas pipeline evident during both time periods (including a newer pipeline), with a generally heavier tree cover in both the northwest and southeast areas. There are no signs of slope instability noted for the northwest property. The only point of note is that the top of bank area along the lower slope is light in colour, with limited trees at the crest during this time period. This may be evidence of movements along the top of slope since the 1950's and the area has since re-vegetated to current conditions.

The 1950 photos are similar to those from the 1965, except that the pipeline right-of-way is not evident at that time and virtually the entire property is tree covered.

In summary, the only significant changes since the 1950's are a gradual removal of trees from the open, non-sloping areas of the property and the construction of the pipeline right-of-way and the gravel access road. Except for some minor disturbance along the top of bank of the lower slope and some minor sloughing of the slope surface above the northwest property, there are no obvious visual signs of instability.

5.0 SUBSURFACE CONDITIONS

5.1 SOIL CONDITIONS

The general subsurface stratigraphy comprises topsoil underlain by a valley glacial moraine deposit comprised predominantly of silty and sandy gravel, with isolated glacial moraine clay layers underlain by relatively shallow bedrock. Specific details of the stratigraphy encountered at each borehole location are presented on the borehole logs and are discussed in this section.

A surficial layer of topsoil was encountered at all borehole locations with a thickness of approximately 150 mm to 200 mm at the borehole locations. The topsoil was described as a clay, which was silty, sandy, moist, and dark brown in colour, with a trace of organics.

At the majority of the borehole locations, underlying the surface topsoil cover, a native glacial moraine (valley glacier) layer was encountered. The glacial moraine was comprised primarily of dense gravel, which was described as sandy, varying between some silt and silty, with trace to some clay, moist, and poorly graded. Cobbles and boulders were also noted within this strata. The depth of this granular layer appeared to vary between ground surface, along the toe of the northwest upper slope, to approximately 13.0 m below ground surface in the southeast area of the property. Augur refusal in this dense granular layer, or within the near surface bedrock strata was encountered in many of the boreholes (refer to individual borehole logs). The results of grain size analysis of a representative granular sample are shown in Appendix D (gravel, sandy, trace silt and clay). Moisture contents within the granular layer were typically in the range of 5 to 8 percent.

As noted on the borehole logs, a layer of native clay was encountered at BH001 and BH002 below a depth of 6.1 m. The clay deposit was also encountered at BH003 below a depth of 1.0 m, at BH004 below a depth of 3.7 m, at BH008 from ground surface to a depth of 5.2 m, and at BH009 from ground surface to a depth of 1.0 m. Where encountered, the clay was described as silty, sandy, with some gravel to gravely, moist, low to medium plastic, and very stiff in consistency. This layer is attributed to being a more cohesive component to the glacial moraine deposit. Auger refusal was also encountered within this layer at a number of the borehole locations. Moisture contents within this clay layer typically varied between approximately 5 and 12 percent.

Bedrock was encountered at various borehole locations throughout the property. The bedrock is at very shallow depth below ground surface along the north and northwest upper slope toe areas. Boreholes BH019 through BH022 were added to the original field program in the northwest corner at the request of Mr. Koentges, to confirm the relatively shallow depth of the bedrock from ground surface in this area. The approximate delineation of a line of shallow bedrock is shown on Figure 1 (denoted 'Shallow Bedrock' on Figure 1). Specifically, to the north of this line bedrock was encountered within 1 m of ground surface. To the south of this line, the thickness of overburden soils overlying the bedrock appears to increase to depths of up to 6 m to 13.6 m. Based on the information currently available, the deepest depth of bedrock appears to be along the southeast property boundary (lower top of slope area) at an estimated depth below ground surface varying between 10 m and 20 m.

Where encountered, (BH003, BH015, and BH017 through BH022) the bedrock was comprised primarily of clay shale, which was weathered at surface and of low to moderate strength. The exceptions include a layer of sandstone at BH003.

A more complete description of the subsurface conditions encountered at the borehole locations is provided on the borehole logs. A stratigraphic cross-section of the soils is presented on Figure 2.

5.2 PERCOLATION TEST RESULTS

The following table provides the results of the field program and percolation test results.

Percolation Test	Subsurface Stratigraphy (0.2 m to 0.9 m)	Percolation Test Result (min/cm)
P01	Gravel, sandy, silty, trace to some clay, moist, dense, brown	1
P02	Gravel, sandy, silty, trace to some clay, moist, dense, brown	5
P03	Gravel, sandy, some silt, trace clay, moist, dense, brown	0.5
P04	Gravel, sandy, some silt, trace clay, moist, dense, brown	2
P05	Silt, sandy, trace clay, moist, low plastic, stiff, brown	5
P06	Gravel, sandy, some silt, trace clay, moist, dense, brown	5
P07	Gravel, sandy, some silt, trace clay, moist, dense, brown Below 0.7 m – Bedrock, Weathered Shale	19
P08	Clay, silty, sandy, gravely, very moist, low to medium plastic, stiff, brown	5

5.3 GROUNDWATER

At the time of drilling, sloughing of the granular layer was commonly noted. Seepage was noted at isolated borehole locations, including BH002, BH003, BH008, BH009, and BH011. The groundwater level was measured within the standpipes on August 1, 2006. The following table summarizes the groundwater monitoring data.

Borehole Number	Depth of Standpipe (m)	Ground Elevation of Borehole (m)	Groundwater Monitoring Data August 1, 2006	
			Depth to Groundwater (m)	Elevation to Groundwater (m)
001	6.4	1332	dry	--
002	9.8	1348	10.4	1337.6
003	4.9	1366	dry	--
004	3.0	1342	dry	--
005	2.7	1350	dry	--
006	3.0	1345	dry	--
008	5.2	1352	4.2	1347.8
011	5.5	1347	2.4	1344.6
016	6.1	1364	5.8	1358.2

Groundwater levels may fluctuate seasonally and in response to climatic conditions and therefore should be monitored prior to construction to provide an early indication of dewatering requirements for excavation of the project's foundations or utility trenches. These groundwater levels are attributed to water trapped within the granular layers overlying lower, less permeable strata and within sandy inclusions within the clay strata. These groundwater levels are generally lower than 4.0 m below ground surface (except for BH011) and as such, should not generally proved to be problematic for most shallow excavations. However, excavations encountering the groundwater table will require dewatering during construction. Further comments regarding groundwater issues are provided in the subsequent sections.

6.0 SUBDIVISION DEVELOPMENT RECOMMENDATIONS

6.1 GENERAL CONSIDERATIONS

Specific geotechnical recommendations that apply to this project are provided for septic disposal fields, shallow footings, basement construction, general site development, lot grading, subgrade preparation, groundwater issues during construction, trench excavation and backfill, pavement structures and concrete type, as well as development restrictions, considering the adjacent slopes.

The results of percolation testing indicate that, although borderline, most areas of the property (P02, and P05 through P08) appear to be suitable for septic disposal fields, in accordance with the Safety Codes Council's, Alberta Private Sewage Systems Standard of Practice 1999. Isolated areas of coarser gravel, with an apparently lower silt and clay component soil (i.e., with a higher percolation rate, such as that of Percolation Test Locations P01, P03, and P04) should be reviewed at the time of septic field placement. Septic disposal mounds may be required in isolated areas, or alternatively, the assessment of alternate septic disposal field locations within each lot (within siltier soils), as deemed necessary. The specific design of septic disposal field is beyond the scope of this report.

Subgrade preparation is recommended in all subdivision development areas, including lot grading as well as all paved areas. This includes stripping of topsoil, scarification and moisture conditioning and compaction. The native clayey granular and granular soils should be generally acceptable for site grading purposes. The local soils have variable moisture content in most areas and as such, moisture conditioning will be required to achieve the compaction standards recommended. Following subgrade preparation, proof-rolling to detect soft areas within roadways is also recommended. Some site selection of engineered fill materials may be required dependent on the fill placement thickness (i.e. more than the maximum aggregate (cobble) size).

Conventional excavation trench cuts are expected as the preferred option for this development. As excavation proceeds, the excavated soil will be comprised of a mixture of predominantly granular soils (including cobbles/boulders), with varying amounts of silt and clay. The design sideslopes of any excavation trenching should take into account the material type, as well as groundwater conditions. Groundwater issues are generally not expected for excavation depths of up to 2.5 m. However, some groundwater seepage is possible below this depth, which may pose some difficulties.

Relatively shallow bedrock with respect to the natural ground surface was encountered during this evaluation. The approximate line of the contact with ground surface and shallow bedrock is shown on Figure 1 (less than ±1 m to the bedrock surface). Rock ripping should be anticipated depending on the depth of excavation into bedrock required. This should be reviewed at the time of tender by an experienced Contractor.

Materials separation and treatment for approved backfill soils are discussed in the subsequent sections of this report. Cohesive and non-cohesive soils should be separated, wherever possible. The contractor should expect moisture conditioning of all soil materials to closer to optimum moisture content. Alternatively, the unusable materials may have to be wasted off-site and replaced with imported backfill materials.

Shallow footings are considered feasible for residential developments in all areas of the subdivision most likely in conjunction with full or partial basements. Further recommendations are provided in Section 8.0. Cast-in-place concrete friction piles or end bearing belled piles are not considered to be a feasible alternate due to the granular soil

conditions and are not expected for general use in this development. Recommendations for this foundation type may be provided upon request.

All foundation design recommendations presented in this report are based on the assumption that an adequate level of monitoring will be provided during construction and that all construction will be carried out by suitably qualified contractors, experienced in foundation and earthworks construction. An adequate level of monitoring is considered to be:

- for shallow foundations; inspection of bearing surfaces prior to placement of concrete or mudslab and design review during construction;
- for earthworks; full-time monitoring and compaction testing.

All such monitoring should be carried out by suitably qualified persons, independent of the contractor. One of the purposes of providing an adequate level of monitoring is to check that recommendations, based on data obtained at discrete borehole locations, are relevant to other areas of the site.

6.2 SEPTIC DISPOSAL FIELDS

The Safety Codes Council's, Alberta Private Sewage Systems Standard of Practice 1999, states that a subsurface effluent disposal system that uses the absorption of effluent into the soil for treatment and disposal, should absorb the effluent into the soil at a rate of:

- not faster than 5 minutes per 2.5 cm (2 minutes / cm); and
- not slower than 60 minutes per 2.5 cm (24 minutes / cm),

as determined by a percolation test. In addition, the natural separation between the point of effluent infiltration into the soil and the groundwater should be a minimum of 1.5 m.

With the exception of some cleaner granular soils at P01, P03, and P04, the siltier gravel, with some clay is expected to predominate across the property. The percolation test results ranged between 5 and 19 minutes/cm and are deemed to reflect the component of silt and clay within the gravel matrix, which help to slow the percolation rate. These results indicate that the near surface soils for design and construction of septic disposal fields generally satisfy the requirements of the Safety Code Council's guidelines in the majority of the property. In localized areas, such as percolation test locations P01, P03, and P04, the rates of percolation for the soils encountered at those locations were noted to be faster than the maximum guidelines, attributed to a lower component of fines within the gravel deposit at these test locations. This may also occur in other areas of the site.

Based on the groundwater levels recorded, it is considered that the phreatic surface for the property would be below 1.5 m from the elevation of the disposal field, satisfying the Safety Codes Council guidelines.

Based on the results of this assessment, the use of septic disposal fields for the country residential developments is considered feasible. However, it is noted that the specific site selection of the proposed field needs careful consideration and additional percolation holes in the proposed footprint are recommended to ensure the site specific soils satisfy the requirements of the Regulators Having Jurisdiction (Municipality of Crowsnest Pass, AENV, Alberta Labour). This requirement is in accordance with the provincial regulations, which state that two percolation tests are required within the final footprint of the field. Following the site-specific testing, the septic disposal field should be designed and sized accordingly. It is further recommended that the design footprint of the residence be determined once the final disposal field is selected, to ensure the appropriate gravity flow or pumping requirements are satisfied.

In areas (lots) where the native soils do not satisfy the minimum requirements of Alberta Labour, alternative waste disposal systems may be required, such as a properly designed and constructed septic mound system or the use of cistern tanks. Design details for the alternative systems are beyond the scope of this project assessment.

In addition, during installation of the weeping trenches, the installer should pay close attention to the soil conditions, to define the extent of any clay or clean gravel layers, if encountered in the soil structure (i.e., to assess whether there are specific areas of slower or faster percolation rates, respectively, which should be addressed). These should be immediately reported to the disposal field designer for review prior to completion of the septic disposal field.

The information provided herein is intended to be a preliminary assessment of the feasibility of septic disposal fields for this residential development as per the provincial regulations. Site specific municipal regulations or septic field siting requirement guidelines with respect to the local health unit, if applicable, have not been addressed.

6.3 LOT GRADING

In general terms, the lot grading should be designed and carried out to the minimum Municipality of Crowsnest Pass standards or equivalent. The particulars for this development are discussed in this section.

It is recommended that the lots be initially graded for drainage at a minimum gradient of 2.0 percent. The maximum lot gradient to be allowed should be 15 percent. Given the topography of the property, areas to the northwest at existing gradients in excess of 15 percent should be left undisturbed. This issue is discussed further in the development restrictions recommended in latter sections of this report.

The existing surficial site soils comprising granular soils, with varying silt and clay contents are suitable for use as 'landscape fill' materials and for 'general engineered fill' materials for lot grading, as defined in Appendix C.

The moisture content of the site soil materials at surface generally appears to be somewhat variable. It is anticipated therefore, that moisture conditioning will be required at the site for proper compaction. The earthwork contractor should, however, make his own estimate of the requirements and should consider such factors as weather and construction procedures.

General engineered fill materials for lot grading should be moisture conditioned to within a range of –1 percent of optimum to +2 percent of the optimum moisture content prior to compaction and compacted to a minimum of 98 percent of SPD.

Further recommendations regarding backfill materials and compaction are contained in Appendix C.

6.4 ROAD SUBGRADE PREPARATION

Within all road areas, the upper 300 mm of native soils or prepared general engineered fill subgrade should be scarified and uniformly moisture conditioned to between minus 2 percent of optimum and 2 percent over optimum moisture content. The subgrade should then be uniformly compacted to a minimum of 98 percent of SPD.

Backfill to raise these areas to subgrade level should be general engineered fill materials, as defined in Appendix C, moisture conditioned and compacted as noted above. The subgrade should be prepared and graded to allow drainage to the road shoulders and/or ditches. Proof-rolling of the prepared surface is recommended to identify localized soft areas and for an indication of overall subgrade support characteristics.

It is imperative that positive surface drainage be provided to prevent ponding of water. Surrounding landscaping should be such that runoff water is prevented from ponding beside paved areas in order to avoid softening and premature failure of the pavement surface.

6.5 EXCAVATIONS AND TRENCH BACKFILL

Excavations should be carried out in accordance with the Alberta Occupational Health and Safety Regulations. For this project, the depth of excavations are anticipated to be shallow to moderate for such components as foundations, service trenches, and tie-ins (<3.0 m). The following recommendations notwithstanding, the responsibility of trench and all excavation cut slopes resides with the Contractor and should take into consideration site specific conditions concerning soil stratigraphy and groundwater. All excavations should be reviewed by a geotechnical engineer prior to personnel working within the base of the excavation.

Excavations which are to be deeper than 1.5 m should have the sides shored and braced or the slopes should be cut back not steeper than 1.0 horizontal to 1.0 vertical. Where excavations are open for longer than one month, or within extensive sandy soils, the slopes may have to be cut back even shallower than 1.0 horizontal to 1.0 vertical. Excavations in saturated soils should be reviewed by qualified experienced personnel.

It is considered unlikely that significant groundwater seepage will occur based on the groundwater data collected to date and our understanding of the development grades. Therefore, dewatering of excavations will most likely not be necessary. In localized areas, where groundwater may be encountered, conventional construction sump pumps should be capable of accommodating groundwater control at the depths anticipated for this project.

Temporary surcharge loads, such as spill piles, should not be allowed within a distance from an unsupported excavation face equal to the depth of excavation. Mobile equipment should be kept back at least 2.0 m. All excavations should be checked regularly for signs of sloughing, especially after rainfall periods. Small earth falls from the sideslopes are a potential danger to workmen and must be guarded against.

The moisture content of the soils encountered across the site may be both above and below the estimated Standard Proctor optimum moisture content for the materials. It is expected that such soils would be satisfactory as trench backfill material, however, may require moisture conditioning prior to reworking.

Trenches must be backfilled in such a way as to minimize the potential differential settlement and/or frost heave movements. A minimum density of 95 percent of SPD is recommended for all trench backfill, at a moisture content of between –1 percent and +2 percent of optimum. The exception is that the top 600 mm of all trenches should be compacted to 98 percent of SPD. The compacted thickness of each lift of backfill shall not exceed 150 mm. The upper 1.5 m of service trenches should be cut back at a maximum slope of 1.0 horizontal to 1.0 vertical to avoid an abrupt transition between backfill and in situ soil.

It should be noted that the ultimate performance of the trench backfill is directly related to the uniformity of the backfill compaction. In order to achieve this uniformity, the lift thickness and compaction criteria must be strictly enforced.

For frost protection, pipes buried with less than 2.1 m of soil cover (above top of pipe) should be protected with insulation to avoid frost effects that might cause damage to or breakage of the pipes. Rigid insulation placed under such areas subject to vehicular wheel loadings should be provided with a minimum thickness of 600 mm of compacted granular base.

General recommendations regarding construction excavation, backfill materials and compaction are contained in Appendix C.

6.6 CONCRETE TYPE

Two tests were conducted to determine the water-soluble sulphate content for soil samples recovered from this site. The test results indicate soluble sulphate contents in the order of 0.1 percent. Therefore, as per CSA A23.00 and EBA's experience in this area, the potential degree of sulphate attack on concrete may be considered to be moderate (Class S-3). Accordingly, the use of Sulphate Resistant Portland cement at a maximum water/cementing materials (W/CM) ratio 0.50 is recommended for foundation concrete and all concrete

exposed to soil and/or groundwater. If available, a proven flyash should be used as a supplemental cementing material. Based on EBA's experience with Alberta aggregates, a W/CM ratio of 0.50 normally corresponds to a 28-day compressive strength of 25 MPa or greater (30 MPa at 56-days). Stricter recommendations may be required due to structural or other considerations, or for exposure to de-icing chemicals.

Air entrainment of 4 to 6 percent by volume is recommended for all concrete exposed to freezing temperatures, native soils and/or groundwater. This should be increased to 5 to 7 percent for exterior flatwork.

6.7 PAVEMENTS

The following design for asphalt concrete surfaced pavement is provided for this development, if considered. Car and light-truck usage only has been assumed for the access road, with occasional to rare delivery truck, garbage disposal truck, and fire truck traffic.

DESIGN PAVEMENT SECTION	
MATERIAL TYPE	**LIGHT-DUTY (mm)**
Surface Course Asphalt Concrete (Type III)*	75
Granular Base Course*	200

* Current City of Lethbridge Transportation Detailed Engineering Standards or equivalent

The above recommended pavement layer thicknesses generally refer to average values and recognize typical construction variability. As constructed layer thicknesses should satisfy the thickness tolerances identified in the City of Lethbridge Engineering Standards for granular materials and asphalt concrete, or equivalent.

Subgrade support for pavements generally consists of dense granular soils. It should be recognized that the consistency of these materials, groundwater, site drainage, weather conditions, or other factors could impact the constructed subgrade support characteristics.

Immediately prior to paving, the upper 300 mm of native soils should be scarified, uniformly moisture conditioned to between minus 2 percent of optimum and 2 percent over optimum moisture content and uniformly recompacted to a minimum of 98 percent of SPD. Backfill to bring these areas to subgrade level should be general engineered fill materials only, as defined in this report. The subgrade should be prepared and graded to allow drainage to the shoulders, or ditches. Proof-rolling of the prepared surface is recommended to identify localized soft areas and for an indication of overall subgrade support characteristics.

It is imperative that positive surface drainage be provided to prevent ponding of water. Recommended minimum grades of 1.0 percent should be used in hard surfaced areas. Surrounding landscaping should be such that runoff water is prevented from ponding beside paved areas in order to avoid softening and premature failure of the pavement surface.

All asphalt paving lifts should be compacted to a minimum of Marshall design density. Additional recommended guidelines for design and construction of pavement structure are presented in Appendix C of this report.

If a granular pavement section is to be considered, it may be comprised of pit-run gravel with a minimum thickness of 300 mm. However, since the local pit-run gravel may be relatively coarse (large, rounded particles) and sandy, it will be difficult to blade smooth during regular maintenance. It is recommended that a surfacing layer of crushed gravel (granular base course) be placed within a nominal thickness of 50 mm, as this layer will be easier to maintain. All granular layers should be compacted to 100 percent of SPD. Recommendations for maintenance of gravel pavement are provided in Appendix C, "Maintenance of Gravelled Yards".

7.0 FOUNDATIONS

7.1 SHALLOW FOUNDATIONS

Shallow foundations, if considered, should be constructed approximately 1.5 m below the final design exterior ground surface (frost protection requirement). At this depth the foundation subgrade soil generally will consist of dense granular soils. It is noted that the northwest area of the site will require special consideration in areas of shallow bedrock (see the shallow bedrock line shown on Figure 1).

The net allowable static bearing pressure for the design of strip and spread footings at this depth may be taken as 100 kPa, on native, undisturbed soils, subject to other recommendations in this report. The allowable static bearing pressure is based on correlation between Standard Penetration Test 'N' values. The factor of safety used from ultimate bearing capacity was 3.0. Footing dimensions should be in accordance with the minimum requirements of the Alberta Building Code 1997 (Section 9.15.3 Footings). Bearing certification is recommended to ensure that the footings are placed on competent native soil. If saturated sand soils are encountered, recommendations may be provided to lower the footing level if deemed necessary at the time of bearing certification.

It is recommended that the final excavation to the foundation subgrade elevation should be intended to minimize disturbance of the founding soils. The foundation concrete should be placed immediately following excavation to ensure the bearing soil does not dry out.

A permanent weeping tile system is also recommended around the outside perimeter of structures at the foundation elevation where the founding soils consist of cohesive soils. In granular soils which occurs a minimum of 1 m below the foundations, a weeping tile system is not warranted as the granular deposit will act as a drainage blanket to maintain a consistent moisture profile of the founding soils. This will reduce the potential of differential movement (heave or consolidation of cohesive soils) of the foundations. Weeping tile drainage is discussed in a separate section.

Settlement of footings designed and constructed in accordance with the above recommendations should be well within the normally tolerated values of 25 mm total and 20 mm differential.

For protection against frost action, perimeter footings in heated structures should be extended to such depths as to provide a minimum soil cover of 1.5 m. Isolated or exterior footings in unheated structures should have a minimum soil cover of 2.1 m unless provided with equivalent insulation.

For houses built on sloped terrain, particularly walk-out basements, uneven horizontal pressures from soil surcharge loading acting on the structure should be considered, due to the relatively deep foundation wall on the upslope side of the residence and shallower foundations on the downgradient side. It is important for the foundation designer to consider such uneven forces on the foundation particularly in the detailing of perimeter step footings and walls. EBA may be contacted for a technical discussion; however, the foundation design is beyond the scope of this assignment.

Further recommendations regarding shallow foundations are given in Appendix C.

7.2 BASEMENT CONSTRUCTION

7.2.1 Basement Floor Slabs

Slab-on-grade construction for basements is considered feasible providing certain precautions are undertaken. All excavation should be carried out remotely using appropriate equipment at final grade in order to minimize disturbance of the base. Basement floor slabs should be supported by a minimum of 150 mm compacted, clean, free-draining granular material.

Some movement of basement floor slabs should be anticipated due to soil volume changes in cohesive soils. Any light columns in the basement designed to support the main floor of should be of the adjustable "telepost" type. If partitions are constructed in the basement, provision must be made so that, if the basement floor slab heaves, the partitions do not raise the main floor. A minimum allowance of 25 mm should be left between the top plates of basement partitions and the floor above them to accommodate heaving of the floor slab. This heaving allowance is less applicable for interior columns founded on spread footings.

The slab subgrade should be sloped to provide positive drainage to the edge of the slab (where the native soils are cohesive). A minimum drainage gradient of 0.5 percent is recommended.

Slabs-on-grade should be separated from bearing members to allow some differential movement. If differential movement is unacceptable, a structurally supported floor system or crawlspace may be considered.

General recommendations regarding floor slab construction are also presented in Appendix C.

7.2.2 Basement Walls

All basement walls should be designed to resist lateral earth pressures in an "at-rest" condition. This condition assumes a triangular pressure distribution and may be calculated using the following:

$$P_o = K_o (\gamma H + q)$$

where:

P_o	=	lateral earth pressure "at-rest" condition (no wall movement occurs at a given depth)
K_o	=	co-efficient of earth pressure "at-rest" condition (use 0.5 for silt or clay backfill and 0.45 for sand and gravel backfill)
γ	=	bulk unit weight of backfill soil (use 19 or 21 kN/m^3 for clay or granular backfill, respectively)
H	=	depth below final grade (m)
q	=	surcharge pressure at ground level (kPa)

It is assumed that drainage is provided for all basement walls through the installation of weeping tile and hydrostatic pressures will not be a factor in design.

An acceptable weeping tile system should consist of a perforated weeping tile wrapped in a geosock or geotextile fabric, in turn surrounded with a minimum of 150 mm thick blanket of washed rock (maximum size 20 mm). The weeping tile should have a minimum 0.5 percent slope leading to a sump with a pump to then discharge away from the foundation.

Backfill around concrete basement walls should not commence before the concrete has reached a minimum two-thirds of its 28-day strength and first floor framing are in place or the walls are laterally braced. Only hand operated compaction equipment should be employed within 600 mm of the concrete walls. Caution should be used when compacting backfill to avoid high lateral loads caused by excessive compactive effort. A compaction standard of 95 percent of Standard Proctor maximum dry density (SPD) is recommended. To avoid differential wall pressures, the backfill should be brought up evenly around the walls. A minimum 600 mm thick clay cap should be placed at the ground surface to minimize the infiltration of surface water.

7.3 FROST PROTECTION

For protection against frost action, perimeter footings in heated structures should be extended to such depths as to provide a minimum soil cover of 1.5 m. Isolated or exterior footings in unheated structures should have a minimum soil cover of 2.1 m unless provided with equivalent insulation.

7.4 SEISMIC DESIGN

A seismic foundation factor of 1.0 is recommended.

8.0 SLOPE STABILITY EVALUATION

8.1 GENERAL

EBA's slope stability evaluation for this project comprised an analysis of the present stability of the lower slope abutting the south limits of the property and the upper slope abutting the north limits of the property, an analysis of the impact of the subdivision development on the stability of the slopes and an analysis of the impact of any potential slope instability on the development, i.e. setback requirements. These aspects are detailed in the following sections. The Factor of Safety (FS) used to determine the setback requirements was 1.5. This FS is typically used for developments of this nature in the current standard of practice.

Development of the site will bring about changes in the factors which contribute to the present stability of the slopes. Evaporation of soil moisture will be reduced by the presence of ground cover such as buildings and roadway structures. Irrigation and possible leakage of water from underground utilities will increase the amount of water infiltrating the site subsoils. This combination of reduced evaporation of subsoil moisture and increased infiltration of water to the subsoils is considered to be the most significant influence of development on the factors that contribute to the present stability of the slopes. Increasing soil moisture content produces a reduction in the total cohesion as the apparent cohesion is reduced or lost and an increase in the pore pressure ratio reduces the effective stress. The result is a corresponding decrease in the factor of safety.

The stability analyses was completed, with the above considerations, using the appropriate soil parameters in order to obtain a minimum Factor of Safety of 1.5 against instability of the both slopes. This analysis established the development setback lines as presented in Section 9.0.

8.2 SLOPE STABILITY

The stability of the slopes of this study has been evaluated based on site reconnaissance and analytical techniques. Visual observations of the slopes in the project area indicate the slopes are currently stable. There is no evidence of recent slope instability along the slopes of the study area.

Soil strength parameters assumed by EBA were based on the results of moisture content and grain size analysis tests conducted by EBA on soil samples recovered from the development site and based on experience by EBA for other sites in similar soil conditions. The upper slope has been assumed to have relatively thin granular soils overlying shallow bedrock. Groundwater conditions reasonably expected from the data collected in the fieldwork, laboratory program, and from information reviewed from past studies were then selected by EBA to satisfy the observed conditions.

The soil strength parameters selected for the analyses, modelling current conditions, are as follows. The order presented is the stratigraphic profile from ground surface to below the base of the slopes being analyzed.

- Materials: Gravel

Unit Weight:	22 kN/m^3
Cohesive Intercept c':	0 kPa
Friction Angle ϕ':	33°

- Material: Sand / Silt

Unit Weight:	21 kN/m^3
Cohesive Intercept c':	0 kPa
Friction Angle ϕ':	33°

- Material: Lower Gravel with Clay

Unit Weight:	20 kN/m^3
Cohesive Intercept c':	0 kPa
Friction Angle ϕ':	30°

- Materials: Bedrock Surface

  Top bedrock layer: Weathered Clay (CI-CH)

Unit Weight:	21 kN/m^3
Cohesive Intercept c':	0 kPa
Friction Angle ϕ_p' (peak):	19°

The current stability of the slopes adjacent to the project site has been evaluated by means of limit equilibrium analyses conducted on typical cross-sections of the slope. It is noted that, both shallow failures as well as deeper seated failures on the bedrock surface (assumed weakened bedrock surface) have been analyzed. The slope profiles for the cross-sections

were derived from the topographic survey provided by EBA (Figure 1), and from EBA's observations on site, where survey data was missing.

Slope stability analyses on the slope cross-sections, using the above parameters, indicate that the existing slopes are stable. For the lower slope, with respect to moderate depth instability affecting the slope crests, the minimum factor of safety is 1.5 and with respect to shallow slope face failures, the minimum factor of safety is 1.1. From this analysis, it is confirmed that a theoretical slope failure within the upper granular layer is the governing slope failure mechanism for the lower slope for consideration in this evaluation.

The approach used in the stability analysis was to first establish the existing Factor of Safety against slope instability using the strength parameters indicated above. For the lower slope, successive points set back from the crest of the slopes were then selected and minimum factors of safety were calculated modelling post-development groundwater levels and partially saturated slope conditions, respectively. For the upper slope, the gradient of the upper slope was considered in each instance, to determine the maximum natural slope angle where a minimum factor of safety of 1.5 is maintained. This maximum slope angle has been determined as 21 degrees.

Based on the analysis, a development setback line was established to provide a Factor of Safety of 1.5 against slope failure for the assumed post development groundwater condition. The location of the setback line was also checked to confirm that a reasonable Factor of Safety exists for anticipated worst case groundwater conditions. The limits of the proposed development setback line established by EBA are described in Section 9.0.

9.0 RECOMMENDED DEVELOPMENT GUIDELINES

For post-development conditions for the lower slope the recommended 'Development Setback Line'[1] is as shown on Figure 1, which is a distance of 30 m in from the Top of Bank. The development setback distance has been determined by establishing the location behind the Top of Bank where the Factor of Safety is 1.5.

For the upper slope, the Development Setback Line was established with the assumption that the maximum developable slope angle is 21 degrees allowing a minimum Factor of Safety of 1.5. The Development Setback Line for the upper slope is shown on Figure 1 also.

The development restriction zone is defined as the area above the development setback line for the upper slope and between the development line and the Top of Bank for the lower slope. This area should generally be left undisturbed.

---

2 Development Setback Line: established by survey which subsequently is registered on a plan of subdivision which determines the extent of development in relation to the Top of Bank.

It is recommended that the development setback lines shown on Figure 1 be established by field survey with EBA in attendance to confirm the location of the Top of Bank and development setback lines prior to any development of the proposed land. The 'surveyed' lines should then form part of the individual lot boundaries for the Real Survey Report of each lot.

Precautionary measures which should be included in the design of the proposed development (with respect to slope stability issues) are outlined as follows:

- Septic disposal fields should be located as far away from slopes as practical.
- Any fill excavated during development should not be disposed of within the development restriction zone unless directed otherwise after a review by the project geotechnical engineer.
- Positive grading should be provided to ensure surface drainage from the development is directed as either sheet flow, away from the lower slope, in particular, and into the property's stormwater management system.
- All utilities and plumbing should be carefully installed and inspected to ensure they are in good working order.
- Normal, prudent design and construction procedures should be followed during development.
- In their current condition, the stability of the slopes is considered acceptable in normally expected events (i.e., seismic, rainfall, snowfall, wind). Instability may occur during extreme events with a likely consequence of shallow sloughing of over-steepened areas of the slope (debris flow), as well as possible erosion of the existing vegetation and topsoil cover of the slopes.
- Some local ravelling and 'toppling' of boulders/bedrock may also occur in these extreme weather instances or due to development. The analysis does not preclude these types of events from occurring. The risk of damages must be understood and borne by the Owner of the residence when developing in these types of terrain.
- There may be a concern regarding the threat of damages due to avalanches from higher elevations. Although there does not appear to be a significant risk, due care should be taken in siting for residential structures. The risks associated with avalanches have not been addressed herein.

The slopes should be treated as a restricted development zone. This involves:

- No excavation on the slopes without review by a geotechnical engineer.
- No clearing of vegetation except those necessary for house construction.
- No fill to be placed on the crest of the slopes or on the slopes.
- Maintain vegetation cover along the crests and on the slopes.

Notwithstanding the setback distances discussed above, some sloughing and slope movements may occur. The development may result in a general increase in the degree of saturation of the site subsoils which may cause minor sloughing of the slopes, particularly the top portion of the lower slope. The setback distance is not intended to prevent failure of the slope but rather to prevent such failures from directly affecting developed areas of the site.

10.0 DESIGN AND CONSTRUCTION GUIDELINES

Recommended general design and construction guidelines are provided in Appendix C, under the following headings.

- Construction Excavations
- Backfill Materials and Compaction
- Proof-Rolling
- Shallow Foundations
- Floor Slabs-on-Grade
- Pavements
- Maintenance of Gravelled Yards

These guidelines are intended to present standards of good practice. Although supplemental to the main text of this report, they should be interpreted as part of the report. Design recommendations presented herein are based on the premise that these guidelines will be followed. The design and construction guidelines are not intended to represent detailed specifications for the works although they may prove useful in the preparation of such specifications. In the event of any discrepancy between the main text of this report and Appendix C, the main text should govern.

11.0 REVIEW OF DESIGN AND CONSTRUCTION

EBA should be given the opportunity to review details of the design and specifications, related to geotechnical aspects of this project, prior to construction.

Bearing surfaces and foundation installation should be monitored by qualified geotechnical personnel during construction. EBA will provide these services, if requested.

12.0 LIMITATIONS

Recommendations presented herein are based on a geotechnical evaluation of the findings from 22 boreholes drilled for this evaluation, a visual site reconnaissance, a review as part of a separate hydroegological assessment by EBA, and a review of the UMA evaluation from 1997. The conditions encountered during the fieldwork are considered to be reasonably representative of the site. If, however, conditions other than those reported are noted during subsequent phases of the project, EBA should be notified and given the opportunity to review our current recommendations in light of new findings. Recommendations presented herein may not be valid if an adequate level of monitoring is not provided during construction. It is recommended EBA be given the opportunity to review the development plans prior to implementation.

This report has been prepared for the exclusive use of Mr. Richard Koentges, and his agents for specific application to the development described in this report. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty is made, either express or implied.

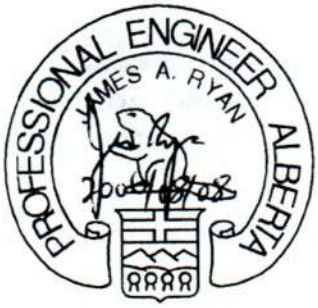
This report incorporates and is subject to the General Conditions presented in Appendix A.

13.0 CLOSURE

We trust this report satisfies your present requirements. We would be pleased to provide further information that may be needed during design and to advise on the geotechnical aspects of specifications for inclusion in contract documents. Should you require additional information or monitoring services, please contact our office.

Respectfully submitted,
EBA Engineering Consultants Ltd.

Prepared by:



J.A. (Jim) Ryan, P.Eng.
Project Engineer

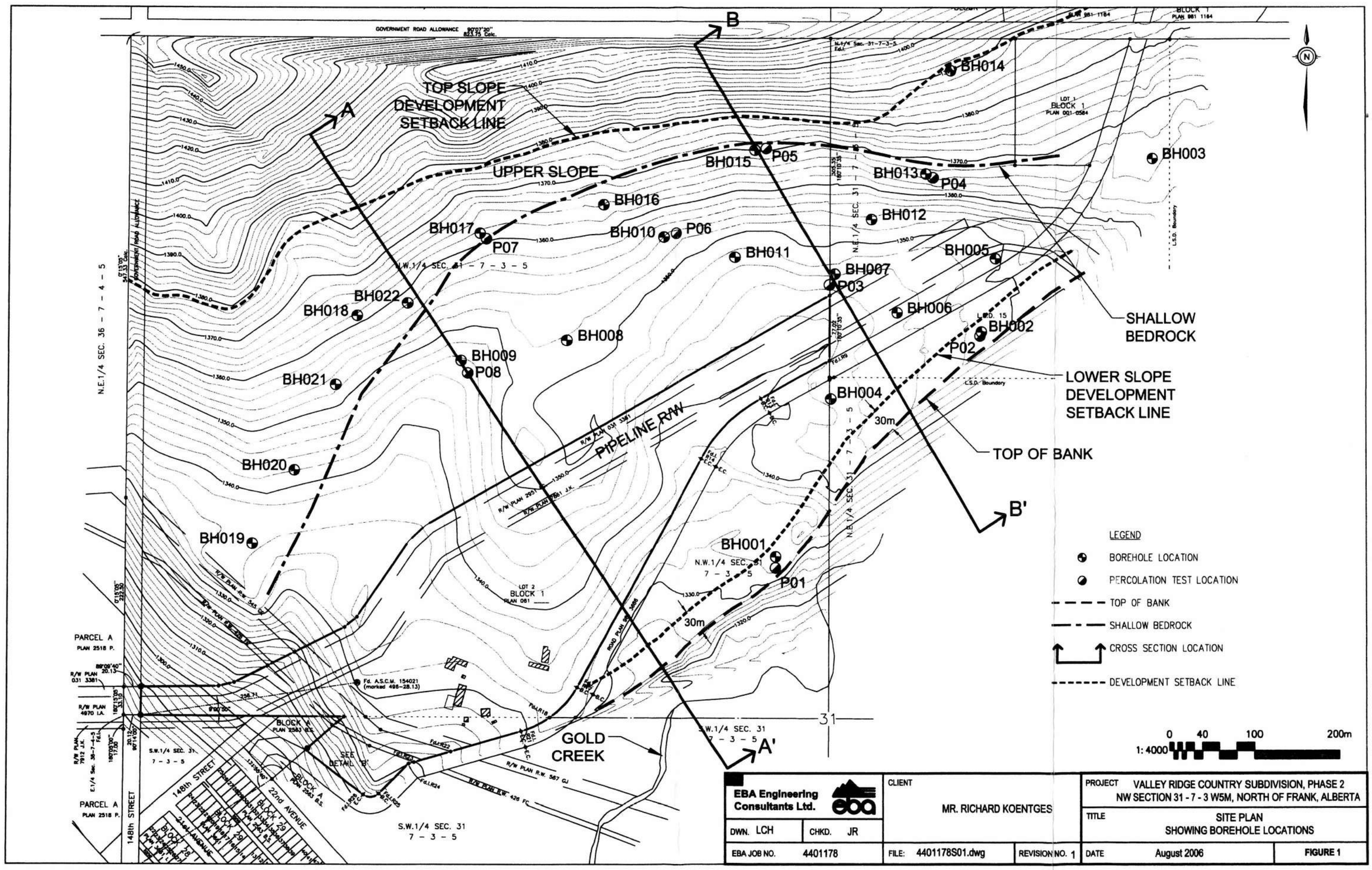
Reviewed by:

Marc Sabourin, P.Eng.
Senior Project Engineer

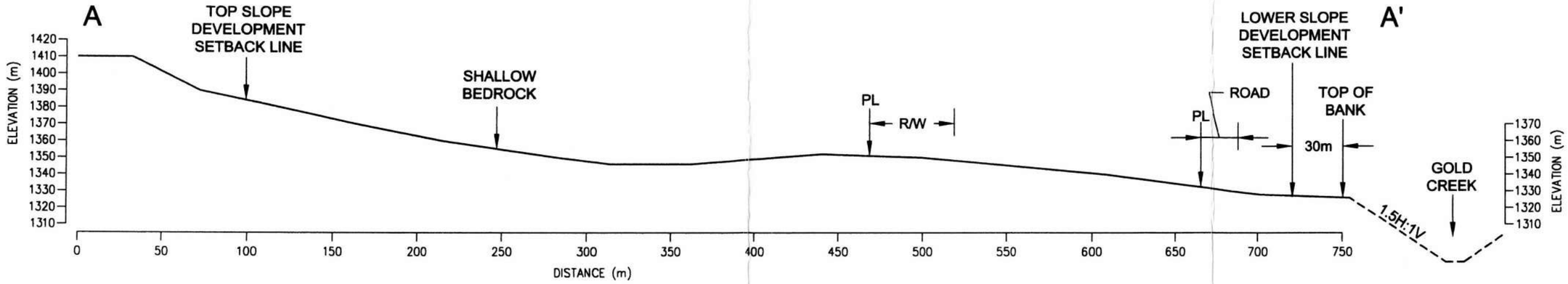
/cld

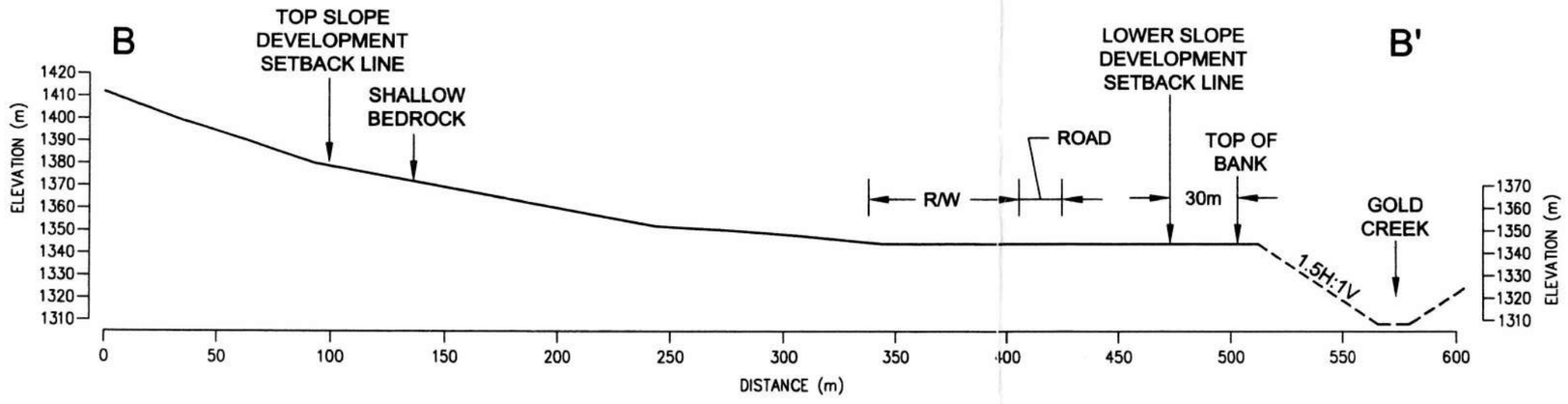
PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature _____
Date Aug 8, 06
PERMIT NUMBER: P245
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

FIGURES



EBA Engineering Consultants Ltd.	CLIENT MR. RICHARD KOENTGES	PROJECT VALLEY RIDGE COUNTRY SUBDIVISION, PHASE 2 NW SECTION 31 - 7 - 3 W5M, NORTH OF FRANK, ALBERTA	
DWN. LCH / CHKD. JR		TITLE SITE PLAN SHOWING BOREHOLE LOCATIONS	
EBA JOB NO. 4401178	FILE: 4401178S01.dwg / REVISION NO. 1	DATE August 2006	FIGURE 1





1: 2500 (0, 50, 100m)

EBA Engineering Consultants Ltd.	CLIENT: MR. RICHARD KOENTGES	PROJECT: VALLEY RIDGE COUNTRY SUBDIVISION, PHASE 2 NW SECTION 31 - 7 - 3 W5M, NORTH OF FRANK, ALBERTA	
DWN. LCH / CHKD. JR		TITLE: CROSS SECTIONS	
EBA JOB NO. 4401178	FILE: 4401178X01.dwg / REVISION NO. 1	DATE: August 2006	FIGURE 2

APPENDIX

APPENDIX A GEOTECHNICAL REPORT – GENERAL CONDITIONS

GEOTECHNICAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA's client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

3.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

4.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

5.0 SURFACE WATER AND GROUNDWATER CONDITIONS

Surface and groundwater conditions mentioned in this report are those observed at the times recorded in the report. These conditions vary with geological detail between observation sites; annual, seasonal and special meteorologic conditions; and with development activity. Interpretation of water conditions from observations and records is judgmental and constitutes an evaluation of circumstances as influenced by geology, meteorology and development activity. Deviations from these observations may occur during the course of development activities.

6.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

7.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

APPENDIX

APPENDIX B BOREHOLE LOGS

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 to 20%	0 to 4
Loose	20 to 40%	4 to 10
Compact	40 to 75%	10 to 30
Dense	75 to 90%	30 to 50
Very Dense	90 to 100%	greater than 50

The number of blows, N, on a 51mm O.D. split spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (kPa)
Very Soft	Less Than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater Than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided	- having inclined planes of weakness that are slick and glossy in appearance.
Fissured	- containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated	- composed of thin layers of varying colour and texture.
Interbedded	- composed of alternate layers of different soil types.
Calcareous	- containing appreciable quantities of calcium carbonate.
Well Graded	- having wide range in grain sizes and substantial amounts of intermediate particle sizes.
Poorly graded	- predominantly of one grain size, or having a range of sizes with some intermediate size missing.

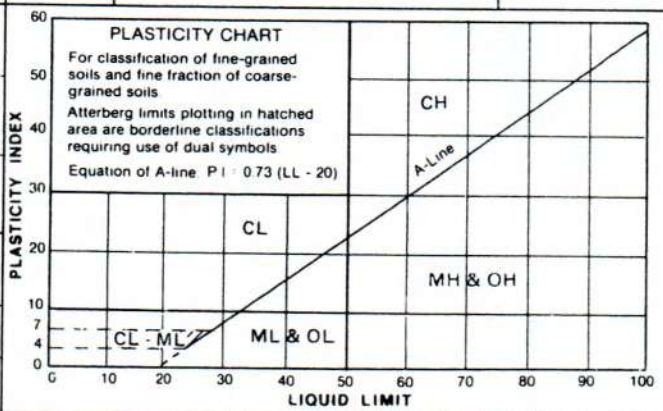
eba

UNIFIED SOIL CLASSIFICATION †

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES	CLASSIFICATION CRITERIA
COARSE-GRAINED SOILS More than 50% retained on No 200 sieve *	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	$C_u = D_{60}/D_{10}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines	Not meeting both criteria for GW
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits plot below "A" line or plasticity index less than 4
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits plot above "A" line and plasticity index greater than 7
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines	$C_u = D_{60}/D_{10}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			SP	Poorly graded sands and gravelly sands, little or no fines	Not meeting both criteria for SW
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures	Atterberg limits plot below "A" line or plasticity index less than 4
			SC	Clayey sands, sand-clay mixtures	Atterberg limits plot above "A" line and plasticity index greater than 7
FINE-GRAINED SOILS 50% or more passes No 200 sieve *	SILTS AND CLAYS Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL	Organic silts and organic silty clays of low plasticity	
	SILTS AND CLAYS Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts	
			CH	Inorganic clays of high plasticity, fat clays	
			OH	Organic clays of medium to high plasticity	
HIGHLY ORGANIC SOILS			Pt	Peat, muck and other highly organic soils	

Classification on basis of percentage of fines
Less than 5% Pass No. 200 sieve — GW, GP, SW, SP
More than 12% Pass No 200 sieve — GM, GC, SM, SC
5% to 12% Pass No 200 sieve — Borderline Classification requiring use of dual symbols

Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols



* Based on the material passing the 3-in. (75-mm) sieve
† ASTM Designation D 2487

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 001
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1332 m

SAMPLE TYPE ■ DISTURBED ▨ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)		SAMPLE TYPE	SAMPLE NO	PLASTIC — M.C. — LIQUID (20 40 60 80)	ELEVATION(m)
0.0	TOPSOIL – clay, silty, sandy, moist, dark brown, root & root hairs				1332.0
1.0	GRAVEL – sandy, silty, trace to some clay, poorly graded, sizes to boulders, subround & round, moist, dense, brown		B1	●	1331.0
2.0			B2	●	1330.0
3.0			B3		1329.0
4.0			B4	●	1328.0
5.0			B5		1327.0
6.0			B6	●	1326.0
7.0	CLAY – silty, sandy, some gravel to gravelly, moist, very stiff, low to medium plastic, dark brown		B7		1325.0
8.0			B8	●	1324.0
9.0	... grey mottling, free water		B9		1323.0
10.0	End of Borehole @ 8.0m		B10	●	1322.0
11.0	Auger Refusal @ 8.0m		B11		1321.0
12.0	No Seepage or Sloughing on Completion		B12	●	1320.0
13.0	Slotted PVC Standpipe Installed to 6.4m		B13		1319.0
14.0	Borehole Measured Dry on Aug. 1, 2006				1318.0
15.0					1317.0
16.0					1316.0

EBA Engineering Consultants Ltd.	LOGGED BY: JHC	COMPLETION DEPTH: 8 m
	REVIEWED BY: JAR	COMPLETE: 06/06/05
	Fig. No: B1	Page 1 of 1

08/08/02 02:37PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 002
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1348 m

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

Symbols for SOILS

Depth(m)		SAMPLE TYPE	SAMPLE NO	ELEVATION(m)
0.0	TOPSOIL – clay, silty, sandy, moist, dark brown, root & root hairs			1348.0
	GRAVEL – sandy, silty, trace to some clay, poorly graded, sizes to boulders, subround & round, moist, dense, brown		B1	
1.0			B2	1347.0
2.0			B3	1346.0
			B4	
3.0			B5	1345.0
4.0			B6	1344.0
			B7	
5.0			B8	1343.0
			B9	
6.0	CLAY – silty, sandy, some gravel to gravelly, moist, very stiff, low to medium plastic, dark brown		B10	1342.0
			B11	
7.0			B12	1341.0
8.0			B13	1340.0
			B14	
9.0			B15	1339.0
10.0	... free water		B16	1338.0
			B17	
11.0	... grey ... soluble sulphate content = 0.1% @ 11.0m		B18	1337.0
			B19	
12.0	... moist ... soluble sulphate content = 0.1% @ 12.2m		B20	1336.0
13.0			B21	1335.0
			B22	
14.0	End of Borehole @ 13.6m Auger Refusal @ 13.6m No Seepage or Sloughing on Completion Slotted PVC Standpipe Installed to 9.8m Indicated Water Level Measured Aug. 1, 2006			1334.0
15.0				1333.0
16.0				1332.0

PLASTIC — M.C. — LIQUID
20 40 60 80

EBA Engineering Consultants Ltd.

LOGGED BY: JHC	COMPLETION DEPTH: 13.6 m
REVIEWED BY: JAR	COMPLETE: 06/06/05
Fig. No: B2	Page 1 of 1

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PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 003
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1366 m

SAMPLE TYPE ■ DISTURBED ▨ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)		SAMPLE TYPE	SAMPLE NO	PLASTIC — M.C. — LIQUID (20 40 60 80)	ELEVATION(m)
0.0	GRAVEL – sandy, silty, trace to some clay, poorly graded, sizes to cobbles, subround & round, moist, dense, brown		B1		1366.0
1.0	CLAY – silty, some sand to sandy, very moist, firm to stiff, medium plastic, dark brown, sand lenses & pockets with free water		B2		1365.0
2.0	... gravelly, brown		B3		1364.0
			B4		
3.0			B5		1363.0
			B6		
4.0			B7		1362.0
5.0	... free water		B8		1361.0
			B9		
6.0	BEDROCK – sandstone, silty, fine grained, moderate strength, slightly weathered, greenish brown				1360.0
	End of Borehole @ 5.5m				
7.0	Auger Refusal @ 5.5m				1359.0
	No Seepage or Sloughing on Completion				
8.0	Slotted PVC Standpipe Installed to 4.9m				1358.0
	Borehole Measured Dry on Aug. 1, 2006				
9.0					1357.0
10.0					1356.0
11.0					1355.0
12.0					1354.0
13.0					1353.0
14.0					1352.0
15.0					1351.0
16.0					1350.0

EBA Engineering Consultants Ltd.

LOGGED BY: JHC	COMPLETION DEPTH: 5.5 m
REVIEWED BY: JAR	COMPLETE: 06/06/05
Fig. No: B3	Page 1 of 1

06/08/02 02:37PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 004
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1342 m

SAMPLE TYPE ■ DISTURBED ▨ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)	SAMPLE TYPE	SAMPLE NO	PLASTIC — M.C. — LIQUID (20 40 60 80)	ELEVATION(m)
0.0				1342.0
TOPSOIL – clay, silty, sandy, moist, dark brown, root & root hairs				
GRAVEL – sandy, silty, trace to some clay, poorly graded, sizes to boulders, subround & round, moist, dense, brown		B1	●	
1.0				1341.0
		B2	●	
2.0				1340.0
		B3	●	
		B4	●	
3.0				1339.0
		B5		
CLAY – silty, sandy, some gravel to gravelly, moist, very stiff, low to medium plastic, dark brown		B6	●	
4.0				1338.0
		B7	●	
5.0				1337.0
		B8	●	
		B9		
6.0				1336.0
		B10	●	
End of Borehole @ 6.1m				
No Seepage or Sloughing on Completion				
Slotted PVC Standpipe Installed to 3.0m				
Borehole Measured Dry on Aug 1, 2006				
7.0				1335.0
8.0				1334.0
9.0				1333.0
10.0				1332.0
11.0				1331.0
12.0				1330.0
13.0				1329.0
14.0				1328.0
15.0				1327.0
16.0				1326.0

EBA Engineering Consultants Ltd.

LOGGED BY: JHC	COMPLETION DEPTH: 6.1 m
REVIEWED BY: JAR	COMPLETE: 06/06/05
Fig. No: B4	Page 1 of 1

06/08/02 02:37PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 005
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1350 m

SAMPLE TYPE ■ DISTURBED ⊘ NO RECOVERY ⊠ SPT ☰ A-CASING ▯▯ SHELBY TUBE ▮▯ CORE

Symbols for SOILS

Depth(m)	SAMPLE TYPE	SAMPLE NO	PLASTIC — M.C. — LIQUID (20 40 60 80)	ELEVATION(m)
0.0				1350.0
GRAVEL – sandy, some silt, trace clay, poorly graded, sizes to 75mm, round & subround, damp to moist, dense, brown	■	B1	●	
1.0				1349.0
... moist	■	B2	●	
2.0	■	B3	●	1348.0
End of Borehole @ 2.7m				
3.0				1347.0
Auger Refusal @ 2.7m				
No Seepage or Sloughing on Completion				
Slotted PVC Stanpipe Installed to 2.7m				
4.0 Borehole Measured Dry on Aug. 1, 2006				1346.0
5.0				1345.0
6.0				1344.0
7.0				1343.0
8.0				1342.0
9.0				1341.0
10.0				1340.0
11.0				1339.0
12.0				1338.0
13.0				1337.0
14.0				1336.0
15.0				1335.0
16.0				1334.0

EBA Engineering Consultants Ltd.

LOGGED BY: PC	COMPLETION DEPTH: 2.7 m
REVIEWED BY: JAR	COMPLETE: 06/07/18
Fig. No: B5	Page 1 of 1

06/08/02 02:37PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 006
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1345 m

SAMPLE TYPE ■ DISTURBED ▨ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)	SAMPLE TYPE	SAMPLE NO	PLASTIC — M.C. — LIQUID (20 40 60 80)	ELEVATION(m)
0.0				1345.0
GRAVEL – sandy, some silt, trace clay, poorly graded, sizes to 75mm, round & subround, damp to moist, dense, brown		B1	•	
1.0				1344.0
... moist		B2	•	
2.0		B3	•	1343.0
		B4	•	
3.0				1342.0
End of Borehole @ 3.0m				
Auger Refusal @ 3.0m				
No Seepage or Sloughing on Completion				
Slotted PVC Stanpipe Installed to 3.0m				
Borehole Measured Dry on Aug. 1, 2006				
4.0				1341.0
5.0				1340.0
6.0				1339.0
7.0				1338.0
8.0				1337.0
9.0				1336.0
10.0				1335.0
11.0				1334.0
12.0				1333.0
13.0				1332.0
14.0				1331.0
15.0				1330.0
16.0				1329.0

EBA Engineering Consultants Ltd.

LOGGED BY: PC	COMPLETION DEPTH: 3 m
REVIEWED BY: JAR	COMPLETE: 06/07/18
Fig. No: B6	Page 1 of 1

06/08/02 02:38PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 007
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1346 m

SAMPLE TYPE ■ DISTURBED ▨ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)	SAMPLE TYPE	SAMPLE NO	PLASTIC — M.C. — LIQUID (20 40 60 80)	ELEVATION(m)
0.0				1346.0
GRAVEL – sandy, some silt, trace clay, poorly graded, sizes to 75mm, round & subround, moist, dense, brown	■	B1	●	
1.0	■	B2	●	1345.0
End of Borehole @ 1.2m				
Auger Refusal @ 1.2m				
No Seepage or Sloughing on Completion				
2.0				1344.0
3.0				1343.0
4.0				1342.0
5.0				1341.0
6.0				1340.0
7.0				1339.0
8.0				1338.0
9.0				1337.0
10.0				1336.0
11.0				1335.0
12.0				1334.0
13.0				1333.0
14.0				1332.0
15.0				1331.0
16.0				1330.0

EBA Engineering Consultants Ltd.

LOGGED BY: PC	COMPLETION DEPTH: 1.2 m
REVIEWED BY: JAR	COMPLETE: 06/07/18
Fig. No: B7	Page 1 of 1

06/08/02 02:38PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 008
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1352 m

SAMPLE TYPE ■ DISTURBED ⊘ NO RECOVERY ⊠ SPT ▤ A-CASING ▥ SHELBY TUBE ◧ CORE

Symbols for SOILS

PLASTIC — M.C. — LIQUID (20 40 60 80)

Depth(m)	Description	SAMPLE TYPE	SAMPLE NO	ELEVATION(m)
0.0	CLAY – silty, sandy, gravelly, sizes to cobble size, very moist, stiff, low to medium plastic, dark brown		B1	1352.0
1.0			B2	1351.0
2.0			B3	1350.0
			B4	
3.0			B5	1349.0
4.0	... free water, soft to firm		B6	1348.0
			B7	
5.0			B8	1347.0
			B9	
	End of Borehole @ 5.2m			
6.0	Auger Refusal @ 5.2m Seepage & Sloughing from 3.7m Slotted PVC Standpipe Installed to 5.2m Indicated Water Level Measured Aug 1, 2006			1346.0
7.0				1345.0
8.0				1344.0
9.0				1343.0
10.0				1342.0
11.0				1341.0
12.0				1340.0
13.0				1339.0
14.0				1338.0
15.0				1337.0
16.0				1336.0

EBA Engineering Consultants Ltd.

LOGGED BY: PC	COMPLETION DEPTH: 5.2 m
REVIEWED BY: JAR	COMPLETE: 06/07/18
Fig. No: B8	Page 1 of 1

06/08/02 02:38PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 009
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1346 m

SAMPLE TYPE ■ DISTURBED ▨ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)		SAMPLE TYPE	SAMPLE NO	PLASTIC / M.C. / LIQUID (20 40 60 80)	ELEVATION(m)
0.0	CLAY – silty, sandy, gravelly, sizes to cobble size, very moist, stiff, low to medium plastic, dark brown	■	B1	●	1346.0
1.0	SAND – silty, trace clay, some gravel to gravelly, poorly graded, fine grained, moist, compact to dense, dark brown	■	B2	●	1345.0
2.0	... free water	■	B3	●	1344.0
	End of Borehole @ 2.1m				
3.0	Auger Refusal @ 2.1m Seepage & Sloughing from 0.9m				1343.0
4.0					1342.0
5.0					1341.0
6.0					1340.0
7.0					1339.0
8.0					1338.0
9.0					1337.0
10.0					1336.0
11.0					1335.0
12.0					1334.0
13.0					1333.0
14.0					1332.0
15.0					1331.0
16.0					1330.0

EBA Engineering Consultants Ltd.

LOGGED BY: PC	COMPLETION DEPTH: 2.1 m
REVIEWED BY: JAR	COMPLETE: 06/07/18
Fig. No: B9	Page 1 of 1

06/08/02 02:38PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 010
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1354 m

SAMPLE TYPE ■ DISTURBED ▨ NO RECOVERY ⊠ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)	SAMPLE TYPE	SAMPLE NO	PLASTIC / M.C. / LIQUID (20 40 60 80)	ELEVATION(m)
0.0				1354.0
GRAVEL – sandy, some silt, trace clay, poorly graded, sizes to 75mm, round & subround, moist, dense, brown	■	B1	●	
1.0				1353.0
	■	B2	●	
2.0				1352.0
	—	B3	●	
End of Borehole @ 2.1m				
Auger Refusal @ 2.1m				
No Seepage or Sloughing on Completion				
3.0				1351.0
4.0				1350.0
5.0				1349.0
6.0				1348.0
7.0				1347.0
8.0				1346.0
9.0				1345.0
10.0				1344.0
11.0				1343.0
12.0				1342.0
13.0				1341.0
14.0				1340.0
15.0				1339.0
16.0				1338.0

EBA Engineering Consultants Ltd.

LOGGED BY: PC	COMPLETION DEPTH: 2.1 m
REVIEWED BY: JAR	COMPLETE: 06/07/18
Fig. No: B10	Page 1 of 1

06/08/02 02:38PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 011
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1347 m

SAMPLE TYPE ■ DISTURBED ▨ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)	SAMPLE TYPE	SAMPLE NO	PLASTIC — M.C. — LIQUID (20 40 60 80)	ELEVATION(m)
0.0				1347.0
GRAVEL – sandy, some silt, trace clay, poorly graded, sizes to 75mm, round & subround, moist, dense, brown		B1		
1.0				1346.0
		B2		
... very moist		B3		
2.0 ... wet				1345.0
		B4		
3.0		B5		1344.0
		B6		
... some clay				
4.0 ... free water		B7		1343.0
		B8		
5.0				1342.0
		B9		
End of Borehole @ 5.5m				
6.0 Seepage & Sloughing from 3.9m				1341.0
Slotted PVC Standpipe Insatlled to 5.5m				
Indicated Water Level Measured Aug. 1, 2006				
7.0				1340.0
8.0				1339.0
9.0				1338.0
10.0				1337.0
11.0				1336.0
12.0				1335.0
13.0				1334.0
14.0				1333.0
15.0				1332.0
16.0				1331.0

EBA Engineering Consultants Ltd.

LOGGED BY: PC	COMPLETION DEPTH: 5.5 m
REVIEWED BY: JAR	COMPLETE: 06/07/18
Fig. No: B11	Page 1 of 1

06/08/02 02:38PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 012
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1354 m

SAMPLE TYPE ■ DISTURBED ▨ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)		SAMPLE TYPE	SAMPLE NO	PLASTIC / M.C. / LIQUID (20 40 60 80)	ELEVATION(m)
0.0	GRAVEL – sandy, some silt, trace clay, poorly graded, sizes to 75mm, round & subround, moist, dense, brown	■	B1	●	1354.0
1.0	End of Borehole @ 1.0m	■	B2	●	1353.0
	Auger Refusal @ 1.0m				
	No Seepage or Sloughing on Completion				
2.0					1352.0
3.0					1351.0
4.0					1350.0
5.0					1349.0
6.0					1348.0
7.0					1347.0
8.0					1346.0
9.0					1345.0
10.0					1344.0
11.0					1343.0
12.0					1342.0
13.0					1341.0
14.0					1340.0
15.0					1339.0
16.0					1338.0

EBA Engineering Consultants Ltd.

LOGGED BY: PC	COMPLETION DEPTH: 1 m
REVIEWED BY: JAR	COMPLETE: 06/07/18
Fig. No: B12	Page 1 of 1

06/08/02 02:38PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 013
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1366 m

SAMPLE TYPE ■ DISTURBED ⊘ NO RECOVERY ⊠ SPT ☰ A-CASING ▯▯ SHELBY TUBE ▮▯ CORE

Symbols for SOILS

Depth(m)	SAMPLE TYPE	SAMPLE NO	PLASTIC — M.C. — LIQUID (20 40 60 80)	ELEVATION(m)
0.0				1366.0
GRAVEL – sandy, some silt, trace clay, poorly graded, sizes to 75mm, round & subround, damp, dense, brown		B1	●	
1.0				1365.0
... moist		B2	●	
		B3	●	
End of Borehole @ 1.5m				
2.0				1364.0
Auger Refusal @ 1.5m				
No Seepage or Sloughing on Completion				
3.0				1363.0
4.0				1362.0
5.0				1361.0
6.0				1360.0
7.0				1359.0
8.0				1358.0
9.0				1357.0
10.0				1356.0
11.0				1355.0
12.0				1354.0
13.0				1353.0
14.0				1352.0
15.0				1351.0
16.0				1350.0

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LOGGED BY: PC	COMPLETION DEPTH: 1.5 m
REVIEWED BY: JAR	COMPLETE: 06/07/18
Fig. No: B13	Page 1 of 1

06/08/02 02:38PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 014
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1390 m

SAMPLE TYPE ■ DISTURBED ⊘ NO RECOVERY ⊠ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)		SAMPLE TYPE	SAMPLE NO	PLASTIC / M.C. / LIQUID (20 40 60 80)	ELEVATION(m)
0.0	GRAVEL – sandy, some silt, trace clay, poorly graded, sizes to 75mm, round & subround, moist, dense, brown	■	B1	●	1390.0
1.0		■	B2	●	1389.0
	... moist				
	End of Borehole @ 1.5m				
2.0	Auger Refusal @ 1.5m				1388.0
	No Seepage or Sloughing on Completion				
3.0					1387.0
4.0					1386.0
5.0					1385.0
6.0					1384.0
7.0					1383.0
8.0					1382.0
9.0					1381.0
10.0					1380.0
11.0					1379.0
12.0					1378.0
13.0					1377.0
14.0					1376.0
15.0					1375.0
16.0					1374.0

EBA Engineering Consultants Ltd.

LOGGED BY: PC	COMPLETION DEPTH: 1.1 m
REVIEWED BY: JAR	COMPLETE: 06/07/18
Fig. No: B14	Page 1 of 1

06/08/02 02:38PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 015
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1370 m

SAMPLE TYPE ■ DISTURBED ⊘ NO RECOVERY ⊠ SPT ☰ A-CASING ▯▯ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)	SAMPLE TYPE	SAMPLE NO	PLASTIC / M.C. / LIQUID (20 40 60 80)	ELEVATION(m)
0.0				1370.0
SILT – sandy, trace clay, gravelly, damp to moist, firm to stiff, low plastic, light brown		B1		
1.0		B2		1369.0
BEDROCK – shale, damp, low strength, weathered, brown				
2.0				1368.0
End of Borehole @ 1.0m				
Auger Refusal @ 1.0m				
No Seepage or Sloughing on Completion				
3.0				1367.0
4.0				1366.0
5.0				1365.0
6.0				1364.0
7.0				1363.0
8.0				1362.0
9.0				1361.0
10.0				1360.0
11.0				1359.0
12.0				1358.0
13.0				1357.0
14.0				1356.0
15.0				1355.0
16.0				1354.0

EBA Engineering Consultants Ltd.

LOGGED BY: PC	COMPLETION DEPTH: 1 m
REVIEWED BY: JAR	COMPLETE: 06/07/18
Fig. No: B15	Page 1 of 1

06/08/02 02:38PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 016
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1364 m

SAMPLE TYPE ■ DISTURBED ⊘ NO RECOVERY ⊠ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)	SAMPLE TYPE	SAMPLE NO	PLASTIC / M.C. / LIQUID (20 40 60 80)	ELEVATION(m)
0.0				1364.0
TOPSOIL – clay, silty, sandy, moist, dark brown, roots & root hairs, organics				
1.0		B1		1363.0
GRAVEL – sandy, trace silt, trace clay, poorly graded, sizes to 75mm, round & subround, moist, dense, brown		B2		
2.0		B3		1362.0
		B4		
3.0		B5		1361.0
... free water		B6		
4.0		B7		1360.0
5.0		B8		1359.0
		B9		
6.0		B10		1358.0
End of Borehole @ 6.1m				
No Seepage or Sloughing on Completion				
Slotted PVC Standpipe Installed to 6.1m				
Indicated Water Level Measured Aug. 1, 2006				
7.0				1357.0
8.0				1356.0
9.0				1355.0
10.0				1354.0
11.0				1353.0
12.0				1352.0
13.0				1351.0
14.0				1350.0
15.0				1349.0
16.0				1348.0

EBA Engineering Consultants Ltd.

LOGGED BY: JHC	COMPLETION DEPTH: 6.1 m
REVIEWED BY: JAR	COMPLETE: 06/06/21
Fig. No: B16	Page 1 of 1

06/08/02 02:39PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 017
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1362 m

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

Symbols for SOILS

Depth(m)		SAMPLE TYPE	SAMPLE NO	PLASTIC / M.C. / LIQUID (20 40 60 80)	ELEVATION(m)
0.0	TOPSOIL – clay, silty, sandy, moist, dark brown, roots & root hairs, organics		B1		1362.0
1.0	GRAVEL – sandy, trace silt, trace clay, poorly graded, sizes to 75mm, round & subround, moist, dense, brown		B2		1361.0
2.0	BEDROCK – shale, low to moderate strength, weathered, fractured, dark grey				1360.0
	End of Borehole @ 1.5m				
3.0	Auger Refusal @ 1.5m No Seepage or Sloughing on Completion				1359.0
4.0					1358.0
5.0					1357.0
6.0					1356.0
7.0					1355.0
8.0					1354.0
9.0					1353.0
10.0					1352.0
11.0					1351.0
12.0					1350.0
13.0					1349.0
14.0					1348.0
15.0					1347.0
16.0					1346.0

EBA Engineering Consultants Ltd.

LOGGED BY: JHC	COMPLETION DEPTH: 1.2 m
REVIEWED BY: JAR	COMPLETE: 06/06/21
Fig. No: B17	Page 1 of 1

06/08/02 02:39PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 018
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1362 m

SAMPLE TYPE ■ DISTURBED ⊘ NO RECOVERY ⊠ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)	SAMPLE TYPE	SAMPLE NO	PLASTIC / M.C. / LIQUID (20 40 60 80)	ELEVATION(m)
0.0				1362.0
TOPSOIL – clay, silty, sandy, moist, dark brown, roots & root hairs, organics				
1.0		B1		1361.0
GRAVEL – sandy, trace silt, trace clay, poorly graded, sizes to 75mm, round & subround, moist, dense, brown		B2		
2.0				1360.0
BEDROCK – shale, low to moderate strength, weathered, fractured, dark grey				
End of Borehole @ 1.5m				
3.0				1359.0
Auger Refusal @ 1.5m				
No Seepage or Sloughing on Completion				
4.0				1358.0
5.0				1357.0
6.0				1356.0
7.0				1355.0
8.0				1354.0
9.0				1353.0
10.0				1352.0
11.0				1351.0
12.0				1350.0
13.0				1349.0
14.0				1348.0
15.0				1347.0
16.0				1346.0

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LOGGED BY: JHC	COMPLETION DEPTH: 1.5 m
REVIEWED BY: JAR	COMPLETE: 06/06/21
Fig. No: B18	Page 1 of 1

06/08/02 02:39PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 019
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1334 m

SAMPLE TYPE ■ DISTURBED ⊘ NO RECOVERY ⊠ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)		SAMPLE TYPE	SAMPLE NO	PLASTIC M.C. LIQUID (20 40 60 80)	ELEVATION(m)
0.0	TOPSOIL – clay, silty, sandy, moist, dark brown, roots & root hairs, organics				1334.0
1.0	GRAVEL – sandy, trace silt, trace clay, poorly graded, sizes to 75mm, round & subround, moist, dense, brown				1333.0
2.0	BEDROCK – shale, low to moderate strength, weathered, fractured, dark grey				1332.0
	End of Borehole @ 1.5m				
3.0	Auger Refusal @ 1.5m No Seepage or Sloughing on Completion				1331.0
4.0					1330.0
5.0					1329.0
6.0					1328.0
7.0					1327.0
8.0					1326.0
9.0					1325.0
10.0					1324.0
11.0					1323.0
12.0					1322.0
13.0					1321.0
14.0					1320.0
15.0					1319.0
16.0					1318.0

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LOGGED BY: JHC	COMPLETION DEPTH: 1.5 m
REVIEWED BY: JAR	COMPLETE: 06/06/21
Fig. No: B19	Page 1 of 1

06/08/02 02:39PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 020
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1342 m

SAMPLE TYPE ■ DISTURBED ▨ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)		SAMPLE TYPE	SAMPLE NO	PLASTIC — M.C. — LIQUID (20 40 60 80)	ELEVATION(m)
0.0	TOPSOIL – clay, silty, sandy, moist, dark brown, roots & root hairs, organics				1342.0
1.0	BEDROCK – shale, low to moderate strength, weathered, fractured, dark grey				1341.0
	End of Borehole @ 1.5m				
2.0	Auger Refusal @ 1.5m No Seepage or Sloughing on Completion				1340.0
3.0					1339.0
4.0					1338.0
5.0					1337.0
6.0					1336.0
7.0					1335.0
8.0					1334.0
9.0					1333.0
10.0					1332.0
11.0					1331.0
12.0					1330.0
13.0					1329.0
14.0					1328.0
15.0					1327.0
16.0					1326.0

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LOGGED BY: JHC	COMPLETION DEPTH: 1.5 m
REVIEWED BY: JAR	COMPLETE: 06/06/21
Fig. No: B20	Page 1 of 1

06/08/02 02:39PM (FEEDLOT)

PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 021
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1353 m

SAMPLE TYPE ■ DISTURBED ⊘ NO RECOVERY ⊠ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

Symbols for SOILS

Depth(m)		SAMPLE TYPE	SAMPLE NO	PLASTIC — M.C. — LIQUID (20 40 60 80)	ELEVATION(m)
0.0	TOPSOIL – clay, silty, sandy, moist, dark brown, roots & root hairs, organics				1353.0
1.0	BEDROCK – shale, low to moderate strength, weathered, fractured, dark grey				1352.0
	End of Borehole @ 1.2m				
2.0	Auger Refusal @ 1.2m				1351.0
	No Seepage or Sloughing on Completion				
3.0					1350.0
4.0					1349.0
5.0					1348.0
6.0					1347.0
7.0					1346.0
8.0					1345.0
9.0					1344.0
10.0					1343.0
11.0					1342.0
12.0					1341.0
13.0					1340.0
14.0					1339.0
15.0					1338.0
16.0					1337.0

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LOGGED BY: JHC	COMPLETION DEPTH: 1.2 m
REVIEWED BY: JAR	COMPLETE: 06/06/21
Fig. No: B21	Page 1 of 1

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PROJECT: VALLEY RIDGE COUNTRY ESTATES	LOCATION: NW & NE 1/4's 31-7-3 W5M	BOREHOLE NO: 022
CLIENT: MR. RICHARD KOENTGES	CONTRACTOR:CHILAKO DRILLING SERVICES LTD	PROJECT NO: 0404-4401178
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 1358 m

SAMPLE TYPE ■ DISTURBED ⊘ NO RECOVERY ⊠ SPT ☰ A-CASING ▯▯ SHELBY TUBE ◧ CORE

Symbols for SOILS

PLASTIC — M.C. — LIQUID

20 40 60 80

Depth(m)		ELEVATION(m)
0.0	BEDROCK – shale, low to moderate strength, weathered, fractured, dark grey	1358.0
1.0	End of Borehole @ 0.7m Auger Refusal @ 0.7m No Seepage or Sloughing on Completion	1357.0
2.0		1356.0
3.0		1355.0
4.0		1354.0
5.0		1353.0
6.0		1352.0
7.0		1351.0
8.0		1350.0
9.0		1349.0
10.0		1348.0
11.0		1347.0
12.0		1346.0
13.0		1345.0
14.0		1344.0
15.0		1343.0
16.0		1342.0

EBA Engineering Consultants Ltd.

LOGGED BY: JHC	COMPLETION DEPTH: 0.7 m
REVIEWED BY: JAR	COMPLETE: 06/06/21
Fig. No: B22	Page 1 of 1

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APPENDIX

APPENDIX C RECOMMENDED GENERAL DESIGN AND CONSTRUCTION GUIDELINES

CONSTRUCTION EXCAVATIONS

Construction should be in accordance with good practice and comply with the requirements of the responsible agencies.

All excavations greater than 1.5 m deep should be sloped or shored for worker protection.

Shallow excavations up to 3 m depth may use temporary side slopes of 1H:1V. A flatter slope of 2H:1V should be used if groundwater is encountered. Localized sloughing can be expected from these slopes.

Deep excavations or trenches may require temporary support if space limitations or economic considerations preclude the use of sloped excavations.

For excavations greater than 3 m depth, temporary support should be designed by a qualified geotechnical engineer. The design and proposed installation and construction procedures should be submitted to EBA for review.

The construction of a temporary support system should be monitored. Detailed records should be taken of installation methods, materials, in-situ conditions and the movement of the system. If anchors are used, they should be load tested. EBA can provide further information on monitoring and testing procedures, if required.

Attention should be paid to structures or buried service lines close to the excavation. For structures, a general guideline is that if a line projected down at 45° from a horizontal, from the base of foundations of adjacent structures, intersects the extent of the proposed excavation, then these structures may require underpinning or special shoring techniques to avoid damaging earth movements. The need for any underpinning or special shoring techniques and the scope of monitoring required can be determined when details of the service ducts and vaults, foundation configuration of existing buildings and final design excavation levels are known.

No surface surcharges should be placed closer to the edge of the excavation than a distance equal to the depth of the excavation, unless the excavation support system has been designed to accommodate such surcharge.

BACKFILL MATERIALS AND COMPACTION

Maximum density, as used in this section, means Standard Proctor Maximum Dry Density (ASTM Test D698) unless specifically noted otherwise. Optimum moisture content is as defined in this text.

"General engineered fill" materials should comprise clean, well-graded granular soils or inorganic, low-plastic cohesive soils. Such material should be placed in compacted lifts not exceeding 200 mm and compacted to not less than 98% of maximum density, at a moisture content at or slightly above optimum.

"Structural fill" materials should comprise clean, well-graded inorganic granular soils. Such fill should be placed in compacted lifts not exceeding 150 mm and compacted to not less than 98% of maximum density, at a moisture content near or slightly above optimum.

"Landscape fill" material may comprise soils without regard to engineering quality. Such soils should be placed in compacted lifts not exceeding 300 mm and compacted to a density of not less than 90% of maximum density.

Backfill adjacent to and above footings, abutment walls, basement walls, grade beams and pile caps or below highway, street or parking lot pavement sections should comprise general engineered fill materials as defined above.

Backfill supporting structural loads should comprise structural fill materials as defined above.

Backfill adjacent to exterior footings, foundation walls, grade beams and pile caps and within 300 mm of final grade should comprise low-plastic cohesive general engineered fill as defined above. Such backfill should provide a relatively impervious surface layer to reduce seepage into the sub-soil.

Backfill should not be placed against a foundation structure until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction. During compaction, careful observation of the foundation wall for deflection should be carried out continuously. Where deflection is apparent, the compactive effort should be reduced accordingly. In order to reduce potential compaction induced stresses, only hand held compaction equipment should be used in the compaction of fill within 500 mm of retaining walls or basement walls.

Backfill materials should not be placed in a frozen state or placed on a frozen subgrade. All lumps of materials should be broken down during placement.

Where the maximum-sized particles in any backfill material exceed 50% of the lift thickness or minimum dimension of the cross-section to be backfilled, such particles should be removed and placed at the other more suitable locations on site or screened-off prior to delivery to site.

Bonding should be provided between backfill lifts, if the previous lift has become desiccated. For the fine-grained materials, the previous lift should be scarified to 75 mm in depth followed by proper moisture conditioning and recompaction.

Recommendations for the specifications for various backfill types are presented below.

"Pit-run gravel" should conform to the following grading:

Sieve Sizes (Square Openings)	Percent Passing By Weight
200 mm	100 of Total Sample
150 mm	96 - 100 of Total Sample
75 mm	60 - 80 of Total Sample
25 mm	70 - 100 of Material Passing 75 mm Sieve
4.75 mm	25 - 63 of Material Passing 75 mm Sieve
1.18 mm	14 - 41 of Material Passing 75 mm Sieve
0.60 mm	7 - 30 of Material Passing 75 mm Sieve
0.15 mm	3 - 18 of Material Passing 75 mm Sieve
0.075 mm	2 - 9 of Material Passing 75 mm Sieve

Any grading variation from the above should be at the discretion of the Engineer; however, the percent of material passing the 0.075 mm sieve should not exceed 2/3 of the material passing the 0.6 mm sieve. The pit-run gravel should be free of any form of coating and any gravel containing clay, loam or other deleterious materials should be rejected. No oversized material should be tolerated.

"Crushed gravel" should conform to the following grading:

Sieve Sizes (Square Openings)	Percent Passing by Weight (Nominal Gravel Size)		
	100 mm	50 mm	25 mm
100 mm	100	—	—
75 mm	90 - 100	—	—
50 mm	—	100	—
40 mm	60 - 80	90 - 100	—
25 mm	—	—	100
20 mm	40 - 66	50 - 75	95 - 100
10 mm	25 - 54	25 - 52	60 - 80
4.75 mm	15 - 43	15 - 40	40 - 60
2.36 mm	10 - 35	10 - 33	28 - 48
0.60 mm	5 - 23	5 - 23	13 - 29
0.30 mm	—	—	9 - 21
0.15 mm	3 - 12	2 - 14	6 - 15
0.075 mm	2 - 10	1 - 10	4 - 10

Gravel:

100 mm Crushed Gravel: At least 13% by weight of the material retained on the 4.75 mm sieve should have two more fractured faces.

50 mm Crushed Gravel: At least 13% by weight of the material retained on the 4.75 mm sieve should have two more fractured faces.

25 mm Crushed Gravel: At least 50% by weight of the material retained on the 4.75 mm sieve should have two more fractured faces.

Any gravel containing deleterious material should be rejected.

"Coarse gravel" for bedding and drainage should conform to the following grading:

Sieve Sizes (Square Openings)	Percent Passing By Weight (Nominal Gravel Size)	
	50 mm	40 mm
50 mm	100	—
40 mm	90 - 100	100
25 mm	—	95 - 100
20 mm	35 - 70	—
15 mm	—	25 - 60
10 mm	10 - 30	—
4.75 mm	0 - 5	0 - 10
2.36 mm	—	0 - 5

"Coarse sand" for bedding and drainage should conform to the following grading:

Sieve Sizes (Square Openings)	Percent Passing By Weight
10 mm	100
4.75 mm	95 – 100
2.36 mm	80 – 100
1.18 mm	50 - 85
0.60 mm	25 - 60
0.30 mm	10 - 30
0.15 mm	2 - 10

"Lean-mix concrete" should be low strength concrete having a minimum 28-day compressive strength of 3.5 MPa.

PROOF-ROLLING

Proof-rolling is a method of detecting soft areas in an "as-excavated" subgrade for fill, pavement, floor or foundations or detecting non-uniformity of compacted embankment. The intent is to detect soft areas or areas of low shear strength not otherwise revealed by means of testholes, density testing or visual examination of the site surface and to check that any fill placed or subgrade meets the necessary design strength requirements.

Proof-rolling should be observed by qualified geotechnical personnel.

Proof-rolling is generally accomplished by the use of a heavy (15—60 tonne) rubber-tired roller having four wheels abreast on independent axles with high contact wheel pressures [inflation pressures ranging from 550 kPa (80 psi) up to 1,030 kPa (150 psi)].

A heavily-loaded truck may be used in lieu of the equipment described in the paragraph above. The truck should be loaded to approximately 10 tonnes (22,000 lbs) per axle and a minimum tire pressure of 550 kPa (80 psi).

Ground speed to be maximum of 8 km/hr (133 m/min) (5 mph) (400 ft/min). Recommended speed is 4 km/hr (65 m/min) (2.5 mph) (200 ft/min).

The recommended procedure is two complete coverages with the Proof-rolling equipment in one direction and a second series of two coverages made at right angles to the first series; one "coverage" means that every point of the proof-rolled surface has been subjected to the tire pressure of a loaded wheel. Less rigorous procedures may be acceptable under certain conditions subject to the approval of an engineer.

Any areas of soft, rutted or displaced materials detected should be either recompacted with additional fill or the existing material removed and replaced with general engineered fill or properly moisture conditioned as necessary.

The surface of the grade under the action of the proof-rolling should be observed, noting visible deflection and rebound of the surface or shear failure in the surface of granular soils as ridging between wheel tracks.

If any part of an area indicates significantly more distress than other parts, the cause should be investigated, by, for example, shallow auger holes.

In the case of granular subgrades, distress will generally consist of either compression due to insufficient compaction or shearing under the tires. In the first case, proof-rolling should be continued until no further compression occurs. In the second case, the tire pressure should be reduced to a point where the subgrade can carry the load without significant deflection and subsequently, gradually increased to its specified pressure as the subgrade increases in shear strength under this compaction.

SHALLOW FOUNDATIONS

Design and construction of shallow foundations should comply with relevant Building Code requirements.

The term "shallow foundations" includes strip and spread footings, mat slab and raft foundations.

Minimum footing dimensions in plan should be 0.45 m and 0.9 m for strip and square footings, respectively.

No loose, disturbed or sloughed material should be allowed to remain in open foundation excavations. Hand cleaning should be undertaken to prepare an acceptable bearing surface. Recompaction of disturbed or loosened bearing surface may be required.

Foundation excavation and bearing surfaces should be protected from rain, snow, freezing temperatures, drying and the ingress of free water, during and after footing construction.

Footing excavations should be carried down into the designated bearing stratum.

After the bearing surface is approved, a mud slab should be poured to protect the soil and provide a working surface for construction, should immediate foundation construction not be intended.

All constructed foundations should be placed on unfrozen soils, which should be at all times protected from frost penetration.

All foundation excavations and bearing surfaces should be observed by a qualified geotechnical engineer to confirm that the recommendations contained in this report have been followed and that soil conditions are consistent with those assumed in the design.

Where over-excavation has been carried out through a weak or unsuitable stratum to reach into a suitable bearing stratum or where a foundation pad is to be placed above stripped natural ground surface, such over-excavation may be backfilled to subgrade elevation utilizing either structural fill or lean-mix concrete. These materials are defined under the separate heading "Backfill Materials and Compaction."

FLOOR SLABS-ON-GRADE

All soft, loose or organic material should be removed from beneath slab areas. If any local hard spots such as old basement walls are revealed beneath the slab area, these should be over-excavated and removed to not less than 0.9 m below underside of slab level. The exposed soil should be proof-rolled and the final grade restored by general engineered fill placement. If proof-rolling reveals any soft or loose spots, these should be excavated and the desired grade restored by general engineered fill placement. Proof-rolling should be carried out in accordance with the recommendations given elsewhere in this Appendix. The subgrade should be compacted to a depth of not less than 0.3 m to density of not less than 95% Standard Proctor Maximum Dry Density (ASTM Test Method D698).

If for economic reasons, it is considered desirable to leave low quality material in place beneath a slab-on-grade, special ground treatment procedures may be considered. EBA could provide additional advice on this aspect, if required.

A levelling course of structural fill at least 150 mm in compacted thickness is recommended directly beneath all slabs-on-grade. Alternatively, a minimum thickness of 150 mm of pit-run gravel overlain by a minimum thickness of 50 mm of crushed gravel may be used. Very coarse material (larger than 25 mm diameter) should be avoided directly beneath the slabs-on-grade to limit potential stress concentrations within the slab.

General engineered fill, structural fill, pit-run gravel and crushed gravel are defined under the heading "Backfill Materials and Compaction" elsewhere in this Appendix.

The slab should be structurally independent from walls and columns supported on foundations. This is to reduce any structural distress that may occur as a result of differential soil movements. If it is intended to place any internal non-load bearing partition walls directly on a slab-on-grade, such walls should be structurally independent from other elements of the building founded on a conventional foundation system so that some relative vertical movement of the walls can occur freely.

The excavated subgrade beneath slabs-on-grade should be protected at all times from rain, snow, freezing temperatures, excessive drying and the ingress of free water. This applies during and after the construction period.

A minimum slab concrete thickness of 100 mm is recommended. Control joints should be provided in all slabs. Typically for a 125 mm slab thickness, control joints should be placed on a 3 m square grid, should be sawn to a depth of one-quarter the slab thickness and have a width of approximately 3 mm.

Wire mesh reinforcement, 150 mm square grid, should be provided to reduce the possibility of uncontrolled slab cracking. The mesh should be adequately supported and should be located at or above mid-height of the slab with adequate cover.

PAVEMENTS

The following recommended procedures for pavements have been based on the use of the area generally by cars with some light truck traffic, as is normal for parking lot areas and access roadways. Recommendations for heavy truck access areas are also presented. These recommendations are intended as minimums only for subgrades having design bearing capacities of 3% CBR or higher, under saturated conditions.

"Maximum density" as used in this section means Standard Proctor Maximum Dry Density (ASTM Test Method D698), unless specifically noted otherwise.

The parking area and roadway subgrade should be brought to required grades by scarifying and recompacting to a depth of not less than 150 mm below the surface. The subgrade should be graded to drain towards catch basin locations. The upper 150 mm of subgrade should be compacted to not less than 98% of maximum density. Proof-rolling of the entire surface area under pavement sections should be carried out to detect any local soft spots. Soft spots detected as a result of proof-rolling should be excavated and backfilled with general engineered fill. Recommended procedures for proof-rolling and general engineered fill are presented under a separate heading.

The parking area and roadways sub-base course should comprise a layer of compacted pit-run gravel placed over the prepared subgrade. The sub-base should be compacted to not less than 98% maximum density.

The parking area and roadways base course should comprise a layer of compacted crushed gravel of nominal size equal to 25 mm placed on top of the compacted sub-base. The base course should have a compacted thickness of not less than 50 mm. The base course should be compacted to not less than 100% of maximum density.

The asphalt thickness is dependent on asphalt mix specifications and should be reviewed when details of the mix are available. Minimum surface lift thickness in multiple-lift construction should be not less than 50 mm.

The sub-base course should be graded to drain to perforated catch basins completely surrounded by coarse gravel. The coarse gravel surrounding the catch basins should be interconnected with the base and sub-base courses.

Perforated pipes or open-jointed pipe installations should be surrounded continuously or at joint sections, respectively with a drainage gravel section enveloped in a suitable geotextile, Texel 7607, Penroad 50, or equal. Positive drainage directing surface water away from all structures to the drainage system at a minimum 2% gradient should be provided for all eaves troughs, down-spouts and external water sources.

Preparation of the subgrade should be carried out within restricted areas. This is to avoid loosening of the prepared areas by site traffic before compaction of the subgrade and placement of the granular material have been completed. Protection of the prepared subgrade against precipitation and frost should be undertaken.

Observation of compaction and asphalt laying operations should be carried out by staff of EBA Engineering Consultants Ltd. (EBA).

Where there is risk of gasoline or diesel oil spillage, such as in the vicinity of pump islands, concrete pavements are preferred to asphalt.

MAINTENANCE OF GRAVELLED YARDS

Gravel surfaced yards are susceptible to rapid deterioration if not properly maintained. For most gravel surfaced roads and yards this will involve grading at least three times yearly, twice in the spring and once in late summer or fall, with occasional touch up in problem areas. No noticeable rutting should be allowed to persist in spring time when frost is coming out of the ground. High wheel loads from forklifts, poor surface drainage and/or a high water table and clay subgrade soils can all result in a need for increased maintenance.

Ruts should not be allowed to exceed 25 mm in 1.2 m (1" in 4'). Areas that rut should be repaired as soon as possible. If not repaired promptly, the rutted areas will hold water, which reduces the ability of the gravel to bridge over soft areas and can lead to softening of the subgrade. Rutting will get progressively worse and more costly and difficult to repair.

In rutted areas, 20 mm crushed gravel should be placed to fill low spots. The high areas should not be graded off to fill in low areas. This creates areas of reduced gravel thickness in the high spots, which will eventually lead to future punchouts and/or soft spots.

The overloading of forklifts can lead to excessively high stresses under the front axle. This should be avoided. High wheel loads from an overloaded forklift could exceed the allowable stresses for the gravel thickness, especially in rutted areas where ponded water can lead to softening.

Excessive regarding will also negatively impact performance. Gravel surfacing tends to form a crust with traffic. This crust provides improved stability and helps shed water. Excessive regarding can breakup this crust and reduce the ability of the gravel surfacing to shed water. There is also a tendency to pull gravel from high spots to fill minor ruts. As noted above, this can cause problems with the reduced gravel thicknesses in areas that initially perform well.

APPENDIX

APPENDIX D LABORATORY TEST RESULTS

EBA Engineering Consultants Ltd.

AGGREGATE ANALYSIS REPORT

PROJECT: Valley Ridge Country Estates Subdiv. Phase 2
PROJECT NUMBER: 0404-4401178
CLIENT: Mr. Richard Koentges
ATTENTION: Mr. R. Koentges
DESCRIPTION: Gravel, sandy, trace silt
LOCATION: Borehole 002 from 0.6m to 5.5m

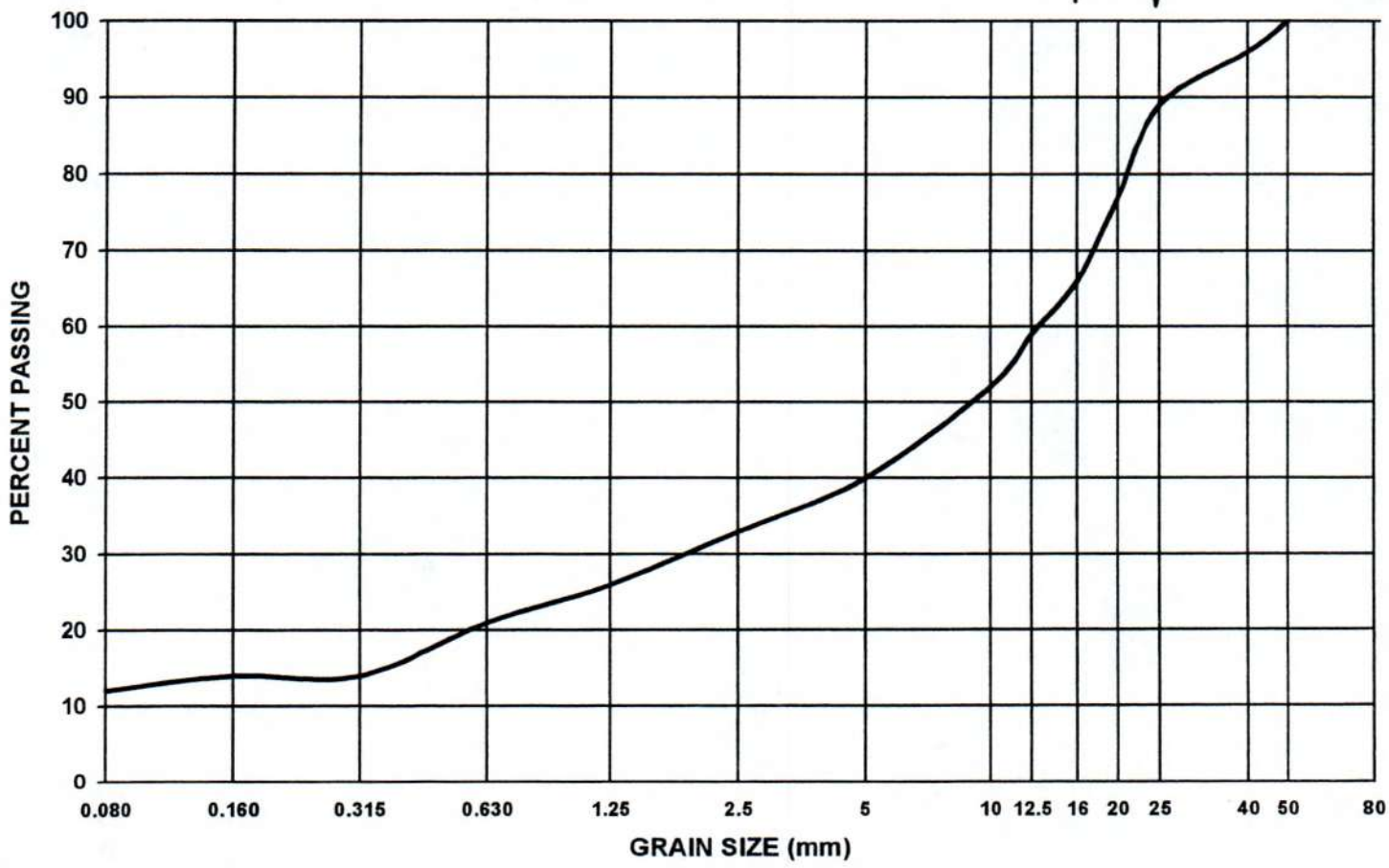
SAMPLE NUMBER: T-571
DATE SAMPLED: June 6, 2006
BY: EBA
TIME:
TWO OR MORE FRACTURED FACES: N/A
MOISTURE CONTENT: 3.5%

PERCENT PASSING SIEVE SIZE

SIEVE SIZE (mm)	80	50	40	25	20	16	12.5	10	5	2.5	1.25	0.630	0.315	0.160	0.080
UPPER LIMIT															
LOWER LIMIT															
TEST RESULT		100	96	89	77	66	59	52	40	33	26	21	14	14	12.0

REMARKS: _____

REVIEWED BY: _____ P.Eng.



eba

APPENDIX

APPENDIX E SITE PHOTOGRAPHS

Photo 1
Existing Gravel Road Through Property, Looking Northeast.

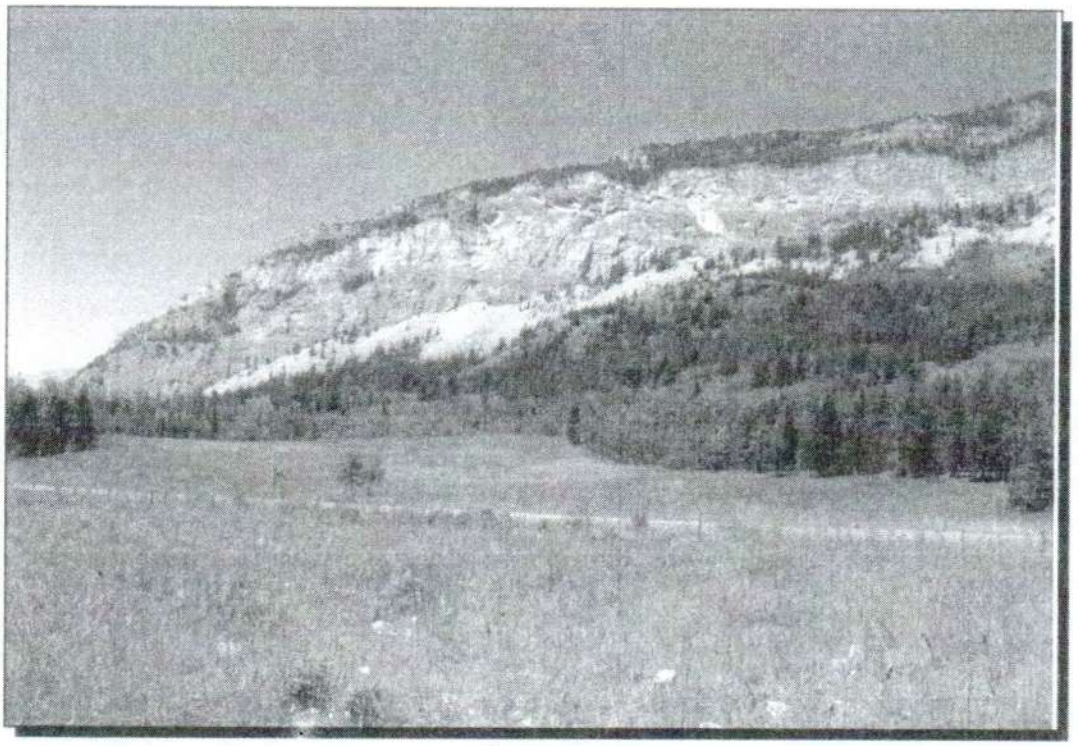


Photo 2
Upper Slope and Mountain Background – Northwest Property.

Photo 3
Southeast Side Property and Top of Bank of Lower Slope.

Photo 4
Top of Bank and Typical Southeast Lower Slope.