BENTON CROSSING
OUTLINE PLAN

Prepared for

City of Lethbridge

by

Associated Engineering

in association with

ARMIN A. PREIKSAITIS & ASSOCIATES LTD.

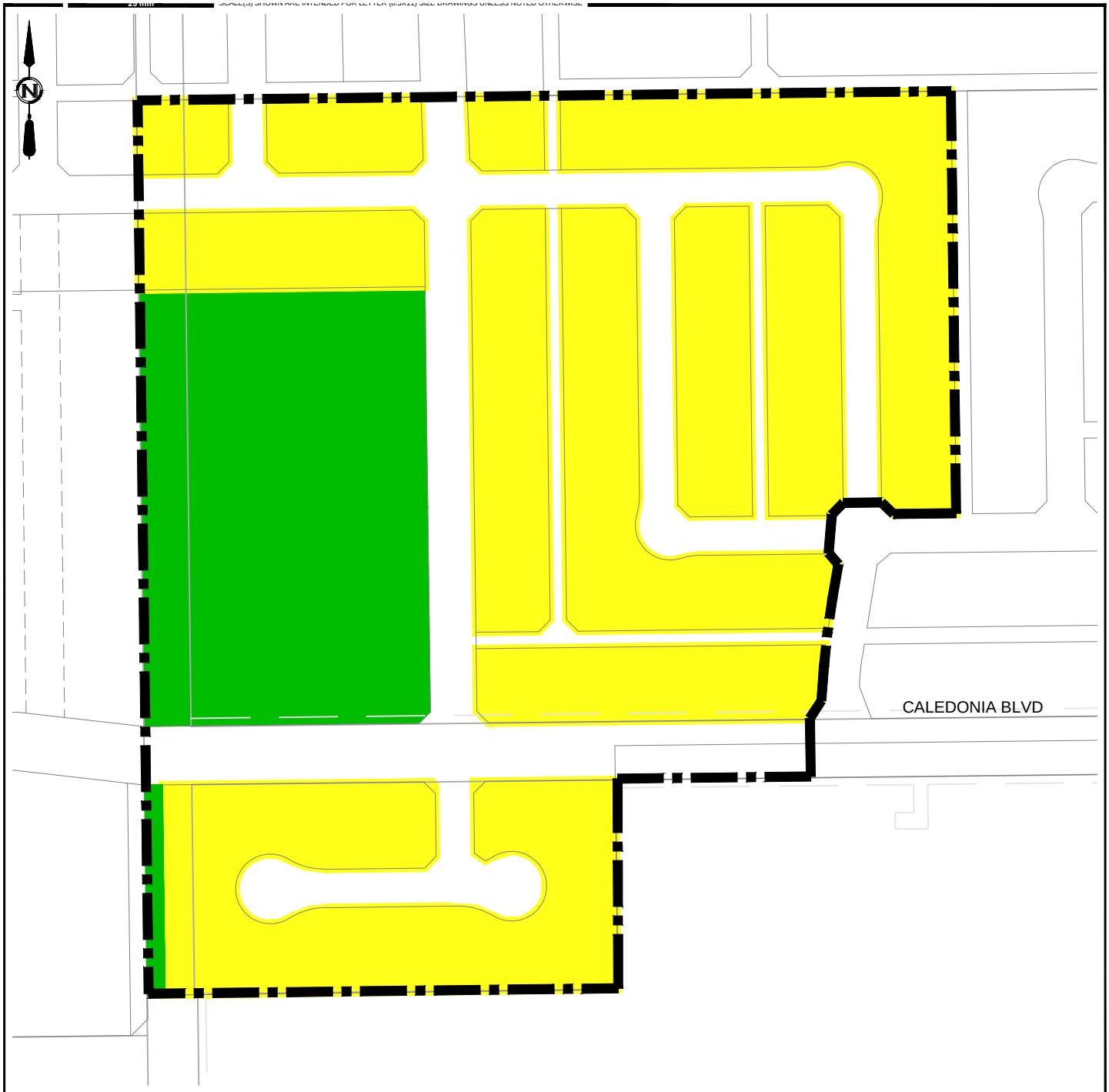
Revised October 2, 2008

Adjusted May 18, 2017

Approved by the Municipal Planning Commission August 29, 2006

Benton Crossing Outline Plan Addendum - May 2017

Figures added through OP adjustment by PRT - May 18, 2017



LEGEND

- THE CROSSINGS OUTLINE PLAN AMENDMENT BOUNDARY
- PUBLIC OPEN SPACE
- LOW DENSITY RESIDENTIAL

Associated Engineering

AE PROJECT No.	20143124-01
SCALE	NTS
APPROVED	T JENSEN
DATE	2017FEB09
REV	1
DESCRIPTION	ISSUED FOR INFORMATION

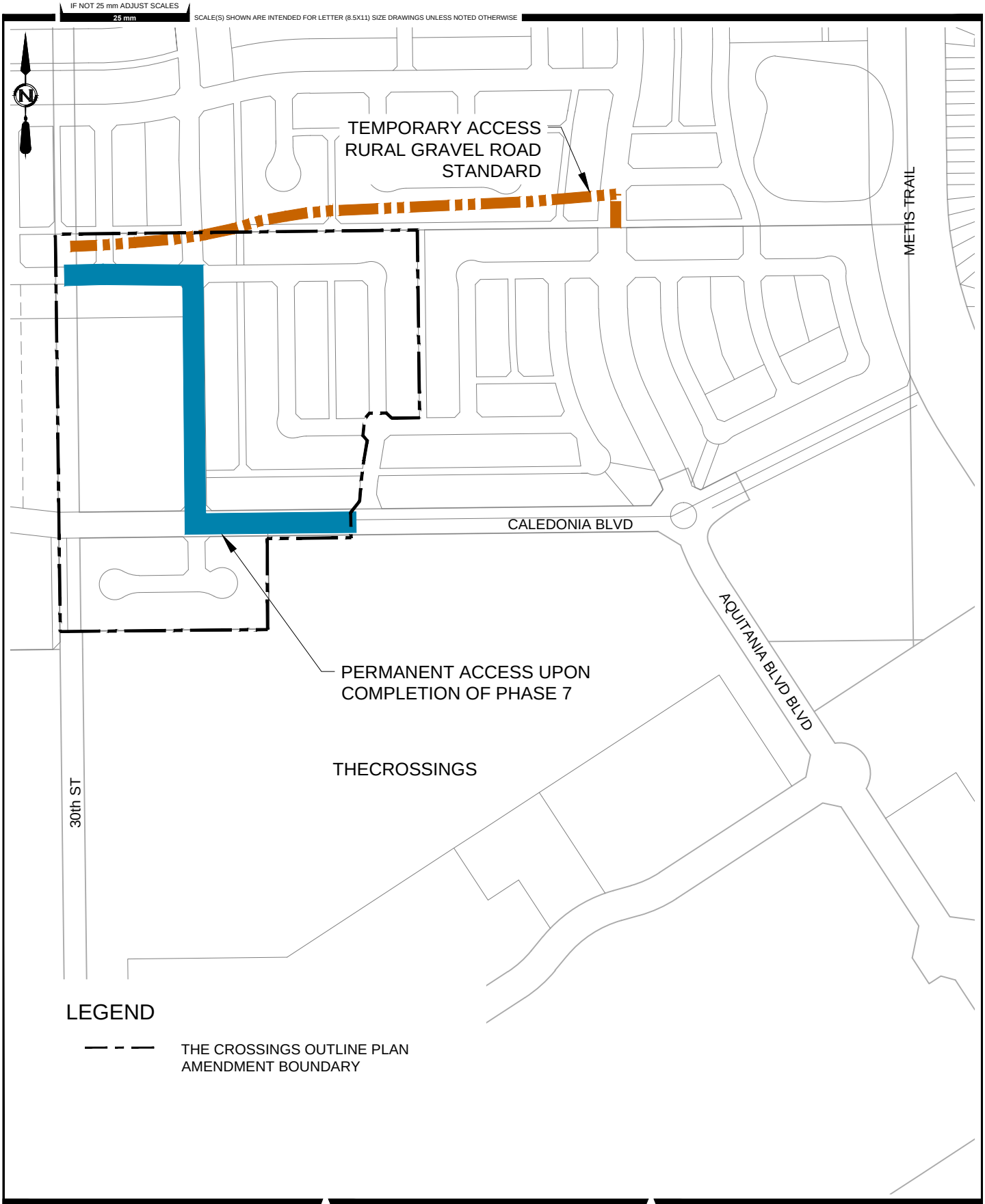
FIGURE 3

LETHBRIDGE LAND
THE CROSSINGS OUTLINE PLAN

PROPOSED ZONING AND LAND USE

IF NOT 25 mm ADJUST SCALES
25 mm

SCALE(S) SHOWN ARE INTENDED FOR LETTER (8.5X11) SIZE DRAWINGS UNLESS NOTED OTHERWISE



LEGEND

THE CROSSINGS OUTLINE PLAN AMENDMENT BOUNDARY

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SCALE	NTS
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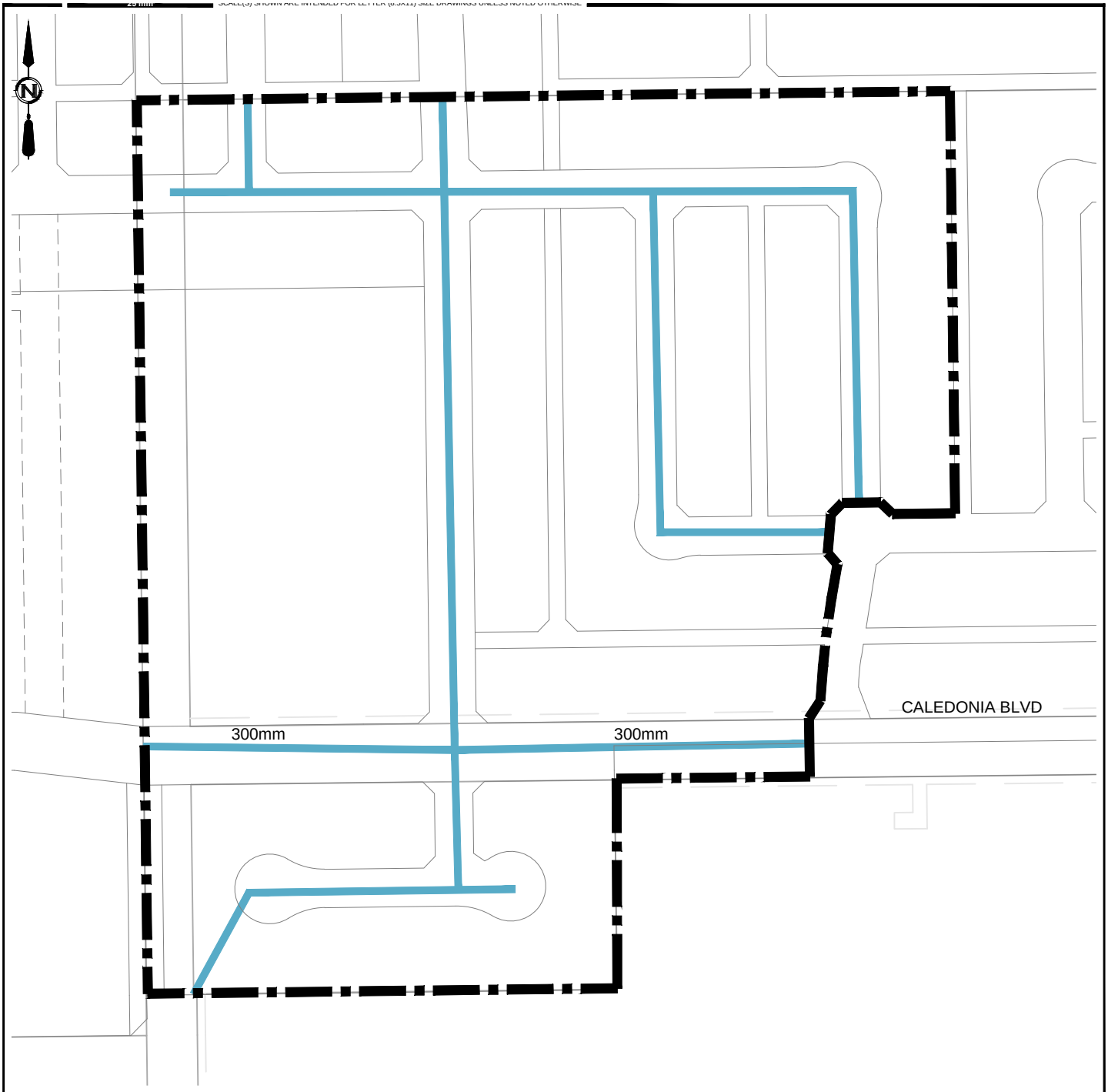
DATE	2017FEB09
REV	1
DESCRIPTION	ISSUED FOR INFORMATION

FIGURE 3a

LETHBRIDGE LAND
THE CROSSINGS OUTLINE PLAN

30th Street Detour



LEGEND

THE CROSSINGS OUTLINE PLAN AMENDMENT BOUNDARY

PROPOSED WATERMAIN

NOTE: ALL PROPOSED WATERMAINS ARE 200mm UNLESS OTHERWISE INDICATED.

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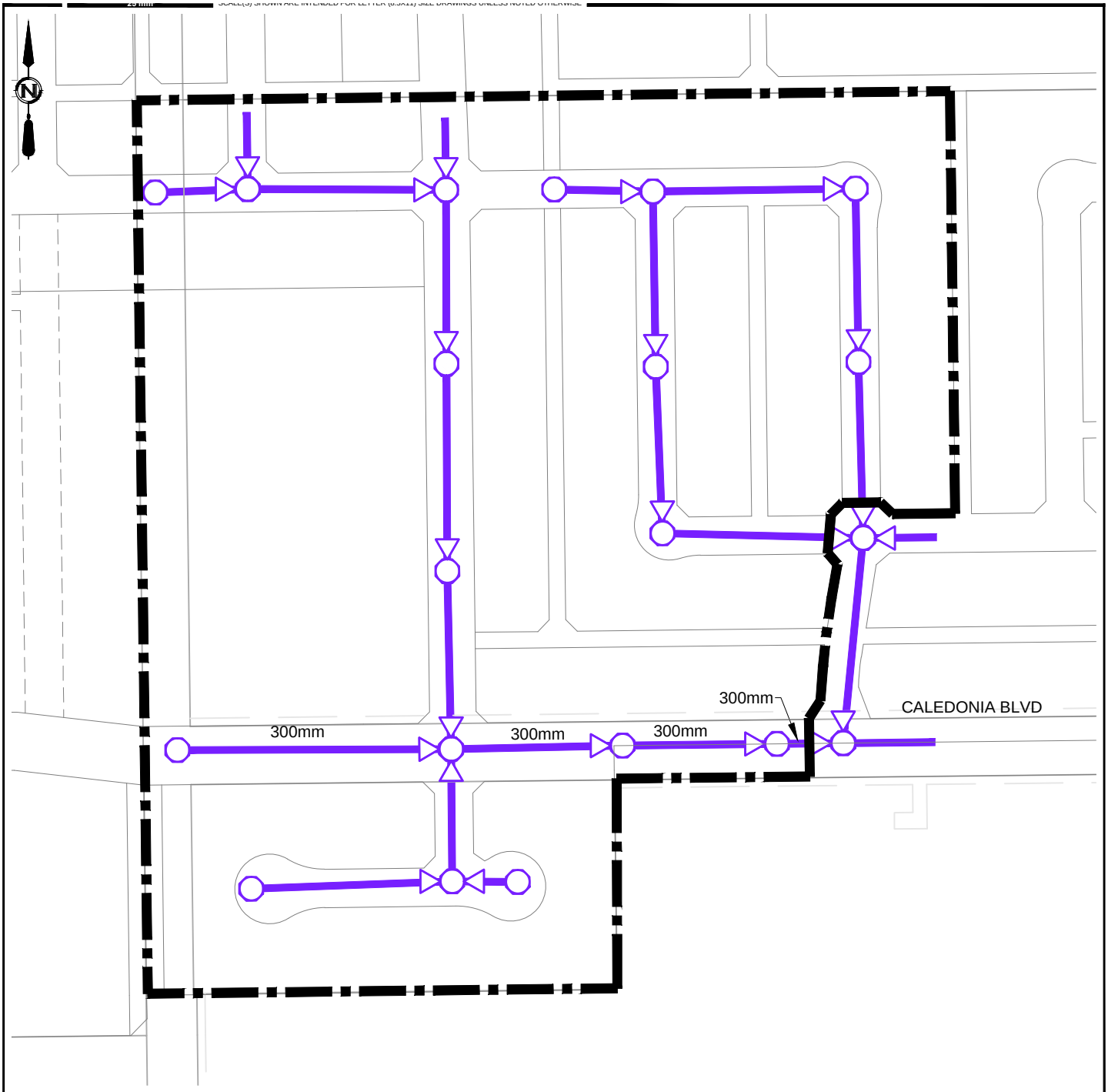
DATE	2017FEB09
REV	1
DESCRIPTION	ISSUED FOR INFORMATION

FIGURE 8

LETHBRIDGE LAND
THE CROSSINGS OUTLINE PLAN

WATER SERVICING CONCEPT



LEGEND

- THE CROSSINGS OUTLINE PLAN AMENDMENT BOUNDARY
- PROPOSED SANITARY SEWER
- PROPOSED SANITARY MANHOLE AND DIRECTION

NOTE: ALL PROPOSED SANITARY MAINS ARE 200mm UNLESS OTHERWISE INDICATED.

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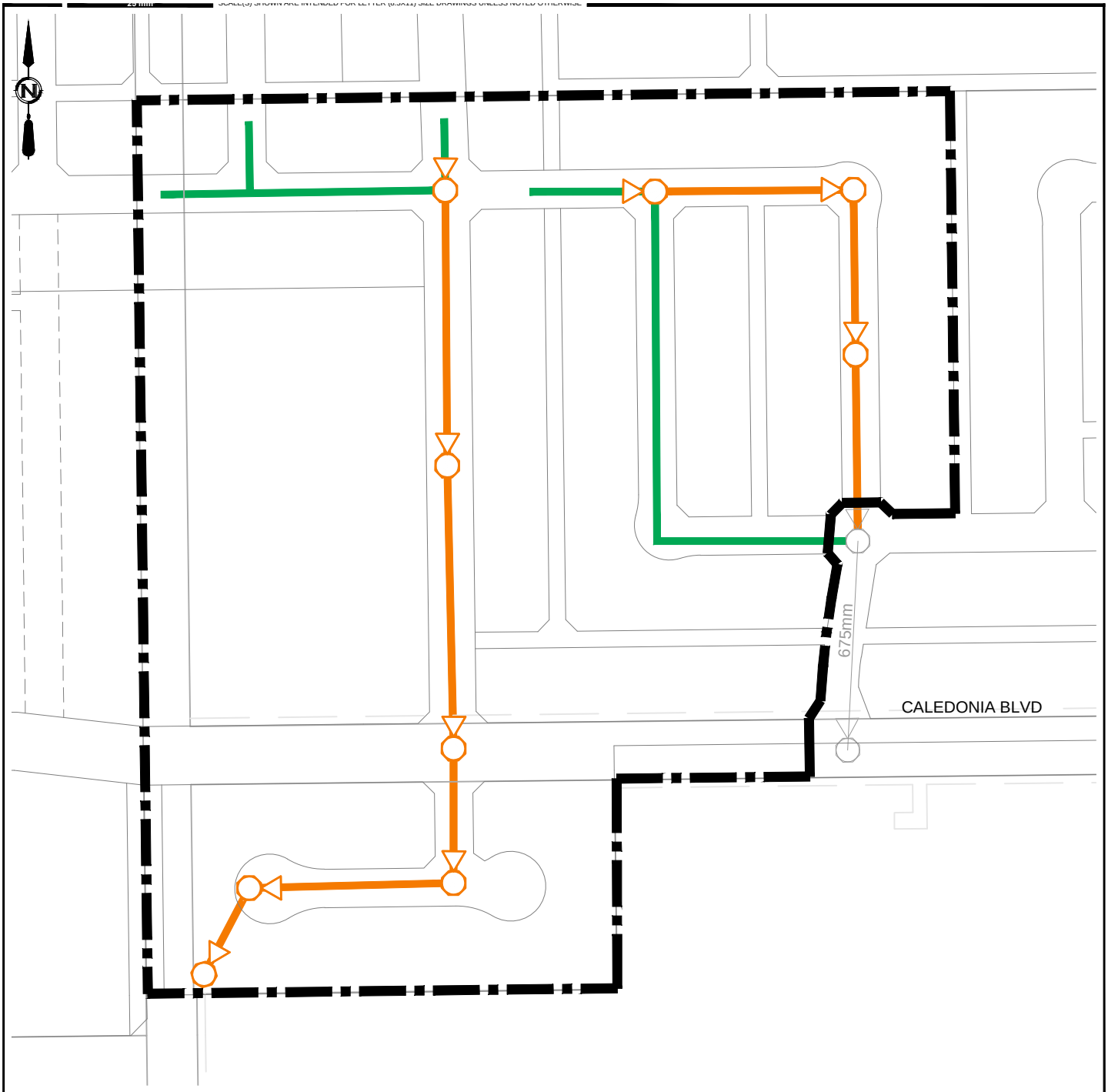
FIGURE 9

LETHBRIDGE LAND
THE CROSSINGS OUTLINE PLAN

SANITARY SERVICING CONCEPT



LEGEND

- THE CROSSINGS OUTLINE PLAN AMENDMENT BOUNDARY
- PROPOSED STORM SEWER
- PROPOSED FOUNDATION DRAIN COLLECTOR
- PROPOSED STORM MANHOLE AND DIRECTION

NOTE: ALL PROPSED STORM SEWERS ARE 300mm UNLESS OTHERWISE INDICATED

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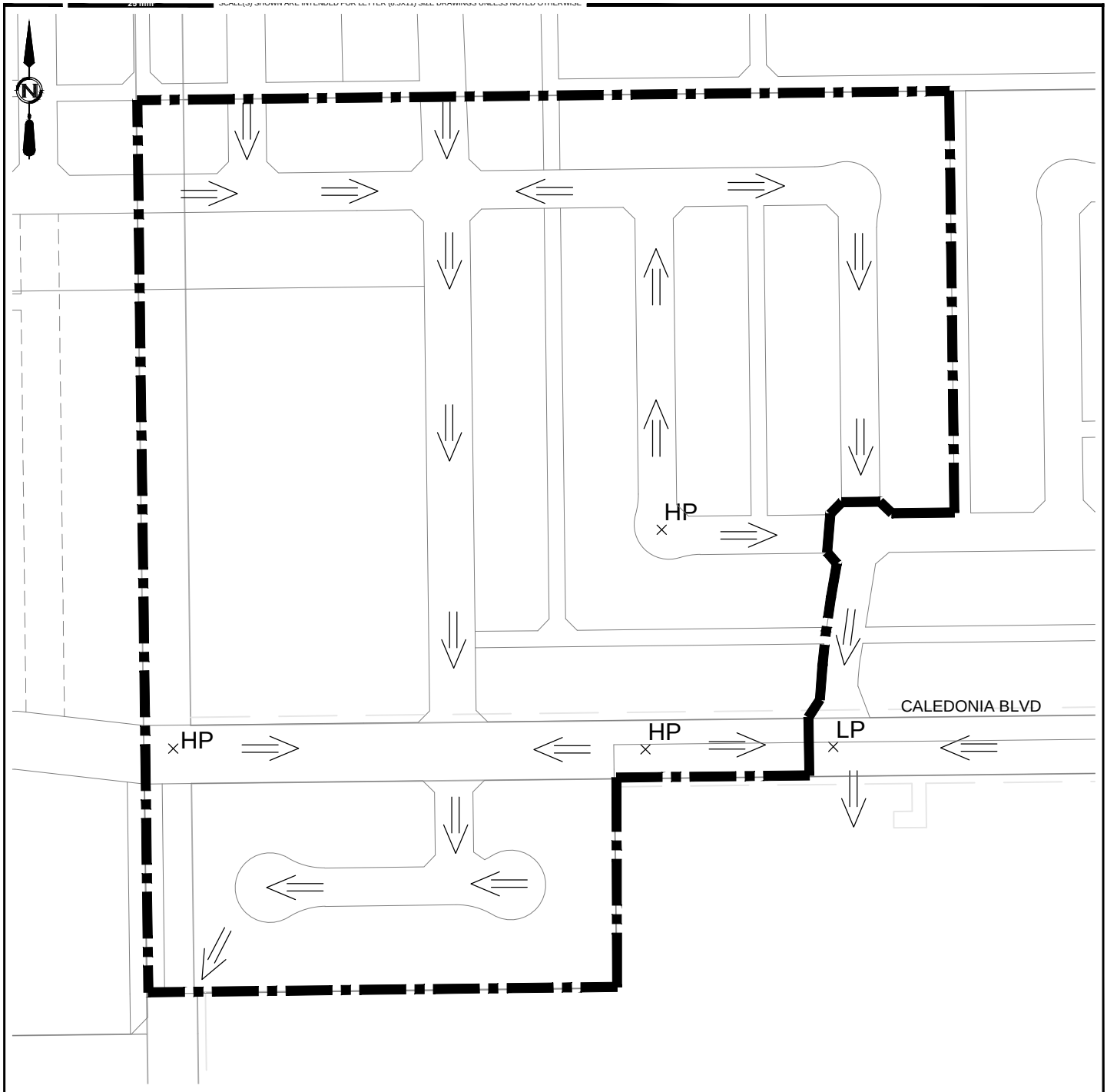
FIGURE 10

LETHBRIDGE LAND
THE CROSSINGS OUTLINE PLAN

MINOR STORMWATER MANAGEMENT



LEGEND

THE CROSSINGS OUTLINE PLAN AMENDMENT BOUNDARY

OVERLAND FLOW DIRECTION

HP POINT OF VERTICAL INTERSECTION

LP

NOTE: GRADING AND OVERLAND FLOW DIRECTIONS ARE CONCEPTUAL.

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REV	1
DESCRIPTION	ISSUED FOR INFORMATION

FIGURE 11

LETHBRIDGE LAND
THE CROSSINGS OUTLINE PLAN

MAJOR STORMWATER MANAGEMENT

BENTON CROSSING
OUTLINE PLAN

Prepared for the

City of Lethbridge

by

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in association with

ARMIN A. PREIKSAITIS & ASSOCIATES LTD.

GIBBS & BROWN LANDSCAPE ARCHITECTS LTD.

B U N T & ASSOCIATES

COHOS EVAMY
ARCHITECTURE
ENGINEERING
INTERIOR DESIGN
PLANNING

eba

Revised October 2, 2008

TABLE OF CONTENTS

LIST OF FIGURES — AFTER PAGE

LIST OF ILLUSTRATIONS — PAGE

APPENDICES

1.0 INTRODUCTION

1.1 Purpose

The purpose of the Benton Crossing Outline Plan is to establish a framework for the future subdivision and development of lands within the Community Core, west of Benton Drive and north of Whoop-Up Drive. The *West Lethbridge Phase II Area Structure Plan* (ASP) was approved by City Council on May 16, 2005. Based upon the planning principles and objectives within the ASP, this Outline Plan provides more detailed information on future land uses and their intensity, the location of the combined school site, parks, open spaces, pedestrian and vehicular circulation within the Outline Plan Area.

The Outline Plan was prepared to comply with requirements within the adopted *West Lethbridge Phase II Area Structure Plan* and is consistent with the *City of Lethbridge Design Standards 2006 Edition*.

1.2 Location and Area

As shown on *Figure 1 - Location*, the Outline Plan Area is located west of the existing residential neighbourhood of Indian Battle Heights and north of the proposed extension of Whoop-Up Drive. The Outline Plan Area comprises approximately 110 ha (272 ac) of primarily City-owned land. Refer to Appendix A for the certificates of title for the Outline Plan Area.

1.3 Planning Context

The Benton Crossing Outline Plan has been prepared within the context of statutory plans and other policy documents of the City of Lethbridge. The following is a brief summary of relevant planning documents.

1.3.1 Municipal Development Plan

The City of Lethbridge Municipal Development Plan (MDP), Bylaw No. 4902, states the objectives and policies for orderly growth and development of the City.

On May 16, 2005, City Council amended the MDP (Bylaw 5320) in order to identify the Benton Crossing Outline Plan Area, including the Community Core, as a future urban growth area.

1.3.2 Urbanization of West Lethbridge, 1969

The "Urbanization of West Lethbridge" report, produced by the Oldman River Regional Planning Commission in 1969, recommended the development of West Lethbridge as a series of villages. The guidelines put forth in this report, regarding the village concept, stated that each village would be comprised of two neighbourhoods with the total area of the village being approximately one square mile in size.

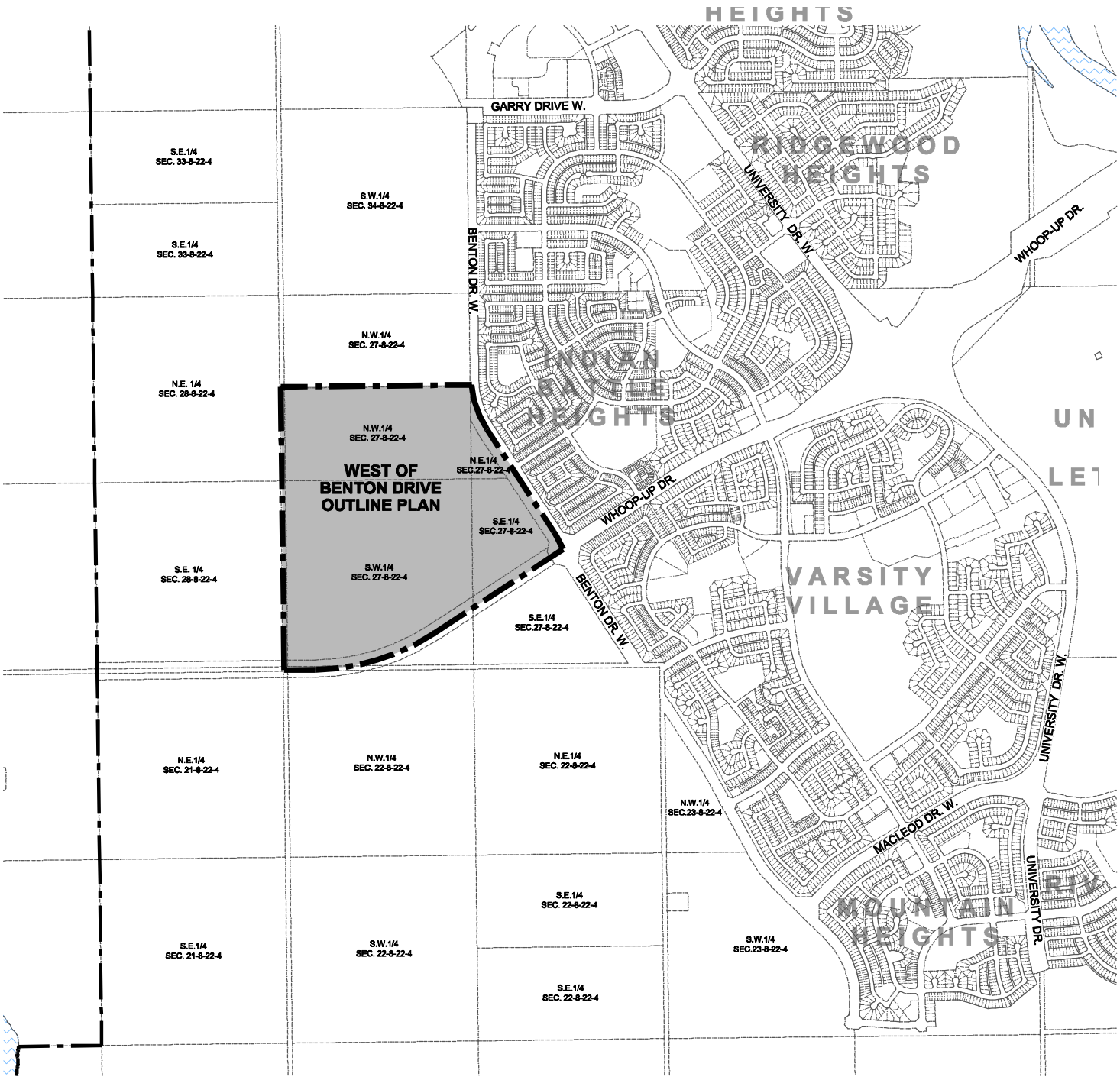
The 1969 Urbanization Plan also contained the framework for a centrally located community core to provide multi-village services to the West Lethbridge service area, which is being addressed through this Outline Plan.

1.3.3 West Lethbridge Phase II Area Structure Plan

City Council passed Bylaw 5321 on May 16, 2005 adopting the West Lethbridge Phase II ASP, thereby establishing a conceptual land use and infrastructure plan to guide future development of lands located west of Benton Drive. The Benton Crossing Outline Plan complies with the approved West Lethbridge Phase II ASP. A decision was made not to develop an access at Blackfoot Boulevard West and Benton Drive. Other major roadway accesses to the Outline Plan area are consistent with the West Lethbridge Phase II ASP, thus an amendment should not be required.

The area structure plan for West Lethbridge Phase II will help guide the growth and development of two future neighbourhoods, to the north and south of Whoop-Up Drive, and the Community Core. The area structure plan provides the framework for the future detailed design and development of land uses (education facilities, retail and office space, recreation facilities, a library, seniors' housing, multi-unit housing and other community services), major roadways, utility services and amenities to accommodate approximately 20,000 people. The purpose of the West Lethbridge Phase II ASP "*is to develop planning, urban design and infrastructure solutions that will ensure the creation of a vibrant, livable and diverse activity centre in West Lethbridge.*"

The ASP area encompasses a total area of 698 ha (1,724.8 ac) and will ultimately accommodate a population of approximately 21,750 at full build-out. The proposed Community Core was identified as encompassing approximately 105 ha (260 ac), while the remaining area, comprising the North Village, will include approximately 228 ha (563 ac). The



LEGEND

OUTLINE PLAN AREA

CITY OF LETHBRIDGE CORPORATE LIMITS

Figure 1 Location

Associated Engineering

in association with:

Armin A. Preiksaitis & Associates Ltd.

0 100 250 500 m

N

Benton Crossing Outline Plan

South Village is proposed to include approximately 365 ha (902 ac).

1.3.4 Adjacent Planning Areas

The Benton Crossing Outline Plan Area lies within the approved West Lethbridge Phase II Area Structure Plan (ASP) (see *Section 1.3.3*). The Mountain Heights / Riverstone / River Bend Area Structure Plan is in effect for these neighbourhoods, located southeast of the Outline Plan Area. The neighbourhoods of Varsity Village and Indian Battle Heights are located immediately to the east of the Outline Plan Area. Varsity Village is bounded by Whoop-Up Drive to the north, University Drive to the east, McLeod Drive to the south and Benton Drive to the west. Indian Battle Heights is bounded by Garry Drive to the north, University Drive to the east, Whoop-Up Drive to the south and Benton Drive to the west. The West Highlands Area Structure Plan is in effect for the area to the northeast of the Outline Plan Area.

1.3.5 Land Use Bylaw

The City of Lethbridge Land Use Bylaw No. 4100 defines land use district for all lands within the City. The land within the proposed Outline Plan Area is currently districted Urban Reserve (UR). The purpose of designating land Urban Reserve is to "*control subdivision and development until the required municipal services are available, area structure or area redevelopment plans are approved, and more appropriate alternative districts are applied*".

Future land use amendments to the Land Use Bylaw will be required in order to reflect land use designations proposed in this Outline Plan.

1.4 Public Consultation

An Open House was held at G.S. Lakie Middle School on May 24, 2006, from 4:00 to 8:00 pm, to present the draft Benton Crossing Outline Plan to the public and provide the opportunity for participants to comment on the draft plan.

In speaking to people attending the Open House, no major concerns were expressed about specific aspects of the Outline Plan. Although few comment sheets were received, many people like the proposed Village Square as a focal point for the Community Core. The only real concern expressed was the impact that construction of Benton Drive may have upon existing housing in the Indian Battle Heights Neighbourhood, which now backs onto farm fields.

1.5 Plan Organization

Section 1.0 - Introduction: Provides an overview of the Outline Plan by documenting the purpose, background, planning context, public consultation opportunities and the West Lethbridge Phase II ASP.

Section 2.0 - Existing Conditions: Profiles existing site conditions including the physical environment and existing land uses, describes the results of the Geotechnical Evaluation and a Phase I Environmental Site Assessment, and provides the response from Alberta Community Development regarding the need for a Historical Resources Impact Assessment.

Section 3.0 - Development Concept: Presents the overall development concept based upon the planning principles, design guidelines, opportunities and constraints in the Outline Plan Area, land use designations, and the proposed location of community mailboxes.

Section 4.0 - Urban Design: Discusses buffering and interface treatment within and adjacent to the Outline Plan Area, as well as architectural controls and entrance features.

Section 5.0 - Transportation and Circulation: Describes the external and internal roadway network, transit routes and the pathway network.

Section 6.0 - Utility Servicing: Provides information regarding the proposed water servicing, sewer servicing, and stormwater management in the Outline Plan area.

Section 7.0 - Staging and Implementation: Summarizes the implementation actions necessary, including the tentative phasing, plan of subdivision and redistricting, and amending the plan.

2.0 EXISTING CONDITIONS

2.1 Site Characteristics

As shown on *Figure 2 - Site Conditions*, the Outline Plan Area is generally characterized as an undulating plain with elevation that ranges from 930 m to 942.5 m.

The Outline Plan Area is well suited for urban development in terms of geology, soils, topography and overall drainage conditions. The sands of the Buffalo Lake till in west Lethbridge are high, which may affect deep foundations such as those for underground parking structures of two-levels or more. With respect to the level of urban development anticipated for the Outline Plan Area, no geotechnical issues are anticipated.

To the north and west of the Outline Plan Area, non-urbanized agricultural lands constitute the main surrounding land use. South of Whoop-Up Drive, construction of the Copperwood neighbourhood is underway. The Copperwood neighbourhood will be composed primarily of low density residential uses, with an estimated population of 4,259 at build out. The residential village of Indian Battle Heights is located immediately to the east of the Outline Plan Area. A prominent surrounding land use is the University of Lethbridge campus located east of Varsity Village.

2.2 Opportunities and Constraints Analysis

As determined during the preparation of the West Lethbridge Phase II ASP, there are several constraints within the larger ASP area such as sweet gas wells and pipelines, but there are no significant constraints affecting development within the Outline Plan Area, except for one abandoned gas well in SW ¼ 27-8-22 W4M (refer to *Section 2.4*).

2.3 Geotechnical Evaluation

A preliminary geotechnical report was prepared by EBA Engineering Consultants Ltd. (EBA) in May 2005 in support of this Outline Plan application. A complete copy of the Summary Report is provided in Appendix B.

Research was conducted to review the possible existence of mine workings within the boundary of the proposed development area (majority portion of Section 27-8-22 W4M), using a publication by ERCB (Coal mine Atlas, 1988) and other literature in EBA's library. The review indicated that no mine

workings exist within Section 27. However, it is noted that underground mine workings present in the area are as follows:

- Section 34 and 35 (north of site - north half of section)

Mine 1464 - commonly referred to as Galt Mine No. 8, most recently owned and operated by Lethbridge Collieries Ltd., between 1935 and 1957.

- Section 35 (northeast side)

Mine 0054 - most recently owned and operated by Lethbridge Collieries Ltd., between 1935 and 1941.

The existence of these mines should not impact the proposed development.

The subsurface stratigraphy for the Benton Crossing Outline Plan Area is expected to be somewhat variable for the surficial soils, however, relatively consistent at lower depths (below 2 m). The site in general should consist of layers of topsoil, localized areas of relatively thin surficial clay fill, isolated areas of native lucustrine clay and silt, with predominantly glacial clay till at underlying depths below ground surface elevation.

The initial topsoil stripping depth has been identified to EBA as being of particular importance. As noted, the surficial topsoil (A Horizon) layer is somewhat variable in thickness and can be attributed to cultivation of the land surface. However, for such a development, the majority of any underlying B Horizon layer (organic stained, but inorganic) can likely remain in place during site stripping and incorporated into the fill mass during general site grading. Full-time monitoring by experienced personnel is recommended in order to avoid over-stripping and ensure appropriate material mixing and placement.

Subgrade preparation is required in all subdivision development areas, including lot grading, as well as all paved areas, to City of Lethbridge Standards. This includes the stripping of topsoil and deleterious fill materials, scarification and moisture conditional and compaction. The native medium plastic clay and clay till soils should be acceptable for site grading purposes in all areas. The clay soil near the surface appears to be variable across the site and moisture conditioning (both wetting and drying) will be required to reduce the swelling potential of this soil and achieve the compaction standards recommended. Proof-rolling within roadways to detect soft areas is also recommended.

LEGEND

- DIRECTION OF DRAINAGE
- 2.5m CONTOUR INTERVAL
- ABANDONED GAS WELL
- OUTLINE PLAN BOUNDARY

Figure 2
Site Conditions

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Armin A. Preiksaitis & Associates Ltd.

0 50 100 250 m

N

Benton Crossing Outline Plan

2.4 Environmental Site Assessment

EBA Engineering Consultants Ltd. (EBA) was retained to conduct a Phase I Environmental Site Assessment (ESA) of properties located in the Outline Plan Area, west of Benton Drive, in West Lethbridge. A copy of the complete report is provided in Appendix C, along with an addendum letter.

The objective of the Phase I ESA was to comment on whether any past or present site use, either on-site or off-site, may have a potential to cause environmental impairment of the subject properties. It is understood that this area is in the planning stage and community core development, including schools, a public library and other recreations facilities, is planned for the site defined in this report.

EBA has obtained and reviewed select historical information pertaining to the site and adjacent lands back to 1912. The potential source of impairment to the site is the abandoned lease in SW ¼ 27-8-22 W4M. Refer to *Figure 2 - Site Conditions*. Thunder Energy Inc. (the licensee of the abandoned wellhead) has reviewed their files pertaining to this lease. Although a reclamation certificate was issued in June 2000, there has been no environmental assessment work conducted on the lease. No information could be provided on the drilling waste disposal. It was further indicated that the wellhead was cut and capped approximately 1 m below grade, all developers and contractors should be notified of the wellhead location. Thunder Energy Inc. will address any contamination concerns clearly associated with historical activity at the wellhead location.

Further information pertaining to the development setbacks from abandoned wellheads was provided. These setback requirements, of 5 m from wellhead with an additional 10-15 m for possible well maintenance, should be considered during the development of the lease area.

Further assessment on the abandoned lease in SW ¼ 27-8-22 W4M is warranted prior to development within the lease boundary. Refer to *Figure 2 - Site Conditions*.

2.5 Historical Resources

The Cultural Facilities and Historical Resources Division (CFHRD) of Alberta Community Development determined that a Historical Resources Impact Assessment was not required and *Historical Resources Act* clearance was given prior to the preparation of the West Lethbridge Phase II ASP. A copy of the letter from Alberta Community Development providing clearance is included in Appendix D.

3.0 DEVELOPMENT CONCEPT

3.1 Vision for the Community Core

The vision articulated in the West Lethbridge Phase II ASP describes the Community Core area as follows.

"*The Community Core is a pedestrian-oriented, mixed use centre where residents can live, work, shop, play and learn. It also provides a focal point for surrounding villages and a range of public and civic facilities such as schools, libraries and recreational centres, offering private commercial / retail businesses, offices, multi-unit housing, senior's housing and a health clinic all integrated into a common destination."*

3.2 Key Planning Principles

The following are a summary of the key planning principles contained in the ASP to guide growth and development within the ASP area. The Outline Plan reflects these planning principles.

Principle #1: *Provide a framework that will facilitate financial viability of future development through the orderly and economic extension of services and strategic allocation of land uses.*

Principle #2: *Promote walkability by creating functional, safe and attractive pedestrian environments.*

Principle #3: *Foster integrated neighbourhoods that encourage a wider range of housing choice for different age and income groups.*

Principle #4: *Provide a logical, safe, and efficient hierarchy of transportation systems within the ASP area to address the public transit, private automobile, and truck movement, pedestrian and bicycle transportation needs of residents and businesses.*

Principle #5: *Create a sense of place that adds visual interest and fosters social interaction, where people want to spend time.*

Principle #6: *Design attractive and functional open spaces.*

Principle #7: *Foster the safety and comfort of residents to enhance liveability.*

Principle #8: *Accommodate needed community services and recreational opportunities.*

Principle #9: Encourage mixed use development within the Community Core to create opportunities to live, work, shop, play, and learn.

3.3 Design Guidelines

As part of the preparation of the ASP, design guidelines, included in Appendix E, were developed to help ensure exemplary public and private development within the Community Core area. The design guidelines are intended to be implemented through the subdivision review process, the Land Use Bylaw and incorporated as requirements in the developer proposal call process.

3.4 Land Use Designations

The proposed land use designations are shown on *Figure 3 - Development Concept*. Land use and population statistics for the Outline Plan Area are found in Appendix F.

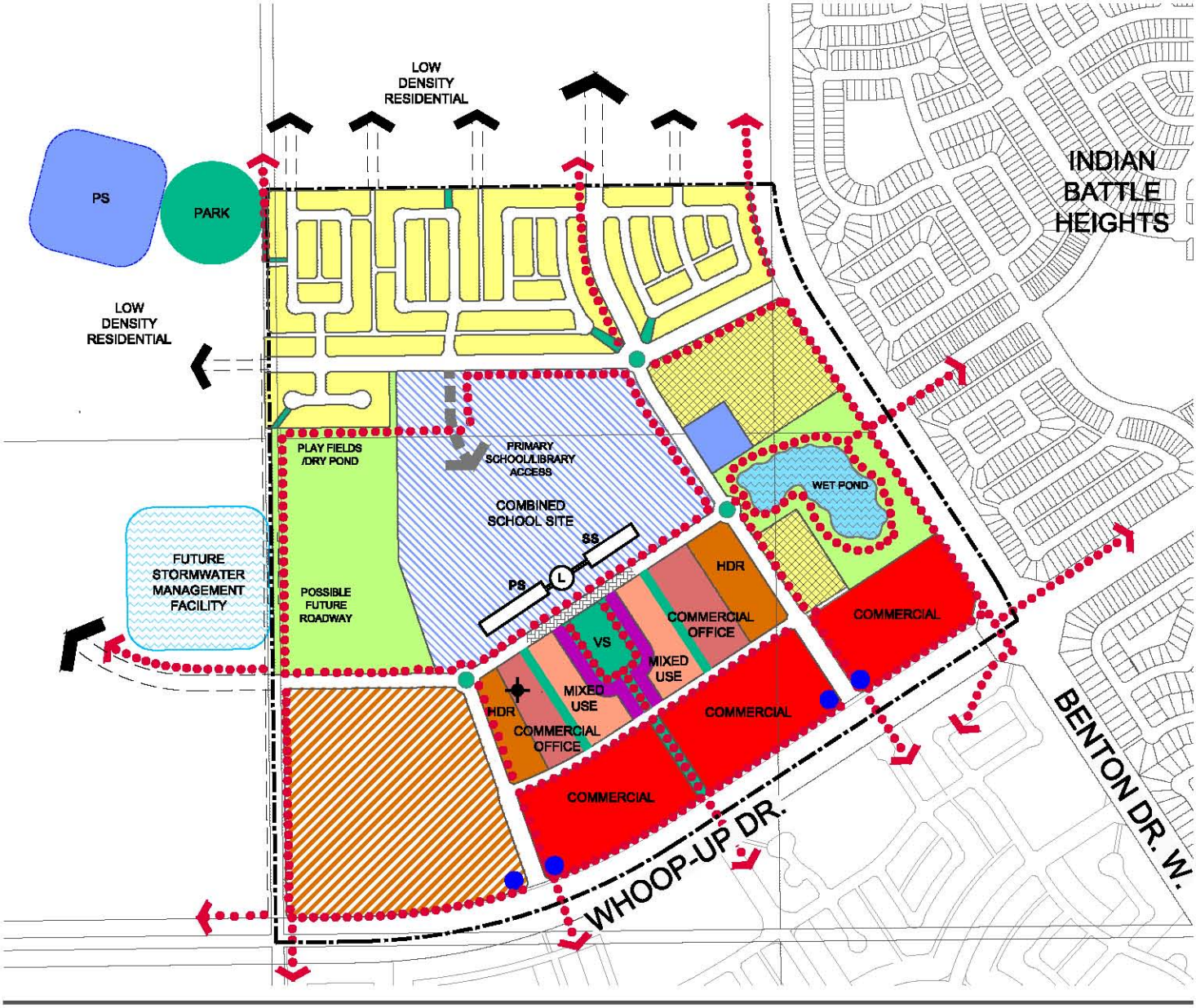
3.4.1 Combined School Site / Library

As part of the preparation for this Outline Plan, consultation with the Lethbridge Public School District No.51, the Holy Spirit Roman Catholic School Board and the Lethbridge Public Library took place. As a result of these discussions, 16.6 ha (41.0 ac), or 16% of the Gross Developable Area (GDA), are allocated to accommodate the two schools. An additional 1.2 ha (3.0 ac) site for a library, or 1% of the GDA, has also been provided.

The combined school site and public library are located midway between the two collector roads accesses from Whoop-Up Drive. The proposed 8.2 ha (20.3 ac) stormwater dry pond on the west side of the combined school site will provide additional space for playfields bringing the total area of the combined Municipal Reserve sites to 24.8 ha (61.3 ac).

The Public School Division envisions that the new high school will be initially designed to accommodate 900 students (Phase I), with the ability to expand to 1,100 students by 2009 (Phase II). The Holy Spirit Roman Catholic Junior / Senior High School will initially accommodate 450 students (Phase I), with the ability to expand to accommodate 600 students (Phase II).

The combined school site and public library would be redistricted as P-B Public Building at an appropriate time prior to subdivision.



LEGEND

- COMBINED SCHOOL SITE
- COMMERCIAL
- COMMERCIAL / RESIDENTIAL (MIXED USE)
- HIGH STREET (COMMERCIAL / RESIDENTIAL / OFFICE)
- COMMERCIAL / OFFICE
- INSTITUTIONAL
- SUBDIVISION ENTRY FEATURES
- ABANDONED GAS WELL
- SINGLE DETACHED / DUPLEX RESIDENTIAL
- COMPREHENSIVE RESIDENTIAL / SENIORS
- HIGH DENSITY RESIDENTIAL
- SWING SITE (RECREATIONAL FACILITY OR LOW DENSITY RESIDENTIAL)
- PAVING PATTERN
- STORMWATER MANAGEMENT FACILITY
- PARK / VILLAGE SQUARE (VS) / PUL
- ROUND-ABOUT
- PATHWAYS
- OUTLINE PLAN BOUNDARY
- PS / SS /L — PUBLIC SCHOOL SEPARATE SCHOOL LIBRARY
- POSSIBLE FUTURE CONNECTION

NOTE:

POND SHAPES ARE CONCEPTUAL AND ARE SUBJECT TO CHANGE DURING DETAILED LANDSCAPING PHASE

ROAD CLASSIFICATIONS ARE SUBJECT TO CONFIRMATION THROUGH T.I.A.

LANES IN NORTHWEST PARCEL ARE TO BE CONTINUED INTO THE DEVELOPMENT TO THE NORTH.

0 50 100 250 m

N

Figure 3
Development Concept

Associated Engineering

in association with:

Armin A. Preiksaitis & Associates Ltd

Benton Crossing Outline Plan

3.4.2 Swing Site (Recreation Multiplex or Low Density Residential)

A swing site of approximately 12.5 ha (30.9 ac), or 12% of the GDA, has been identified for the south west corner of the plan area. This location provides for easy access from the combined school site and Whoop-Up Drive.

Dependant on market demand, the swing site could function as a major regional facility that may include a recreation multiplex with a swimming pool, ice arenas, gymnasiums, fitness centre, multi-purpose meeting rooms and community services. Alternatively, this area could be developed as single detached / duplex residential.

The swing site is proposed to be designated as either P-B Public Building or as R-L Low Density Residential, dependant on its ultimate land use, at an appropriate time prior to subdivision.

3.4.3 Commercial

A district level shopping centre anchored by a grocery store is proposed northwest of the intersection of Whoop-Up and Benton Drive and proceeding west to the second site access. The three commercial sites, totaling approximately 11.5 ha (28.4 ac) or 11% of the GDA, have good visibility and access from the arterial roadway system. The proposed districting of the commercial sites would be C-H Highway Commercial. In keeping with the design guidelines, additional performance standards may need to be provided to ensure the design of the shopping centre is pedestrian friendly in addition to accommodating vehicular access and parking.

3.4.4 Commercial / Residential / Office Mixed Use

Directly south of the combined school site and surrounding the village square, 3.0 ha (7.41 ac) has been designated for commercial / residential and commercial / office mixed use development, representing 3% of the GDA, to accommodate commercial, residential, office, and institutional uses. A *high street* style development is also proposed within the mixed use area, surrounding the village square, to foster a pedestrian and street-oriented commercial environment.[1] Residential uses are included as discretionary uses in the existing Commercial

[1] A *high street* features a mixture of land uses, integrated both horizontally and vertically, typically with retail uses on the main floors and office and / or residential uses on upper floors. It is as a human-scaled environment with an attractive and lively streetscape that accommodates both vehicular and pedestrian traffic.

Districts of the City of Lethbridge Land Use Bylaw. As an appropriate mixed use land use development district does not currently exist within the City of Lethbridge Land Use Bylaw, a new district would be created or the DC Direct Control provisions in the Land Use Bylaw could be employed.

3.4.5 Institutional

A 0.7 ha (1.7 ac) parcel for institutional uses, 1% of the GDA, is located east of the combined school site and adjacent to the stormwater management wet pond facility. It is proposed that this parcel shall be re-districted to P-B Public Building at an appropriate time prior to subdivision.

3.4.6 Low Density Residential

Low density residential land uses are proposed for 15.5 ha (38.3 ac) or 15% of the GDA. Single detached and duplex residential areas with rear lane access decreases the need for on-street parking and limits direct driveway access to roadways, thereby creating a safe and attractive streetscape.

Proposed low density residential areas may be redistricted R-L Low Density Residential.

3.4.7 Comprehensive Residential / Seniors

Two areas, one north of the stormwater management wet pond facility, adjacent to Benton Drive, and the other north of the commercial area on the east side of the eastern access from Whoop-Up Drive, are designated for comprehensive residential / seniors development. In total, 5.4 ha (13.3 ac) or 5% of the GDA is proposed to include a range of housing including single detached residential, street oriented duplexes, fourplexes, townhouses, walk-up apartments, and seniors development, dependant on market demand.

Comprehensive residential / seniors development in the Outline Plan Area is located adjacent or in close proximity to the collector roadway network and the stormwater management wet pond facility. Care must be taken in these areas to ensure a logical transition in height and density between different housing types, with medium density residential located along collectors roads and providing a transition from high density residential areas to low density residential areas.

Dependant on market demand, the lands designated for comprehensive residential / seniors development in the Outline Plan Area could be redistricted to a range of Land Use Districts to accommodate a variety of housing types. Districts in these areas could include R-CL Comprehensively Planned Low Density Residential, R-CM Comprehensively Planned Medium Density Residential, and R-75 Medium Density Residential.

Illustration 1: Residential / Seniors Development Adjacent to the Stormwater Management Wetpond Facility

3.4.8 High Density Residential

Proposed high density residential development is 2.4 ha (5.9 ac) or 2% of the GDA.

High density development in the Outline Plan Area is located adjacent to mixed use and commercial areas and to collector roadways to encourage walkability and to minimize the impact of high volumes of traffic through low density residential areas.

It is proposed that the lands designated for high density residential development in the Outline Plan Area be designated as High Density Residential (R-150).

3.4.9 Parks, Open Space and Pathways

Figure 3 - Development Concept shows the parks, open space and pathways proposed in the Outline Plan Area.

The parks and open system consists of school playfields, a village square, wet and dry stormwater ponds, and complementary pathways. The design of the parks and open space system provides both passive and active recreational opportunities for the community, and creates visual interest and focal points within the Outline Plan Area.

The west stormwater dry pond is approximately 8.2 ha (20.3 ac) and the east stormwater wet pond is 5.7 ha (14.1 ac), representing 14% of the GDA. Wherever possible, low density housing has been designed to back onto stormwater management facilities to offer increased amenity. Treated stormwater may be used to irrigate parks and the school site and the feasibility of supplementing the wet pond with irrigation water, in order to maintain a consistent water level, will be investigated.

A 1.1 ha (2.7 ac) village square, representing 1% of the GDA, has been sited directly south of the combined school site, across the collector road from the library. Mixed use development and a ground level high street ring the village square so as to take advantage of local pedestrian traffic generated from surrounding uses and create an active and safe public space.

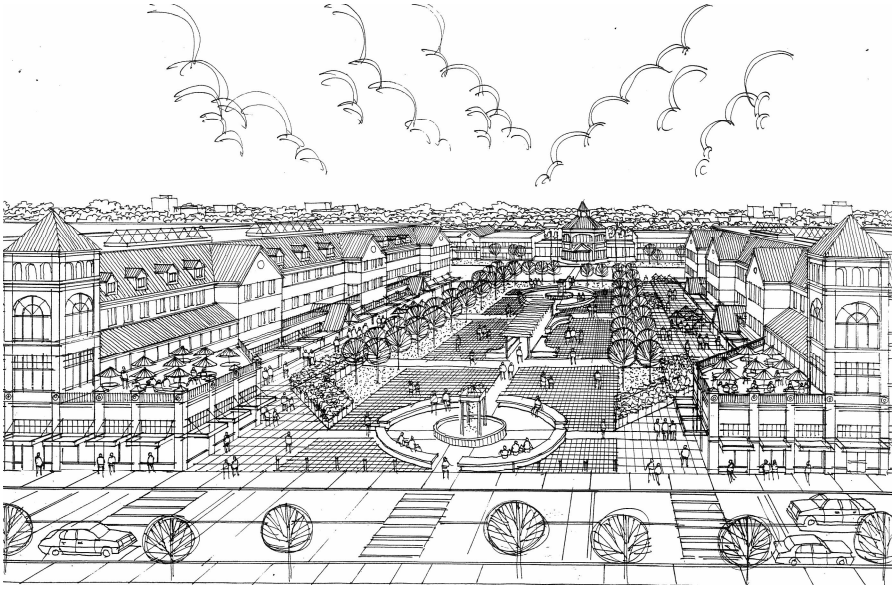


Illustration 2: Ground Level High Street Surrounding the Village Square.

As shown on *Figure 3 - Development Concept*, the pathway network is intended to link amenities such as stormwater management ponds, neighbourhood parks, the combined school site and other amenities together, and connect with the City's regional trail system. Pathway crossings are located at intersections and, as much as possible, are incorporated into stormwater management facilities, linear connections and utility right-of-ways.

3.4.10 Municipal and Environmental Reserve

The dedication of Municipal Reserve (MR) will be the primary means of developing the parks and open space system and is illustrated on *Figure 3 - Development Concept*.

It should be noted that portions of the stormwater management facility areas may qualify for MR credit. The specific amounts of MR credit within these stormwater management facilities will be determined at the subdivision application stage when the detailed design of these facilities is completed.

It should also be noted that the combined school site area consists of 16% of the gross developable area of the site.

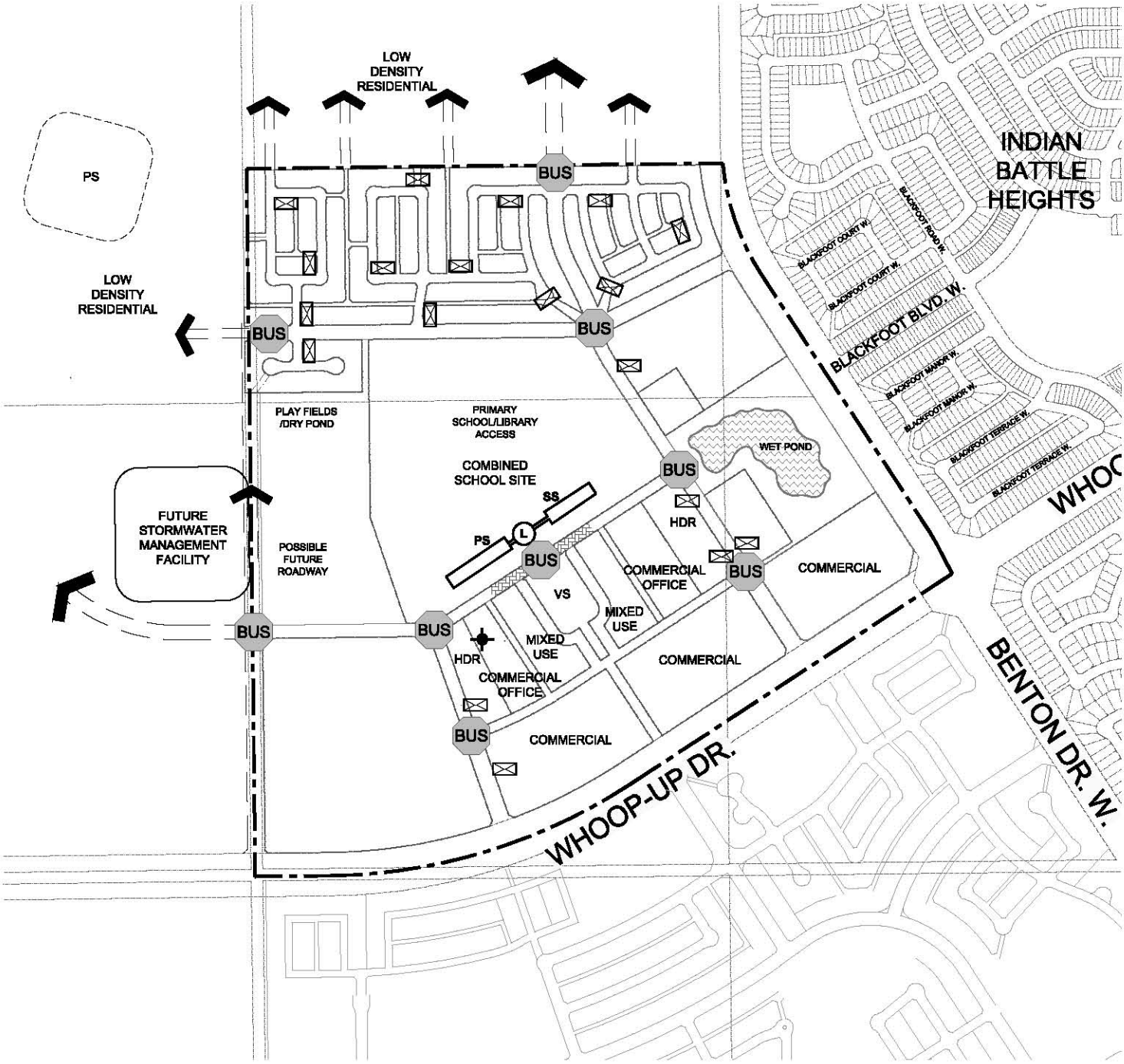
All areas within the Outline Plan Area are deemed to be developable, so there is no need for any environmental reserve dedication in accordance with Section 664 of the Municipal Government Act.

3.5 Community Mailboxes

Canada Post has provided conceptual locations for community mailboxes throughout the Plan area as shown on *Figure 4 - Community Mailboxes and Transit*. The final locations of Community Mailboxes will be established at the detailed design stage.

3.6 Abandoned Gas Well

An abandoned gas well is located in the south west of the Outline Plan area, as illustrated in *Figure 3 - Development Concept*. At the detailed design stage, an unobstructed working space of 10 x 15 metres around the well and an access route of 8 metres to the well, from the nearest road right-of-way, will be maintained. This is in accordance with Alberta Energy and Utility Board recommendations for setbacks from abandoned wells.



LEGEND

- CANADA POST MAILBOX SITES
- BUS — POSSIBLE BUS STOP LOCATION
- OUTLINE PLAN BOUNDARY
- POSSIBLE FUTURE CONNECTION

NOTE:

ALL TRANSIT STOPS ARE APPROXIMATE AND ARE SUBJECT TO CHANGE AS LANDS OF WEST BENTON DRIVE DEVELOPS.

MAILBOX SITE COULD REQUIRE PULLOUT IN FUTURE.

0 50 100 250 m

N

Figure 4
Community Mailboxes & Transit

Associated Engineering

in association with:

Armin A. Preiksaitis & Associates Ltd.

Benton Crossing Outline Plan

4.0 URBAN DESIGN

4.1 Buffering and Interface Treatments

The community core area is designed to promote a compact, higher density mixed use development that encourages walkability. As such, various land uses such as the commercial areas, higher density housing, mixed use areas, village square, and high street and amenities have been organized in close proximity to each other.

The Outline Plan Area will be separated from the Indian Battle Heights neighbourhood with the future development of Benton Drive as a divided arterial roadway. Adequate right-of-way exists to make provisions for buffering and noise attenuation if necessary. The uses proposed within the community core will not create any conflicts with existing land uses within the Indian Battle Heights neighbourhood to the east. In fact, the Outline Plan proposes to enhance connectivity between the community core and Indian Battle Heights with improved pedestrian connections to the high schools, shopping, and community services the community has to offer.

The Copperwood Outline Plan has been approved for a portion of the ASP area south of the future extension of Whoop-Up Drive. Land uses proposed within the Copperwood area include multi family residential development, a religious assembly site and a predominantly low density residential development providing a good transition and interface treatment with the community core to the north.

Lands east of and north of the community core provide for logical extensions of land uses, roadways, and stormwater management facilities to make the continuation and compatibility of land use patterns seamless.

4.2 Design Guidelines and Architectural Controls

In addition to the Design Guidelines contained in Appendix E, architectural controls for residential, commercial and mixed use developments will be registered by the developer on title subsequent to subdivision and the registration of title lots. Architectural controls are an effective way of ensuring architectural compatibility and a high quality of development, which not only provides a means of implementing the objectives of the Outline Plan, but also provides a level of comfort for potential homebuyers and other investors / developers.

4.3 Subdivision Entrance Features

Subdivision entrance features are proposed in the locations shown on *Figure 3 - Development Concept*. They provide a gateway feature to the neighbourhood and help create a strong sense of place and pride for area residents, businesses and users.

The subdivision entrance features may include any of the following elements: signage, special pavements, landscaping, public art or a combination thereof. The form and character of the subdivision entrance features will be determined at the subdivision stage through a detailed design. Consideration will be given during the design stage to ensure the entrance features are durable and designed in such a way as to minimize ongoing maintenance and operating costs.

5.0 TRANSPORTATION AND CIRCULATION

5.1 Access and External Roadway System

The Plan area will be serviced with the westerly extension of Whoop-Up Drive and the future construction, on the east boundary, of Benton Drive, as major arterial roadways. Both roadways will be developed to a divided arterial standard with 75 m right-of-ways. A functional planning study and detailed design has been completed for the extension of Whoop-Up Drive and construction is complete.

Roadway connections from the Outline Plan area to the north village of the West Lethbridge Phase II Area Structure Plan will be provided primarily utilizing the proposed Collector roadways. From the Single Detached / Duplex Residential area in the north portion of the Outline Plan area, two Local roadway connections are provided to the Low Density Residential areas in the West Lethbridge Phase II Area Structure Plan. These connections will provide vehicular and pedestrian connectivity for these residential areas. Roadway connections from the Outline Plan area to the West Lethbridge Phase II Area Structure Plan are illustrated on *Figure 5 - Transportation Network*.

5.2 Internal Roadway System

The internal road network will exhibit a combination of Collector and Local roadways. One all-turns T-intersection access point is shown with the future extension of Benton Drive. Two T-intersection accesses to the plan area are shown from Whoop-Up Drive. Future extension of Whoop-Up Drive as a paved arterial roadway would provide an all-directional access on the western boundary of the Plan area. Three roundabouts are proposed as intersection treatments. These roundabouts are anticipated to help facilitate the flow of traffic, calm traffic near the public institutes, and act as a gateway feature for the community.

A traffic impact assessment (TIA) was completed for the Outline Plan area to determine the required sizing of roadways, intersection traffic control, and corresponding lane arrangement requirements. The results of the TIA will confirm the road network prior to application for subdivision approval.

The detailed intersection capacity and critical road link analysis, along with the recommended traffic control and corresponding lane arrangements for the interim (10-year) and long-term (Full build-out) planning horizons are addressed in the TIA.

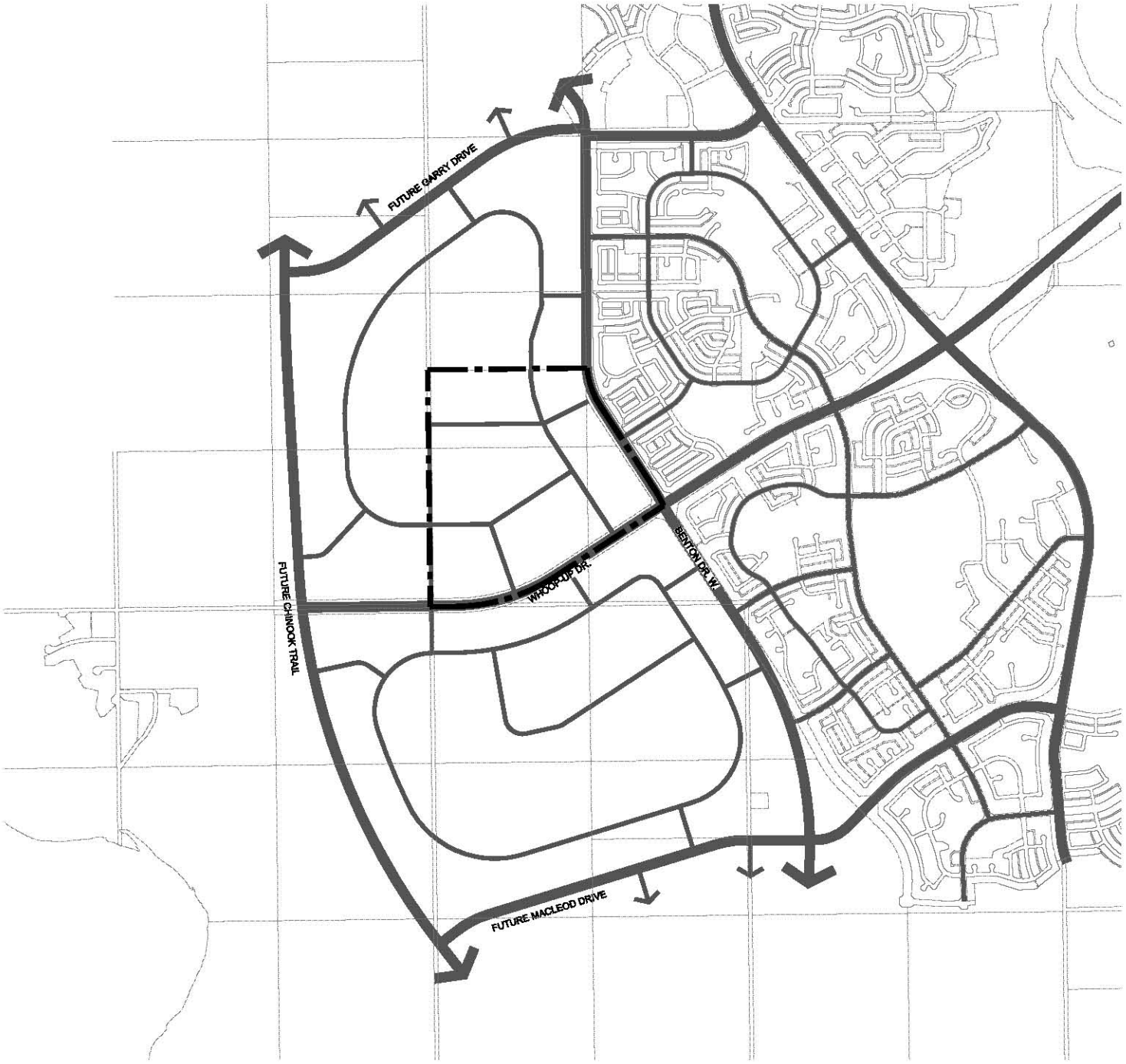
5.3 Sound Attenuation

The width of the arterial right-of-ways for both Whoop-Up and Benton Drives are 75 m (246 ft.), which will allow adequate separation space and buffering if required.

5.4 Transit Routes

A plan for the tentative transit stop locations is shown of *Figure 4 - Community Mailboxes and Transit*. In accordance with the City of Lethbridge subdivision design standards, public transit routes will be designed to follow the internal collector roadway system. The City of Lethbridge uses a public transit-servicing standard that provides public transit access within 400 metres of at least 95 percent of all residences, commercial facilities and public service facilities. A 200 m bus stop spacing along collector roads and as near as possible to intersections is recommended in order to control jaywalking.

Transit routes in the Outline Plan Area should avoid deadheading. As the phases of development advance, any transit routes terminating in dead ends should be extended to create circuitous routes.



LEGEND

- ARTERIAL ROAD
- COLLECTOR ROAD
- OUTLINE PLAN BOUNDARY

Figure 5
Transportation Network

Associated Engineering

in association with:

Armin A. Preiksaitis & Associates Ltd

0 0.25 0.50 1.00 km

N

Benton Crossing Outline Plan

6.0 UTILITY SERVICING

6.1 Water Distribution

The City of Lethbridge water distribution system is divided into three pressure zones. West Lethbridge comprises one pressure zone. A set of high-lift pumps at the Water Treatment Plant delivers water through a dedicated fill line to the West Lethbridge Reservoir, from which water is pumped into West Lethbridge.

The City of Lethbridge UIMP Study (Stantec, 2000) recommended that an additional river crossing be constructed to provide additional reliability and security of delivery. The UIMP also stated that additional water storage is required in West Lethbridge to improve the operation of the existing system and to provide for new development. A new reservoir within West Lethbridge and an additional river crossing are included in the City of Lethbridge's Capital Development Plan. Construction of both projects is planned for 2012.

The existing water distribution network adjacent to the Outline Plan Area consists of:

- a 400 mm diameter watermain along the Benton Drive ROW between Whoop-Up Drive and Garry Drive
- a 400 mm diameter watermain along the Whoop-Up Drive extension west of Benton Drive

The proposed water distribution network in the Outline Plan Area is shown on Figure 6 - Water Servicing Concept. The network will be sized to satisfy the following City of Lethbridge level of service objectives:

- minimum acceptable pressures to be no less than 310 kPa during peak hour demand
- minimum acceptable pressures to be no less than 345 kPa during maximum day demand
- maximum delivered pressures to be no greater than 620 kPa

An additional service objective is that the minimum fire flow be no less than 75 L/s in residential areas, with a minimum residual pressure of 150 kPa, during maximum day demand.

The majority of the watermains within the Outline Plan Area will consist of 200 mm diameter PVC pipe. 300 mm diameter PVC pipe will extend along the collector roads and some lots will be serviced from these watermains.

The water distribution network in the Outline Plan Area will connect to the City's network at four locations: one connection to the 400 mm diameter watermain along Benton Drive and three connections to the 400 mm diameter watermain along Whoop Up Drive. The water distribution network in the Outline Plan Area will connect to the future development area to the north at three locations and will connect to the future development area to the west at two locations, as shown on Figure 6.

The Outline Plan Area will be developed in nine phases (see Section 7.0 for more information of the development phasing). Figure 7 - Water Service Staging shows the boundary of the nine phases of development. In the initial phase, the water distribution network in the Outline Plan Area will connect to the City's network at two locations. The third connection to the City's network will occur in the second phase of development. The fourth connection to the City's network will occur when Whoop-Up Drive is extended west of the Outline Plan Area.

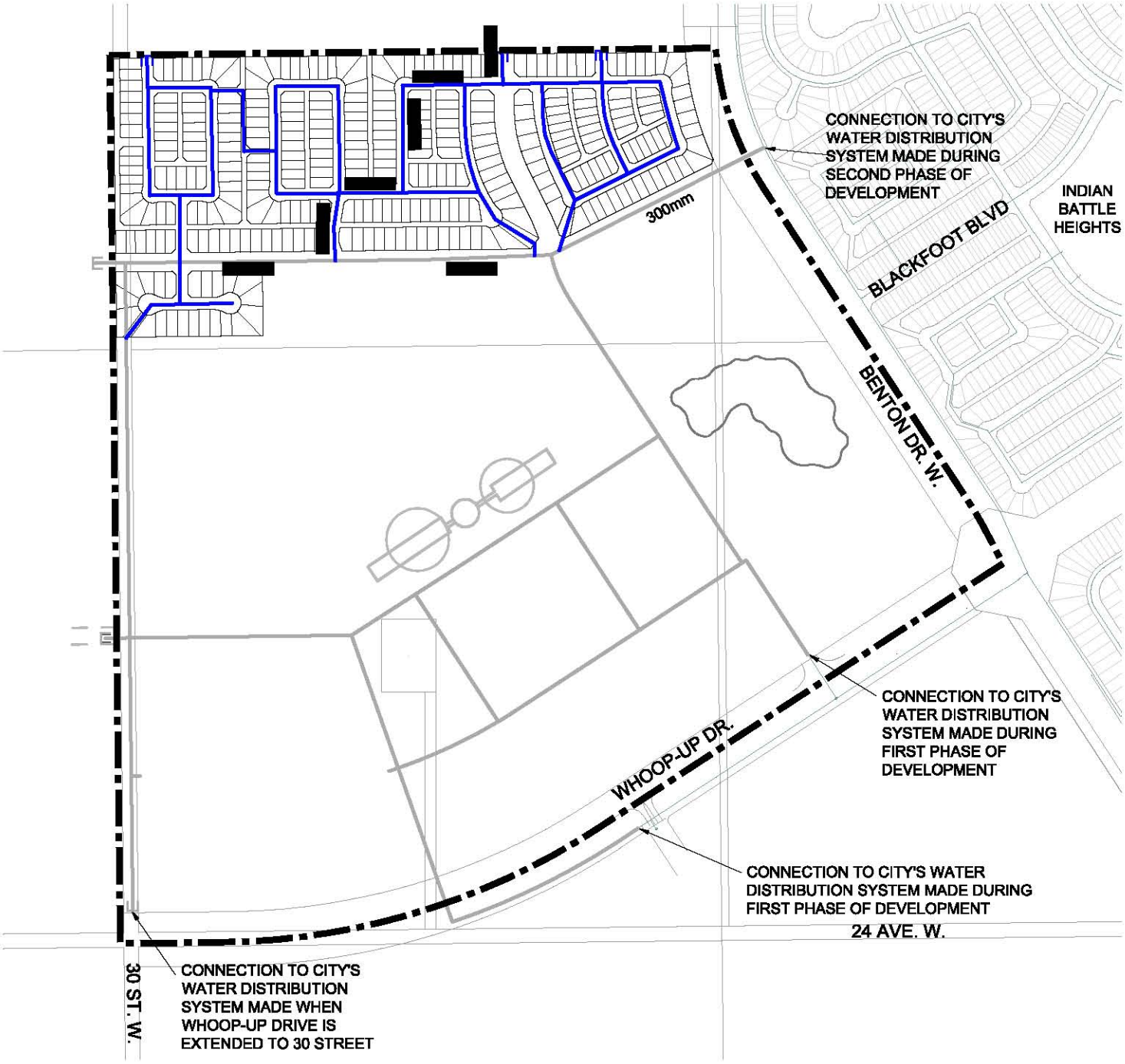
The proposed water distribution network in the Outline Plan Area was modeled using WaterCAD (Version 6.5). Four demand scenarios were modeled:

- average day demand (ADD)
- maximum day demand (MDD)
- peak hour demand (PHD)
- maximum day demand plus fire flows

Supply pressures of 986.58 kPa for ADD, 983.40 kPa for MDD and 974.92 kPa for PHD were assumed at the connections to the existing distribution system. Total water demands for the various demand scenarios and phases are summarized in Table 6-1. These demands were developed using water use rates presented in the City of Lethbridge Design Standards (2006). Appendix G contains a more detailed summary of the water demands. Note that the water demands for the off-site catchments were not included in the model.

Table 6-1 Water Demands in Outline Plan Area

Demand Scenario	Full Development MLD (L/s)
Average Day Demand	1.829 (21.18)
Maximum Day Demand	4.061 (47.01)
Peak Hour Demand	6.439 (74.52)
Population Equivalent for Design	2614



LEGEND

- Outline Plan Boundary
- Existing Watermains
- Proposed Watermains

Figure 6
Water Servicing Concept

Associated Engineering

in association with:
Armin A. Preiksaitis & Associates Ltd.

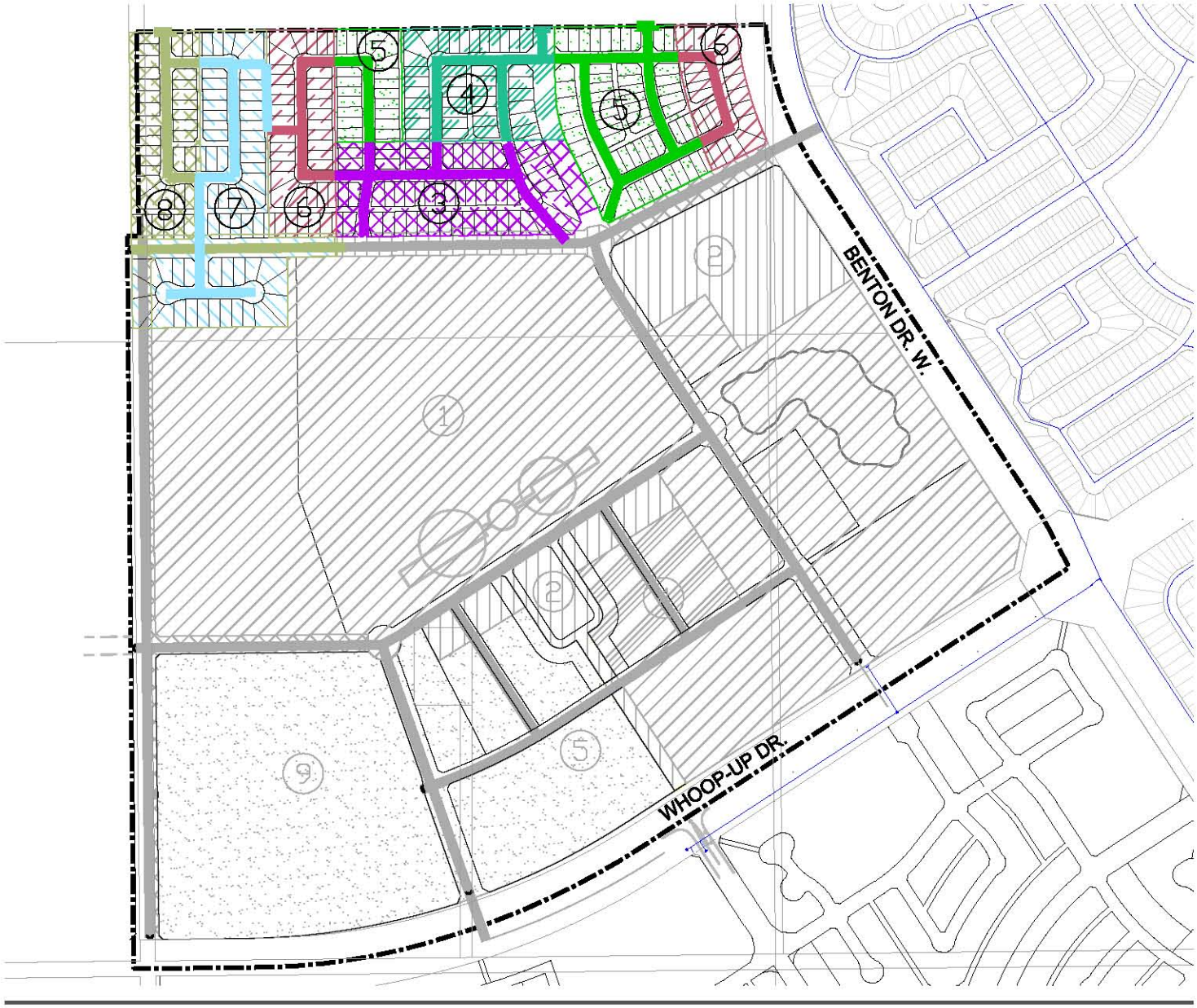
NOTES

1. All proposed watermains are 200mm unless otherwise indicated

0 50 100 250 m

N

Benton Crossing Outline Plan



LEGEND

	Outline Plan Boundary		Existing Watermains
1	Phase 1		Proposed Watermains Phase 1
2	Phase 2		Proposed Watermains Phase 2
3	Phase 3		Proposed Watermains Phase 3
4	Phase 4		Proposed Watermains Phase 4
5	Phase 5		Proposed Watermains Phase 5
6	Phase 6		Proposed Watermains Phase 6
7	Phase 7		Proposed Watermains Phase 7
8	Phase 8		Proposed Watermains Phase 8
9	Phase 9		Proposed Watermains Phase 9

Figure 7
Water Service Staging

Associated Engineering

in association with:
Armin A. Preiksaitis & Associates Ltd.

Benton Crossing Outline Plan

0 50 100 250 m

N

The modeling results showed that the proposed network satisfies the level of service objectives during ADD, MDD and PHD. The modeling results also showed that the proposed network satisfies the level of service objectives with respect to fire flows. Fire flows of 300 L/s will be available in the south portion (i.e., commercial area) of the Outline Plan Area. Fire flows of 210 L/s to 300 L/s will be available in the north portion. Fire flows of 300 L/s will be available around the school site.

6.2 Sanitary Collection

Wastewater flows from West Lethbridge are conveyed via a single siphon across the Oldman River to the Wastewater Treatment Plant. The City of Lethbridge UIMP Study (Stantec, 2000) stated that the ultimate development in West Lethbridge will require the expansion of the siphon system to the Wastewater Treatment Plant. The UIMP also stated that upgrades are required to the existing sanitary collection system in West Lethbridge to accommodate the additional flow that will be produced in the West Lethbridge Phase II development area.

The existing sanitary collection system near the Outline Plan Area consists of:

- a 675 mm diameter sewer along Whoop-Up Drive east of Benton Drive
- a 450/525/600 mm diameter sewer along the Whoop-Up Drive Extension west of Benton Drive

The Whoop-Up Drive sanitary sewer upgrade and the siphon system upgrade projects are included in the City of Lethbridge's Capital Development Plan. Construction of the Whoop-Up Drive sewer upgrade is planned for 2006 and construction of the siphon system upgrade is planned for 2008.

The proposed sanitary sewer system in the Outline Plan Area is shown on Figure 8 - Sanitary Servicing Concept. The network will be sized to satisfy the following City of Lethbridge level of service objectives:

- meet the dry weather demand with appropriate allowances made for wet weather inflows
- provide sanitary sewer capacity so that surcharging does not occur for the design peak flows

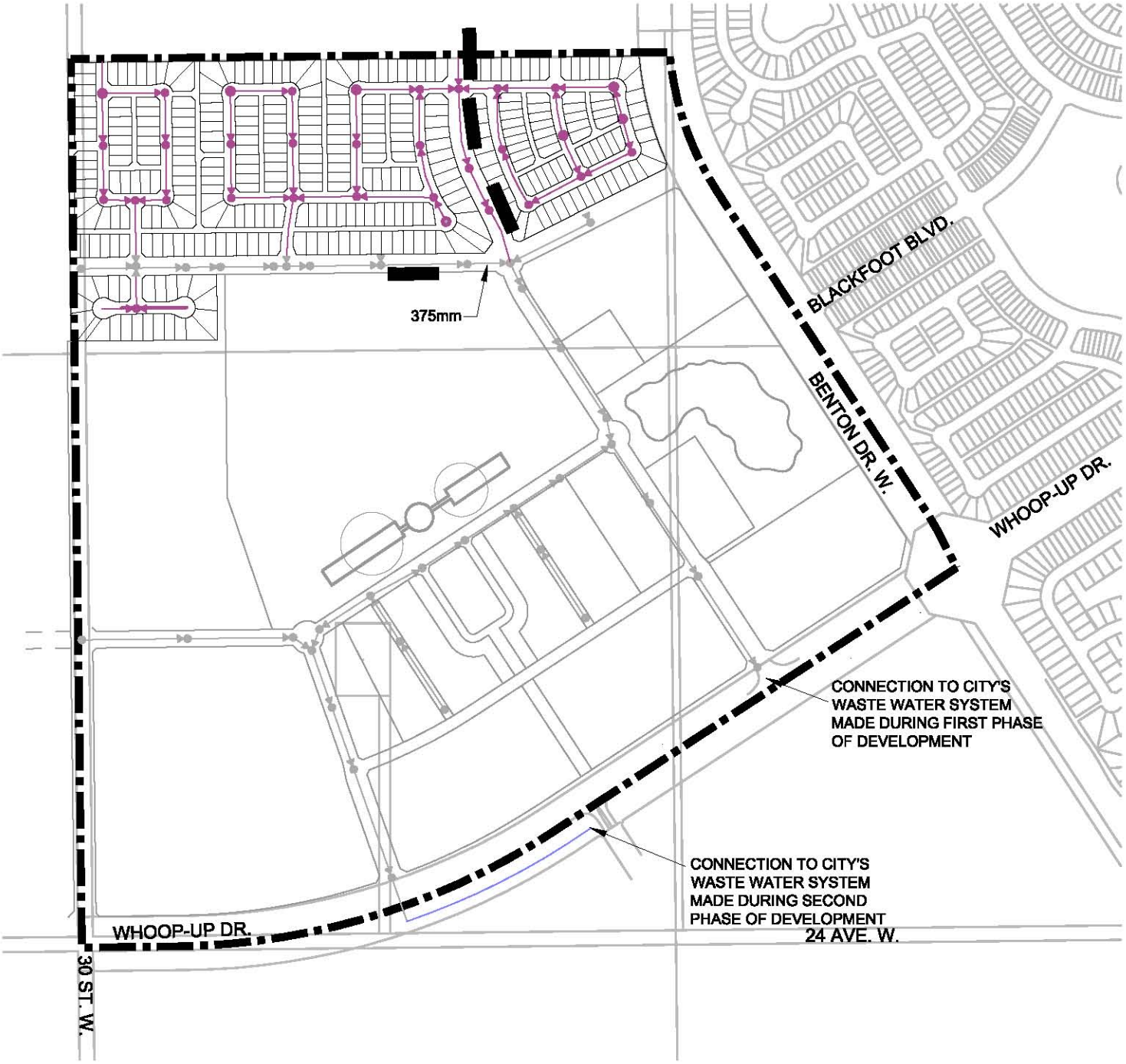
The majority of the sanitary sewers within the Outline Plan Area will consist of 200 mm diameter PVC pipe. There will be two sanitary trunk sewers within the Outline Plan Area. These two trunk sewers will range in size between 250 mm and 450 mm in diameter (for the purposes of this Outline Plan, the two sanitary trunks are referred to as Trunk A and Trunk B).

The sanitary sewer system in the Outline Plan Area will connect to the City's network at two locations. Both of these connection locations will be to the 450/525/600 mm diameter sewer along the Whoop-Up Drive extension.

As noted in Section 6.1, the Outline Plan Area will be developed in nine phases (see Section 7.0 for more information of the development phasing). Figure 9 - Sanitary Service Staging shows the boundary of the nine phases of development. In the initial phase, the sanitary sewer system in the Outline Plan Area will connect to the City's sewer system at only one location. The second connection to the City's sewer system will occur in the second phase of development. The schools and library will be serviced by Trunk A in the first phase of development. Also in the first phase, a section of sanitary sewer, located southwest of the schools, will be constructed in conjunction with the roadway. This section of sewer will not become operational until the second phase of development when Trunk B is connected to the City's sewer system.

In accordance with the West Lethbridge Phase II Area Structure Plan, an "off-site" area to the west of the Outline Plan Area will contribute wastewater flow to Trunk B. Hence, Trunk B will be oversized to handle this additional wastewater flow. The West Lethbridge Phase II Area Structure Plan proposed that an "off-site" area to the north of the Outline Plan Area will require a separate sanitary trunk along Benton Drive. It is proposed that this "off-site" area to the north of the Outline Plan Area contribute wastewater flow to Trunk A. Hence, Trunk A will be oversized to handle this additional wastewater flow and the separate sanitary trunk along Benton Drive may not be required.

Peak sanitary flows for the Outline Plan Area are summarized in Table 6-2. These flows were developed using sewage generation rates presented in the City of Lethbridge Design Standards (2006). A dry weather peaking factor of 3.10 was used (to match the design of the proposed sanitary trunk along Whoop-Up Drive). As mentioned above, the sanitary trunks will convey flows from off-site areas to the north and west of the Outline Plan Area. A design flow of 79 L/s was calculated at the west boundary of the Outline Plan Area (i.e., along Trunk B) based on a population of 3616. A design flow of 30 L/s was calculated at the north boundary of the Outline Plan Area (i.e., along Trunk A) based on a population of 1726. Appendix H contains a more detailed summary of the flows. Appendix I also contains information pertaining to the sizing of the two sanitary trunk sewers within the Outline Plan Area.



LEGEND

- Outline Plan Boundary
- Proposed Sanitary Sewer
- Proposed Sanitary Manhole & Direction

Figure 8
Sanitary Servicing Concept

Associated Engineering

in association with:
Armin A. Preiksaitis & Associates Ltd.

NOTES

1. All proposed sanitary sewers are 200mm unless otherwise indicated

0 50 100 250 m

N

Benton Crossing Outline Plan

File: F:\AAP Project Files\ASPs\05-009 Lethbridge Outline Plan & Detailed Design W Benton\Mapping\AAP\Map 7 - Servicing Servicing Concept.dwg

Project No.: 05-009

Date: June 2006

LEGEND

Outline Plan Boundary		Existing Sanitary Sewer	
1	Phase 1	Proposed Sanitary Sewer Phase 1	
2	Phase 2	Proposed Sanitary Sewer Phase 2	
3	Phase 3	Proposed Sanitary Sewer Phase 3	
4	Phase 4	Proposed Sanitary Sewer Phase 4	
5	Phase 5	Proposed Sanitary Sewer Phase 5	
6	Phase 6	Proposed Sanitary Sewer Phase 6	
7	Phase 7	Proposed Sanitary Sewer Phase 7	
8	Phase 8	Proposed Sanitary Sewer Phase 8	
9	Phase 9	Proposed Sanitary Sewer Phase 9	

Figure 9
Sanitary Service Staging

Associated Engineering

in association with:
Armin A. Preiksaitis & Associates Ltd.

Benton Crossing Outline Plan

0 50 100 250 m

N

Table 6-2 Sanitary Flows

Demand Scenario	Trunk A m^3/d (L/s)	Trunk B m^3/d (L/s)	Total m^3/d (L/s)
Dry Weather Flow	1822 (21.09)	1923 (22.26)	3745 (43.34)
Peaked Dry Weather Flow	5648 (65.37)	5960 (68.98)	11608 (134.35)
Wet Weather Flow	1767 (20.45)	2297 (26.59)	4064 (47.04)
Infiltration	531 (6.15)	689 (7.97)	1220 (14.12)
Peak Sanitary Flow	7946 (91.97)	8946 (103.54)	16892 (195.51)
Population (Outline Plan Area)	1726	888	2614
Population (Off-site Areas)	1373	3616	4989
Total Population	3099	4504	7603

6.3 Stormwater Management

The Alberta Environment Stormwater Management Guidelines identify Best Management Practices (BMP) that can be used to control the quantity and quality of runoff discharged from a developed area. Alberta Environment requires the removal of 85% of the Total Suspended Solids (TSS), greater than 75 µm (0.075 mm) in diameter, in the stormwater pollutant washoff from a developed area prior to discharge. The City of Lethbridge would like to obtain the highest water quality improvement for West Lethbridge that is practical and economically possible.

The stormwater management concept proposed in the West Lethbridge Phase II Area Structure Plan utilizes storm water detention facilities as the primary BMP. Storm water management facilities will be constructed as wet ponds to provide stormwater quality enhancement and storage at the downstream end of drainage catchments, while dry ponds may be used in the upper reaches of drainage catchments to provide storage and attenuation.

The stormwater management system for the Outline Plan Area will conform to the stormwater management concept proposed in the Area Structure Plan. A wet pond, located near the downstream end of the drainage catchment, will provide stormwater quality enhancement and storage. A dry pond, located near the centre of the Outline Plan Area, will provide storage and attenuation. Stormwater flows released from the dry pond will be conveyed to the wet pond for additional water quality enhancement. Stormwater from the Outline Plan Area will ultimately be discharged to the Oldman River via the existing storm sewer system. A new outfall is not required. The stormwater ponds will discharge only when there is available capacity in the existing downstream storm sewer system. The

stormwater system will utilize a dual drainage concept consisting of storm sewers to transport runoff from minor rainfall events and a major system to convey runoff from the extreme rainfall events.

Currently, land to the west of the Outline Plan Area naturally drains to a low lying area along the west boundary of the Outline Plan Area. It is recommended that the existing stormwater from the undeveloped lands west of the Outline Plan Area be contained in the low lying area and prevented from entering the Outline Plan Area. Water will either infiltrate or evaporate from this low lying area. When the lands west of the Outline Plan Area are developed, a separate stormwater management system will then be constructed.

Since the northern boundary of the Outline Plan Area is located roughly along a ridge, relatively small volumes of stormwater runoff from lands to the north are expected to enter the Outline Plan Area. This off-site runoff can be temporarily incorporated into the proposed stormwater management system in the Outline Plan Area. When the lands north of the Outline Plan Area are developed and a separate stormwater management system is constructed, the flows into the Outline Plan Area will be zero.

The proposed stormwater management system in the Outline Plan Area is shown on Figures 10 - Minor Stormwater Management and 11 - Major Stormwater Management. Appendix J contains a more detailed summary of the stormwater management system.

LEGEND

- Outline Plan Boundary
- Proposed Storm Sewer
- Proposed Foundation Drain Collector
- Proposed Storm Manhole & Direction

NOTES

1. All proposed storm sewers are 300mm unless otherwise indicated

0 50 100 250 m

N

Figure 10
Minor Stormwater Management

Associated Engineering

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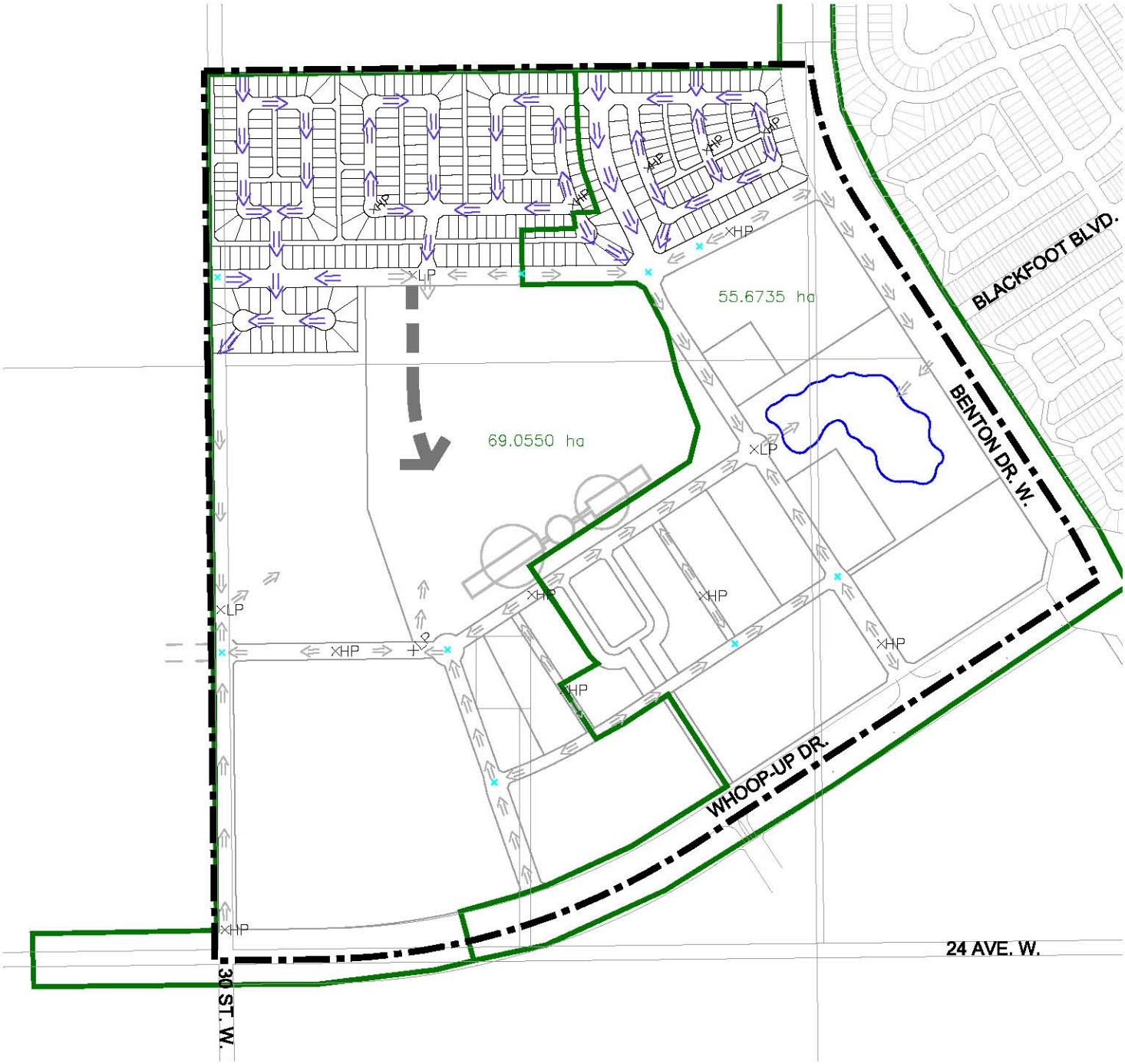
Benton Crossing Outline Plan



LEGEND

- Outline Plan Boundary
- Stormwater Catchment Boundary
- Stormwater Management Facility
- Overland Flow Direction
- XHP × XLP Point of Vertical Intersection

Figure 11
Major Stormwater Management

Associated Engineering

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Armin A. Preiksaitis & Associates Ltd.

NOTES

1. Grading and overland flow directions are conceptual

0 50 100 250 m

N

Benton Crossing Outline Plan

7.0 STAGING AND IMPLEMENTATION

7.1 Tentative Staging

In general, development will occur from east to west and from south to north. Further, the staging of development in the Outline Plan Area will be in line with the orderly and economic expansion of roadways, provision of municipal services and in response to market demand.

Tentative phasing is shown on *Figure 12 - Staging Plan*.

7.2 Redistricting and Subdivision

Following adoption of the Outline Plan, implementation of the plan will be on stage-by-stage basis achieved through the City's redistricting and subdivision process. Application for appropriate redistricting shall be consistent with the land use designations and descriptions provided within the Benton Crossing Outline Plan and West Lethbridge Phase II ASP, as well as the City of Lethbridge Land Use Bylaw (Bylaw No. 4100). Redistricting and subdivision applications will be advanced for specific stages in response to market demand.

7.3 Amending the Plan

The Benton Crossing Outline Plan is intended to provide a detailed description and illustration of development issues such as land use, circulation, parks, open space and pathways development. However, the plan remains conceptual and is subject to alterations and adjustments as a result of market conditions, new standards and consumer demand at the time of development. It is therefore important to create a flexible plan that still provides certainty to the City of Lethbridge, neighbourhoods and their residents.

Requirements for the adoption and amendment of an Outline Plan are the responsibility of a municipality. It is the City of Lethbridge Municipal Planning Commission that approves Outline Plans and this process would apply to any subsequent amendment applications to the Benton Crossing Outline Plan.

LEGEND

- OUTLINE PLAN BOUNDARY
- 1 PHASE 1
- 2 PHASE 2
- 3 PHASE 3
- 4 PHASE 4
- 5 PHASE 5
- 6 PHASE 6
- 7 PHASE 7
- 8 PHASE 8
- 9 PHASE 9

Figure 12
Staging Plan

Associated Engineering

in association with:
Armin A. Preiksaitis & Associates Ltd.

0 50 100 250 m

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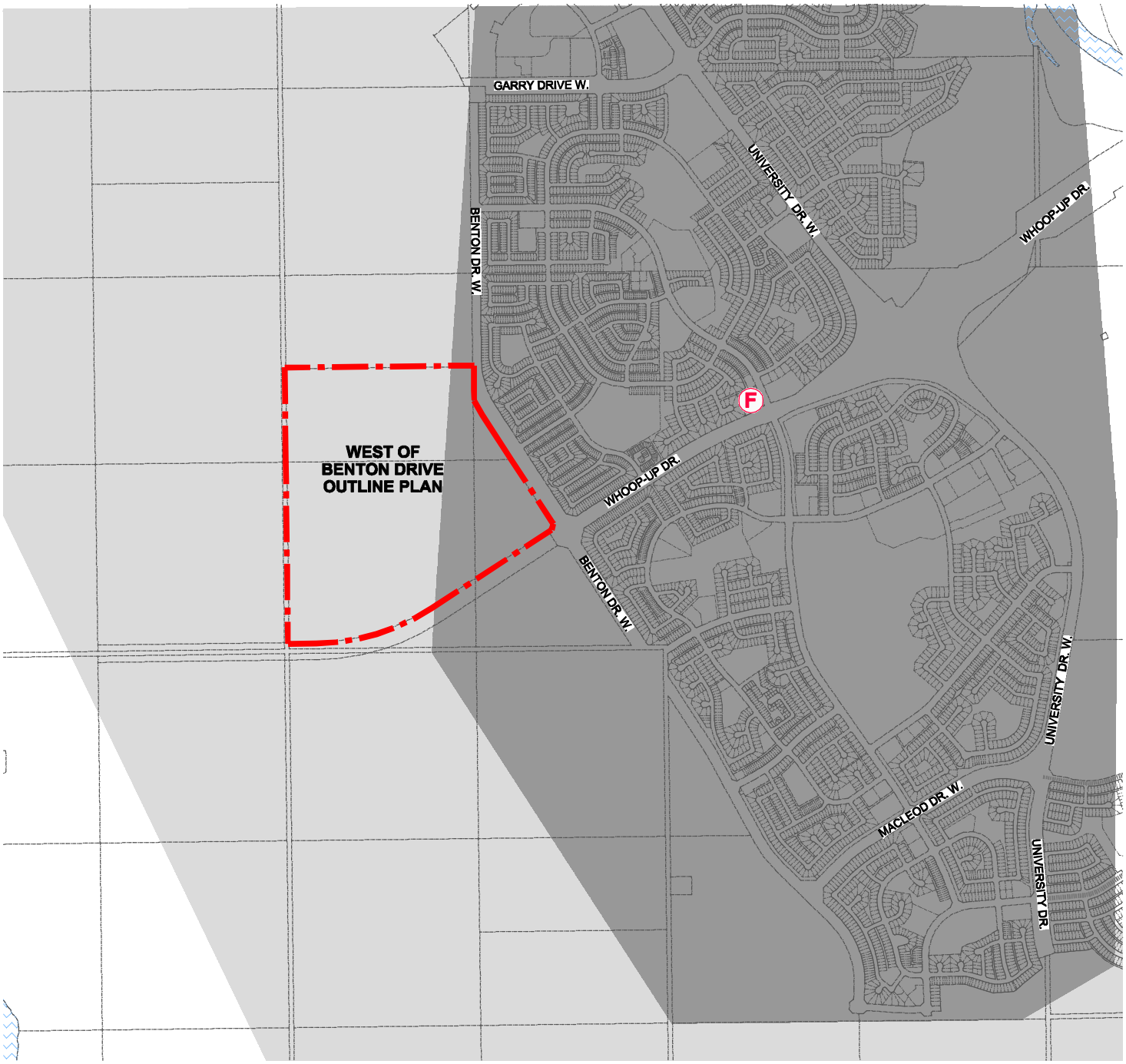
Benton Crossing Outline Plan

AE Project No.:20053769 AAP Project No.: 05-009 Date: May 3, 2006



LEGEND

- F — FIRE STATION #2
- 4 MINUTE RESPONSE TIME
- 8 MINUTE RESPONSE TIME
- OUTLINE PLAN BOUNDARY

Figure 13 Emergency Response Times

Associated Engineering

in association with:
ARMIN A. PREIKSAITIS & ASSOCIATES LTD.

NOTES

RESPONSE TIMES LISTED ARE FROM FIRE STATION #2

0 50 100 250 m

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Benton Crossing Outline Plan

APPENDIX A

Certificates of Title

ALBERTA REGISTRIES

LAND TITLE CERTIFICATE

S

LINC	SHORT LEGAL	TITLE NUMBER
0029 977 014	4;22;8;27;SE	031 220 099 +55

LEGAL DESCRIPTION

THE SOUTH EAST QUARTER OF SECTION TWENTY SEVEN (27)
TOWNSHIP EIGHT (8)
RANGE TWENTY TWO (22)
WEST OF THE FOURTH MERIDIAN
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING:

PLAN	NUMBER	HECTARES	(ACRES)	MORE OR LESS
REPLOTTING SCHEME	7710705	21.36	52.89	
ROAD	0210492	2.931	7.24	
SUBDIVIISON	0211300	0.625	1.54	
SUBDIVISION	0212162	0.053	0.13	
SUBDIVISION	0310382	1.416	3.50	
SUBDIVISION	0311888	5.49	13.57	

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

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 031 216 679 +1

REGISTERED OWNER(S)

REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
031 220 099	30/06/2003	SUBDIVISION PLAN		

OWNERS

WALTER J WILLMS

AND
CLARA B WILLMS
BOTH OF:
SITE 7,BOX 29,SS 1
CALGARY

(CONTINUED)

ALBERTA T2M 4N3
AS JOINT TENANTS

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
741 091 031	27/09/1974	IRRIGATION ORDER/NOTICE THIS PROPERTY IS INCLUDED IN THE LETHBRIDGE NORTHERN IRRIGATION DISTRICT
771 058 484	10/05/1977	CAVEAT RE : DEFERRED RESERVE CAVEATOR - THE OLDMAN RIVER REGIONAL PLANNING COMMISSION.
931 085 909	21/04/1993	UTILITY RIGHT OF WAY GRANTEE - THE CITY OF LETHBRIDGE. 910 - 4TH AVE. SOUTH, LETHBRIDGE ALBERTA AS TO PORTION OR PLAN:9310837
041 145 785	26/04/2004	CAVEAT RE : AGREEMENT FOR SALE CAVEATOR - THE CITY OF LETHBRIDGE. DOUGLAS S. HUDSON 910-4 AVE SOUTH LETHBRIDGE ALBERTA T1J0P6 AGENT - DOUGLAS S HUDSON
041 360 476	22/09/2004	CAVEAT RE : ASSIGNMENT OF AGREEMENT FOR SALE CAVEATOR - CANADIAN WESTERN BANK. 6127 BARLOW TR SE CALGARY ALBERTA T2C4W8 AGENT - GARY J COCHRANE

(CONTINUED)

TOTAL INSTRUMENTS: 005

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 6 DAY OF JUNE, 2005 AT 02:13 P.M.

ORDER NUMBER:2865257

CUSTOMER FILE NUMBER:

END OF CERTIFICATE

ALBERTA REGISTRIES

LAND TITLE CERTIFICATE

S

LINC	SHORT LEGAL	TITLE NUMBER
0030 080 650	4;22;8;27;NE	031 301 862 +37

LEGAL DESCRIPTION

THE NORTH EAST QUARTER OF SECTION TWENTY SEVEN (27)
TOWNSHIP EIGHT (8)
RANGE TWENTY TWO (22)
WEST OF THE FOURTH MERIDIAN
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES	(ACRES) MORE OR LESS
SUBDIVISION	8011133	0.306	0.756
SUBDIVISION	9112156	1.43	3.53
SUBDIVISION	9210228	2.81	6.94
SUBDIVISION	9311275	2.349	5.80
SUBDIVISION	9312265	1.359	3.36
SUBDIVISION	9411526	1.621	4.005
SUBDIVISION	9412103	1.616	3.99
SUBDIVISION	9412105	2.83	6.99
SUBDIVISION	9512774	4.452	11.00
SUBDIVISION	9611870	0.052	0.13
SUBDIVISION	9811302	9.291	22.96
SUBDIVISION	9811554	0.129	0.32
SUBDIVISION	9813070	0.061	0.15
SUBDIVIISON	9912154	0.019	0.05
SUBDIVISION	9913324	1.027	2.54
SUBDIVISION	0010999	3.836	9.48
SUBDIVISION	0012861	5.146	12.72
SUBDIVISION	0110697	0.526	1.30
SUBDIVISION	0210432	4.412	10.90
SUBDIVISION	0210784	2.045	5.05
SUBDIVISION	0211300	8.969	22.16
SUBDIVISION	0212162	0.753	1.86
SUBDIVISION	0212366	2.712	6.70
SUBDIVISION	0310382	1.793	4.43
SUBDIVISION	0311888	0.109	0.27
SUBDIVISION	0312479	3.178	7.85

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

ESTATE: FEE SIMPLE

(CONTINUED)

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 031 220 099 +54

REGISTERED OWNER(S)

REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
031 301 862	05/09/2003	SUBDIVISION PLAN		

OWNERS

838 LAND DEVELOPMENTS LTD..
OF BOX 511
LETHBRIDGE
ALBERTA T1J 3Z4

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
741 091 031	27/09/1974	IRRIGATION ORDER/NOTICE THIS PROPERTY IS INCLUDED IN THE LETHBRIDGE NORTHERN IRRIGATION DISTRICT
931 085 908	21/04/1993	UTILITY RIGHT OF WAY GRANTEE - THE CITY OF LETHBRIDGE. 910 - 4TH AVE. SOUTH, LETHBRIDGE ALBERTA AS TO PORTION OR PLAN:9310837

(CONTINUED)

TOTAL INSTRUMENTS: 002

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 6 DAY OF JUNE, 2005 AT 02:13 P.M.

ORDER NUMBER:2865257

CUSTOMER FILE NUMBER:

END OF CERTIFICATE

ALBERTA REGISTRIES

LAND TITLE CERTIFICATE

S

LINC	SHORT LEGAL	TITLE NUMBER
0012 908 216	4;22;8;27;;11,12	041 141 053

LEGAL DESCRIPTION
MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 27
LEGAL SUBDIVISIONS 11 AND 12
EXCEPTING THEREOUT ALL MINES AND MINERALS
AREA: 32.4 HECTARES (80.06 ACRES) MORE OR LESS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 881 029 179

REGISTERED OWNER(S)

REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
041 141 053	22/04/2004	TRANSFER OF LAND	$920,000	$920,000

OWNERS

THE CITY OF LETHBRIDGE.
OF 910 - 4TH AVENUE SOUTH, LETHBRIDGE,
ALBERTA T1J 0P6

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
741 091 031	27/09/1974	IRRIGATION ORDER/NOTICE THIS PROPERTY IS INCLUDED IN THE LETHBRIDGE NORTHERN IRRIGATION DISTRICT
041 141 054	22/04/2004	MORTGAGE MORTGAGEE - EDNA JEAN MARNOCH

(CONTINUED)

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
		9-2-3 LETHBRIDGE ALBERTA T1J4S9 ORIGINAL PRINCIPAL AMOUNT: $652,000 (DATA UPDATED BY: TRANSMISSION OF MORTGAGE 041364457) (DATA UPDATED BY: TRANSFER OF MORTGAGE 041364491)

TOTAL INSTRUMENTS: 002

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 6 DAY OF JUNE, 2005 AT 02:13 P.M.

ORDER NUMBER:2865257

CUSTOMER FILE NUMBER:

END OF CERTIFICATE

ALBERTA REGISTRIES

LAND TITLE CERTIFICATE

S

LINC	SHORT LEGAL	TITLE NUMBER
0022 090 435	4;22;8;27;SW	841 077 241

LEGAL DESCRIPTION
MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 27
QUARTER SOUTH WEST
EXCEPTING THEREOUT ALL MINES AND MINERALS
AREA: 64.7 HECTARES (160 ACRES) MORE OR LESS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REGISTERED OWNER(S)

REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
841 077 241	04/05/1984			SEE INSTRUMENT

OWNERS

THE CITY OF LETHBRIDGE.
OF 910-4 AVE S
LETHBRIDGE
ALBERTA

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
741 091 031	27/09/1974	IRRIGATION ORDER/NOTICE THIS PROPERTY IS INCLUDED IN THE LETHBRIDGE NORTHERN IRRIGATION DISTRICT
751 006 968	27/01/1975	UTILITY RIGHT OF WAY GRANTEE - CANADIAN WESTERN NATURAL GAS COMPANY LIMITED.

(CONTINUED)

TOTAL INSTRUMENTS: 002

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 6 DAY OF JUNE, 2005 AT 02:13 P.M.

ORDER NUMBER:2865257

CUSTOMER FILE NUMBER:

END OF CERTIFICATE

APPENDIX B

Geotechnical Investigation

Associated Engineering Alberta Ltd.

GEOTECHNICAL EVALUATION
BENTON CROSSING RESIDENTIAL SUBDIVISION
LETHBRIDGE, ALBERTA

4400840

May 2006

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

TABLE OF CONTENTS

PAGE

TABLE OF CONTENTS

PAGE

FIGURES

APPENDICES

1.0 INTRODUCTION

This report presents the results of a geotechnical evaluation conducted by EBA Engineering Consultants Ltd. (EBA) for the Benton Crossing Residential Subdivision to be located in West Lethbridge, Alberta.

The scope of work for the geotechnical evaluation was described in a proposal issued to Mr. Greg Kaupp, C.E.T., of Associated Engineering Alberta Ltd. (Associated) on October 14, 2005. The objective of this 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 residential subdivision development.

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

EBA has also completed a Phase I Environmental Site Assessment for the subdivision (issued under separate cover). Environmental issues are not discussed in this report.

2.0 PROJECT DETAILS AND SCOPE OF WORK

The major components of this development will include single family residential housing, commercial developments, and park areas across most of the property limits, as shown on Figure 1. The foundation system for the housing will likely be shallow spread footings and a grade supported lower level floor slab, typical of other residential developments in the area.

The proposed street developments will be designed and constructed to the current City of Lethbridge Infrastructure Services Engineering Standards. The majority of the roadways will consist of designated 'local' pavement structure with some arterial pavement structures, as required. A detailed pavement design for the respective street sections has not been requested as part of this evaluation, but may be completed at a later date.

One major component of this development will include a 'wet pond' to be constructed in the east area of the property, as depicted on Figure 1. The possibility of a future stormwater containment pond is also being considered in the western area of the property, also depicted on Figure 1 which would be evaluated separately at a later date.

An additional major development for the subdivision is the combined west Lethbridge High Schools and Library, located in the central area of the development. The geotechnical evaluation for this development has been issued under separate cover to the City of Lethbridge (EBA file no. 0404-4401045). Note that a component of this report included the sports field/dry pond area. Other geotechnical evaluations completed by EBA in the vicinity of the project site in 2005 include the Whoop-Up Drive Extension project (EBA file no. 0404-4400839) as well as the West Lethbridge Distribution Looping project (EBA

file no. 0404-4400740). These previous evaluations have been used to supplement this evaluation, and the borehole locations are shown on Figure 1.

The land to be developed is bounded on the east by the Indian Battle Heights and Varsity Village Subdivisions, and is surrounded on the west, south, and north by undeveloped farmland. A gravel-surfaced road, 24 Avenue West, bounds the south area. The recently constructed Whoop-Up Drive extension runs through the site in the south area. The legal land description includes the majority of the SE and SW ¼, Sect. 27, Twp. 8, Rge. 22, W4M, as well as a portion of the SE ¼ Sect. 28, Twp 8, Rge. 22, W4M.

The property was noted to be largely undeveloped at the time of fieldwork, with the exception of the Whoop-Up Drive extension. Based on EBA's knowledge of this property's history, it has been utilized solely for agricultural purposes. One feature of note is an abandoned gas well, located in the southwest, indicated approximately on Figure 1.

The property at the time of fieldwork was surfaced in all areas with stubble crop. The ground surface was noted to be moderately undulating (Geodetic Elevation ranging between 929 m and 941 m). The lowest elevations were in the east central area, with ponded water noted at ground surface (slough area). Site drainage generally appeared to be towards the low-lying area.

The agreed work scope for this evaluation consisted of the installation of 34 geotechnical boreholes (for the general property development, street developments, and the east stormwater pond). A laboratory program was completed to assist in classifying the subsurface soils and this report provides the following design and construction recommendations.

- Recommendations for lot grading, backfill materials and compaction.
- Recommendations for utility line installation, including trench excavation, backfill, and compaction standards.
- Recommendations for subgrade preparation for street pavements.
- Recommended design parameters for footings and basements.
- Recommendations for construction of basement slabs-on-grade and subgrade preparation, considering the potential for volumetric change of soil due to changes in moisture content.
- Recommendations for dewatering during construction.
- Recommended design and construction provisions for control of groundwater.
- Recommendations for concrete type.
- Recommendations regarding suitability of on-site materials for the construction of compacted clay liners for a stormwater containment pond.

- Recommendations for stormwater pond construction, including design thickness for a compacted clay liner.

3.0 GEOTECHNICAL FIELD AND LABORATORY WORK

The majority of fieldwork for this evaluation was carried out between November 7 and 17, 2005 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. Marcus Cranford, E.I.T. and Mr. John Christensen. Additional borehole drilling was required on March 7, 2006 to investigate the southern area of the re-designed east pond. EBA's field representative for this drilling was Mr. Aaron Strand. The location of buried utilities was first carried out through Alberta First Call and through the use of a private locater, Advanced Locating Services.

Thirty four boreholes in total were drilled across the property area, to depths varying between approximately 6.1 m to 18.3 m below ground surface (Boreholes (BH)001 through BH034). BH025 through BH029 were drilled within the initial proposed east wet pond footprint, with boreholes BH030 to BH033 located within the revised wet pond location. Borehole BH034 was drilled within a proposed future stormwater pond, west of the current subdivision development. The remaining boreholes were drilled at representative locations within the proposed street alignments and lot areas. The borehole locations are depicted on Figure 1.

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 in all of the boreholes 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 locations of the boreholes were selected based on the initial proposed subdivision layout site plan provided by Associated. The locations and Geodetic Elevations of the existing ground surface at the borehole locations were subsequently determined by detailed surveying by Mike Spencer Geometrics (Spencer). The borehole elevations are indicated on the borehole logs. Since the time of borehole drilling, the subdivision layout has been revised somewhat, and the most recent site plan development concept, with borehole locations and elevation contours is presented as Figure 1.

Classification tests, including natural moisture content, Atterberg Limits, and soluble sulphate content were subsequently performed in the laboratory on samples collected from the boreholes, to aid in the determination of engineering properties. In addition, from within the stormwater pond areas (initial and revised locations), two bulk clay samples were obtained and tested for Standard Proctor maximum dry density (SPD), as well as remoulded

hydraulic conductivity (for assessment of its use as a compacted clay liner) using the constant head permeability test method. The results of the laboratory tests are presented on the borehole logs in Appendix B and in Appendix D.

4.0 SUBSURFACE CONDITIONS

4.1 GENERAL

The subsurface stratigraphy generally comprises topsoil underlain by native lacustrine clay, in turn underlain by glacial clay till. Specific details of the stratigraphy encountered at each borehole location are presented on the borehole logs and are discussed in this section.

It should be noted that geological conditions are innately variable. Glacial deposits in particular are seldom spatially uniform. At the time of preparation of this report, information on subsurface stratigraphy is available only at discrete borehole locations. In order to develop recommendations from the information, it is necessary to make some assumptions concerning conditions other than that at borehole locations. Adequate monitoring should be provided during construction to check that these assumptions are reasonable.

4.2 TOPSOIL

In general, the surface covering of the site consisted of a stubble crop in all areas at the time of fieldwork. Topsoil depths generally varied between approximately 100 mm and 300 mm below ground surface.

It is important to note that based on the proposed stripping methodology (i.e. equipment usage) the thickness of stripping may vary. The method of stripping should therefore be taken into account when determining stripping volumes.

Wind blown topsoil deposits of greater thickness may exist in areas downwind of topographic high areas (generally in lower lying areas). Due to agricultural cultivation, variable thickness of topsoil should also be expected across the site.

4.3 SOIL CONDITIONS

At all borehole locations, with the exception of BH002, BH005, BH006, BH010, BH013, BH014, BH017, BH018, and BH030, underlying the surficial topsoil cover, native clay layers were generally encountered. The clay layers typically extended to depths ranging between approximately 0.4 m to 5.3 m below grade (with a depth of approximately 1.0 m being most common across most of the property). The clay layers were generally described as silty, with some sand to sandy, moist to very moist, with some wet areas noted with free water, varying between low to high plastic, and soft to very stiff in consistency. The primary differences in the description between clay layers were in the percent of sand materials and moisture contents.

The surficial clay layers are lacustrine (lake deposited) clays. One of their unique characteristics is a tendency to swell with increasing moisture content. The results of Atterberg Limit testing (five tests) carried out on surficial clay soil samples indicated Plastic Limits of 13 to 15 percent and Liquid Limits of 31 to 37 percent. At these Limits, the clay soils are considered to be generally medium in plasticity. One test from BH019 returned results of a Plastic Limit of 19 percent and a Liquid Limit of 75 percent. At this location, the clay soil is considered to be high in plasticity.

Based on the laboratory testing conducted, the near surface medium and high plastic clay soils have a moderate swelling potential due to its plasticity as well as its existing moisture content, which was determined to be approximately 17 to 27 percent within approximately 1 m of ground surface in most areas. At this moisture content range, the surficial clay in most areas of the site is considered to vary between close to and significantly wet its optimum moisture content.

Underlying the topsoil and/or clay layers in all boreholes, glacial clay till was encountered to the full depths penetrated in all boreholes. The clay till was silty, with some sand to sandy, a trace of fine gravel, moist to very moist, with some wet locations, medium plastic and firm to very stiff in consistency. The clay till was noted to contain traces of fine coal fragments, zones of higher plastic inclusions and layers, as well as occasional thin sand lenses with free water.

Moisture contents, taken on random clay till samples, typically varied between 14 percent and 27 percent. Atterberg Limit testing carried out on the clay till soil (four tests) indicated Plastic Limits of 12 to 16 percent and Liquid Limits of 33 to 37 percent, indicative of medium plasticity. The clay till soil is also estimated to range between close to and up to 9 percent wet of its optimum moisture content for most areas of the site.

Standard Proctor maximum dry density testing was completed on two composite samples of clay and clay till. The testing was completed on bulk samples taken from borehole BH029 (original pond location) and BH031 (new pond location). The results were determined to be 1800 kg/m^3, at an optimum moisture content of 15.5 percent for BH029 and 1760 kg/m^3, at an optimum moisture content of 18.0 percent for BH031 (Appendix D). The clay proctor samples were subsequently compacted to approximately 98 percent of SPD at a moulding moisture content of approximately the optimum moisture content (OMC) for the soil samples (Refer Appendix D) and two constant head permeability tests were conducted. The measured steady state permeability (K) was 2.58E-08 cm/sec for BH029 and 1.58E-08 cm/sec for BH031. One Atterberg Limit test carried out on the composite sample from BH029 indicated a Plastic Limit of 12 percent and a Liquid Limit of 38 percent, indicative of medium plasticity.

A more complete description of the subsurface conditions encountered at the borehole locations is provided on the borehole logs presented in Appendix B.

4.4 GROUNDWATER CONDITIONS

At the time of drilling, seepage and sloughing was encountered at borehole locations BH016, BH018, and BH033 at depths of between approximately 2.8 m and 4.4 m below ground surface. The groundwater level was measured within the standpipes on December 19, 2005, 32 to 42 days following the initial drill program and on April 5, 2006, 31 days following the second drill program in each case. The following table summarizes the groundwater monitoring data.

Borehole Number	Depth of Standpipe (m)	Ground Elevation of Borehole (m)	Groundwater Monitoring Data December 19, 2005 and April 5, 2006	
			Depth to Groundwater (m)	Elevation to Groundwater (m)
001	7.6	934.95	4.4	930.6
002	7.6	935.45	Dry	-
003	7.6	937.97	3.0	935.0
004	7.6	935.42	2.0	933.4
005	9.1	936.02	7.3	928.7
006	7.6	936.06	6.7	929.4
007	7.6	934.95	1.0	934.0
008	7.6	937.66	1.8	935.9
009	9.1	936.27	8.5	927.8
010	7.6	938.91	7.4	931.5
011	7.6	936.95	3.4	933.6
012	6.1	938.19	4.0	934.2
013	7.6	936.67	Dry	-
014	9.1	935.34	1.8	933.5
015	9.1	932.23	Dry	-
016	7.6	930.14	1.6	928.5
017	7.6	930.39	2.5	927.9
018	7.6	933.11	3.0	930.1
019	7.6	940.95	Dry	-
020	7.6	937.28	3.7	933.6
021	7.6	939.46	Dry	-
022	7.6	938.48	4.7	933.8
023	7.6	939.95	Dry	-
024	7.6	941.08	Dry	-
025	7.6	933.09	3.6	929.5
026	9.1	934.57	4.2	930.4
027	7.6	932.63	2.2	930.4
028	7.6	931.95	2.3	929.7

Borehole Number	Depth of Standpipe (m)	Ground Elevation of Borehole (m)	Groundwater Monitoring Data December 19, 2005 and April 5, 2006	
			Depth to Groundwater (m)	Elevation to Groundwater (m)
029	18.3	932.24	4.0	928.2
*030	12.2	929.25	0.2	929.1
*031	9.1	929.26	0.3	929.0
*032	9.1	929.95	0.6	929.4
*033	9.1	929.29	0.3	929.0
034	18.3	931.23	6.5	924.7

* Water levels recorded on April 5, 2006 within the low proposed east pond area.

It should be noted that groundwater levels will fluctuate seasonally and in response to climatic conditions and may be at a different depth when construction commences. Groundwater levels should be monitored periodically prior to development. The intent is to provide an early indication of dewatering requirements during excavation for foundations or utility trenches.

The above-noted groundwater levels are attributed to groundwater perched or trapped within thin sandy seams within the clay till or within the sandy lacustrine clay. From this data, varying amounts of groundwater infiltration may be expected for the shallow to moderate excavations expected for this development (less than 3 m). Dewatering may be necessary in localized areas where the excavation intercepts wet sandy inclusions within the clay or clay till strata. However, in the area adjacent to boreholes BH030 to BH033 water was noted to be at ground surface (a slough) and increased dewatering efforts in wet soil conditions will be required in this area during construction.

Further comments regarding groundwater issues are provided in subsequent sections.

5.0 GENERAL CONSIDERATIONS

5.1 GENERAL SUBDIVISION DEVELOPMENT

Specific recommendations that apply to this project are provided in the following subsections for general site development and lot grading, groundwater issues, trench excavation and backfill, stormwater pond liner construction, shallow footings, basement construction, floor slabs, and concrete type. Pavement structures considered for this development should be designed and constructed to the City of Lethbridge Infrastructure Services Engineering Standards and as such, are not presented in this report. However, recommendations for subgrade preparation within the proposed asphalt concrete surfaced roadways are discussed. A detailed pavement design may be completed at a later date.

A groundwater study has not been requested as part of this evaluation. It is EBA's understanding that weeping tiles for the residences will most likely include tie-ins to the storm sewer utility.

The initial topsoil stripping depth has been identified as being of particular importance. As noted in this report, the surficial topsoil (A Horizon) soil layer is somewhat variable in thickness and can be attributed to cultivation of the land surface. However, for such a development, the majority of any underlying B Horizon layer (brown organic stained clay) can likely remain in place during site stripping and incorporated into the fill mass during general site grading. Full-time monitoring by experienced personnel is recommended in order to avoid over-stripping and to ensure appropriate material mixing and placement.

Subgrade preparation is required in all subdivision development areas, including lot grading as well as all paved areas to City of Lethbridge Standards as noted in Section 6.0. This includes stripping of topsoil and deleterious soil materials, scarification and moisture conditioning (drying in most areas) and compaction. The native medium plastic clay soils should be acceptable for site grading purposes in all areas. The clay surface appears to vary between close to and significantly above its optimum moisture content in most areas and moisture conditioning (drying) will be required to reduce the swelling potential of this soil and to achieve the compaction standards recommended. Proof-rolling within roadways to detect soft areas is also recommended.

The soil conditions encountered indicate general suitability for usage as a compacted clay liner for the storm ponds, although moisture conditioning should be expected. Detailed recommendations are provided in subsequent sections.

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 7.0.

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.

5.2 STORMWATER POND DEVELOPMENT

The approximate location of the stormwater management pond proposed for this subdivision is shown on Figure 1. The existing ground surface elevation appears to vary between approximately 929 m to 935 m in this area. Specific design details of the pond have not yet been finalized, however, it is understood that the invert of wet pond component will be approximately 4 m to 5 m below final design grades. Areas of 'dry ponds' are also anticipated adjacent to the wet pond, as well as within the west school property/play fields.

It is also understood that the stormwater wet pond will retain water throughout the year. As with other such 'wet ponds' in the Lethbridge area, it is assumed that the retention pond will be initially infilled with irrigation water. The retention pond will also provide overland stormwater drainage for this area in accordance with municipal regulations.

Once the normal, operational water level elevation is designed, it is recommended that the surrounding residences have basement and footing elevations of at least 1.0 m above this design high water level. Based on similar developments in the City, it is recommended that the proposed sideslopes for the pond below normal operating level will be no steeper than 3 horizontal to 1 vertical. Above normal water level and in dry pond areas, the sideslopes are recommended to be approximately 5 horizontal to 1 vertical.

In the preparation of the recommendations provided in this report for the geotechnical aspects of design and construction of the containment pond, EBA reviewed pertinent sections of the "Stormwater Management Guidelines for the Province of Alberta", dated January 1999 as prepared by the Municipal Program Development Branch of Alberta Environmental Protection (known now as Alberta Environment (AENV)). Detailed recommendations for the design and construction of this water retention pond are provided in subsequent sections.

6.0 SUBDIVISION DEVELOPMENT RECOMMENDATIONS

6.1 LOT GRADING

In general terms, the lot grading should be designed and carried out to the current City of Lethbridge Infrastructure Services Engineering Standards. The particulars for this development are discussed as follows.

All lots should be initially graded for drainage at a minimum gradient of 2.0 percent. The existing surficial site soils comprising medium plastic plastic clay and clay till are suitable for use as 'landscape fill' materials or for use as 'general engineered fill' materials for lot grading, as defined in Appendix C. The moisture content of the site soil materials near surface generally appears to range between close to end significantly above the anticipated optimum moisture content for these soils in most areas. It is anticipated, therefore, that moisture conditioning consisting primarily of drying 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.

6.2 STREET SUBGRADE PREPARATION

Within all asphalt concrete surfaced paved areas, within utility trench sections, the upper 300 mm of trench backfill soils or prepared general engineered fill subgrade should be scarified and uniformly moisture conditioned to between minus 1 percent of optimum and 2 percent over optimum moisture content. Outside of trench zones, undisturbed, native clay subgrades should be conditioned and compacted to a depth of 600 mm for the full width of the roadway, including sidewalks. The subgrade should then be uniformly compacted to a minimum of 98 percent of SPD.

Based on EBA's local experience, the contractor should be made aware that subgrade difficulties often arise at moisture contents of 3 percent over optimum, as noted in the current City of Lethbridge Standards, where siltier soils are encountered. Therefore, in practice, the moisture content within proposed paved areas should be limited to no more than 2 percent over optimum for acceptable subgrade support conditions.

Backfill to raise these areas to subgrade level should be general engineered cohesive fill materials, as defined in the report text or Appendix C, moisture conditioned and compacted as noted previously. The subgrade should be prepared and graded to allow drainage into catchbasins. 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 within the roadway structure and subsequent softening and loss of strength of the subgrade materials. 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.

If small localized areas of soft subgrade soils are encountered, provisions may be required to subcut each small area and replace with cohesive engineered fill, or alternatively, with granular (pit-run) fill with the use of a geotextile grid or geotextile fabric to strengthen the subgrade support characteristics. Further design information can be provided following initial proof-rolling of the subgrade soils.

6.3 EXCAVATIONS AND TRENCH BACKFILL

Excavations should be carried out in accordance with the Alberta Occupational Health and Safety (OH&S) Regulations.

For this project, the depths of excavations are anticipated to vary between 2 m and 9 m for such components as sewer trunks, service trenches, and tie-ins. 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 1.7 vertical for periods up to one month. Flatter sideslopes may be required in areas where groundwater is encountered within sand/silt seams, which may cause local sloughing and instability of the excavation sidewalls. Where excavations are open for longer than one month, the slopes should be cut back so they are not steeper than 1.0 horizontal to 1.0 vertical.

The maximum allowable sideslopes for utility trenches may not be governed by OH&S regulations, but by construction methodology for ensuring appropriate transition lengths from backfill soils to native soils. As an example, an appropriate transition of 1H:1V is normally recommended to avoid abrupt changes in subgrade stiffness and subsequent consolidation/cracking of the pavement structure. However, areas of multiple trenches, varying trench depth, and position of trenches (parallel or perpendicular to roadway alignments) need to be considered. EBA would be pleased to provide further specific recommendations, once final roadway/utility configurations are known.

It is considered unlikely that significant groundwater seepage will occur where construction is less than 1.5 m below the existing ground surface, except in the vicinity of the slough area where increased seepage should be expected. Therefore, dewatering of excavations is generally not expected unless excavations are deeper than 1.5 m. However, for the main utility trenches (deeper than 1.5 m), varying amounts of seepage should be expected and where encountered, should be directed towards sumps for removal from the excavations.

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 3.0 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 clay soils encountered across the site is generally close to or above the estimated Standard Proctor optimum moisture content for the materials. It is expected that such soils would be satisfactory as trench backfill material, however, will require moisture conditioning prior to compaction.

Trenches must be backfilled in such a way as to minimize the potential differential settlement and/or frost heave movements. A minimum density of 98 percent of SPD is recommended for all trench backfill, at a moisture content of between –1 percent and +2 percent of optimum. 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 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.

6.4 CONCRETE ISSUES

6.4.1 Concrete Type

The water soluble sulphate content of two representative soil samples recovered from the site (determined in a laboratory) are 1.99 and 4.10 percent. For this development, based on EBA's experience and CSA A23.1-04, the recommended concrete exposure classification for general usage should be Class S-2 (CSA A23.1-04, Table 3). For this exposure classification, alternatives include the usage of Type HS (Sulphate Resistant) Portland cement, or blends of cement and supplementary cementing materials, conforming to Type MSb and/or Type HSb cements (CSA A3001-03).

For all concrete exposed to soil and/or groundwater (i.e., including all building foundation concrete, all below grade concrete, and surface works concrete), a maximum water/cementing materials (W/CM) ratio of 0.45 is recommended. Based on EBA's experience with Alberta aggregates, a W/CM ratio of 0.45 normally corresponds to a 28-day compressive strength of 28 MPa or greater (32 MPa at 56-days).

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.

6.4.2 Concrete Surface Works

With respect to surface works concrete (i.e., specifically concrete curbs and sidewalks), the recommendations provided in this report for subgrade preparation, including moisture conditioning and compaction, are intended to provide relative uniformity in the subgrade. The intention of uniformity, with respect to material type and moisture content, is to reduce the risk of differential concrete movements due to soil volume changes as a result of fluctuating moisture content. For these types of developments, a gradual increase in moisture content is common, resulting from precipitation, reduced evaporation, and irrigation. However, some differential movement and subsequent cracking of concrete surface works should be anticipated, typical for the Lethbridge area.

With respect to providing a layer of granular material beneath surface works concrete, there are both positive and negative consequences. In the positive sense, it must be assumed that the subgrade will be uniformly graded properly such that any moisture gaining access beneath the concrete within the granular layer would be drained away quickly to an area designed to accommodate excess moisture (i.e., roadway weeping tile tied into the storm system). If well drained, the provision of granular material also serves to reduce some differential distortions, when washed materials are used, and has been documented as helping to reduce longitudinal cracking.

On the negative side, if free drainage of the granular layer is not designed, constructed, and maintained, granular materials provide easy access for excess moisture to pond below the concrete, causing swelling of the medium to high plastic subgrade soils and/or consolidation of fill soils. There is also a risk of softening of the adjacent roadway pavement edges.

The risk of differential movement of the subgrade soils and the economic consequence for either option should be given due consideration by the municipal engineer.

7.0 FOUNDATIONS

7.1 SHALLOW FOUNDATIONS

Shallow foundations, if considered, should be constructed approximately 1.4 m below the final design exterior ground surface (frost protection requirement). At this depth the foundation subgrade soil generally consists of firm to very stiff, moist to very moist, medium plastic, silty clay or clay till.

The net allowable static bearing pressure for the design of strip and spread footings for residential construction at this depth may be taken as 75 kPa, on native, undisturbed clay 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 clay soils.

It is recommended to use a smooth edge-trimming bucket or Grade-All for final excavation to the foundation subgrade elevation to minimize disturbance of the founding soils. The foundation concrete should be placed immediately following excavation to ensure the bearing clay soil does not dry out to below the plastic limit.

The anticipated foundation clay soils are expected to be prone to volume changes (both heave and consolidation) with varying moisture content. Therefore, a permanent weeping tile system is also recommended around the outside perimeter of the structure at the foundation elevation to maintain a consistent moisture profile of the founding soils. This

will reduce the potential of differential movement (heave or consolidation) of the foundations. Weeping tile drainage is discussed in subsection 7.3.

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.

Recommendations for minimum depth of cover for footings are presented under the heading 'Frost Protection' below. 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 a smooth-mouth bucket or Grade-All 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.

In areas where floor slabs bear on a clay subgrade, the clay at this site may swell following completion of the floor slabs. Therefore, some movement should be anticipated. 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. 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.

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 engineered clay cap should be placed at the ground surface to minimize the infiltration of surface water.

7.3 FOUNDATION PERIMETER DRAINAGE REQUIREMENTS

As part of this evaluation, a review included a document entitled, "A Consolidation of a By-Law of the City of Lethbridge Respecting a Sewerage Service Charge and Regulating the Disposal of Sewage and the Discharge of Liquids and Waste into the Lethbridge Sewerage System".

However, since the project schedule does not allow sufficient time for a groundwater monitoring period, it is understood that all residential weeping tiles will be tied into the City storm sewer system.

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 to then discharge as noted above.

7.4 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 1.4 m. Isolated or exterior footings in unheated structures should have a minimum soil cover of 2.1 m unless provided with equivalent insulation.

7.5 SEISMIC DESIGN

Given the lower frequency and low magnitude of earthquakes for this area, a seismic foundation factor of 1.0 is recommended.

8.0 STORMWATER MANAGEMENT POND DESIGN AND CONSTRUCTION

8.1 GENERAL

As discussed in the previous sections, the subsurface stratigraphy of the proposed site consists primarily of lacustrine clay overlying a glacial clay till sheet. For purposes of discussion of the native site soils with regards to containment, only the clay till soils need be considered as they will most likely comprise the majority of the clay liner and are found naturally below the proposed pond invert.

Literature references (geology) for the clay till (Buffalo Lake Till Sheet) confirm that the till is vertically fractured (due to over consolidation during periods of glaciation). The till is also referenced (as confirmed by the site specific drilling program) to contain sand and/or silt lenses or pockets throughout its matrix. These preferential paths for groundwater seepage may or may not be horizontally continuous and attempts to quantify potential seepage losses are typically unsuccessful.

As such, the utilization of the clay till soils in their native state is not recommended because of the potential loss of containment through the fissured till structure and possible silty or sandy pockets within the native clay till, which may provide preferential seepage paths. For this development, it is recommended that the native, cohesive clay till soils be reworked into a low permeable, compacted clay liner to provide the required containment. With this option, some loss of containment is still possible (as with any earth retention structure). However, the recommendations presented herein are intended to limit seepage losses to an acceptable level, consistent with current industry standards.

Alternate liner types, such as synthetic membranes, are suitable but are not addressed in this evaluation. They may provide additional protection against leakage but are substantially more expensive.

The use of the native clay till materials encountered on this site for construction of a remolded clay liner for the ponds is considered feasible, provided certain precautions are undertaken as recommended in the following sections. The use of native lacustrine clay soils (if required) for construction of remolded clay liners should be limited to areas above the normal water level.

It is understood that above the normal water level, the sideslopes are to be 5 horizontal to 1 vertical (5H:1V) up to the residential lots. Below the normal water level, the sideslopes are understood to be at 3H:1V. For this configuration, and assuming the embankment between the normal water level and high water level is constructed with an engineered clay liner (as recommended in this report), the potential for erosion from wave action should be considered and erosion protection of the berms is recommended. In this instance, slope

protection consisting of rip-rap designed for potential wave erosion is recommended with the use of a filter fabric median between the native soils and rip-rap. Detailed design recommendations for this protection is beyond the scope of this report.

Full time monitoring is recommended 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.

The following discussions and recommendations pertain to the pond construction, including the design and construction of a low permeability compacted clay liner.

8.2 POND CONSTRUCTION

8.2.1 General Base Preparation

Following drainage of the slough area, and stripping of the organic material, the containment basin area should be overexcavated beneath the proposed invert elevation in order to allow sufficient thickness of compacted clay base liner. The clay till soil within the base of the excavation should then be scarified to a minimum depth of 300 mm (i.e. below the covering liner thickness), moisture conditioned to between –1 percent and +2 percent of optimum moisture content, and recompacted to a minimum of 98 percent of SPD. The intent is to improve the base conditions and to provide a low permeable pond base, effectively increasing the clay liner thickness by 300 mm. Note that the base preparation is deemed sufficient for dry pond areas, where a covering liner is not required.

The basin sidewalls in the cut areas (up to high water level) should also be overexcavated a sufficient amount to allow the construction of a compacted clay liner with the exposed subgrade scarified, moisture conditioned, and compacted as noted above.

Monitoring of excavated soils within the pond footprint is recommended so that unsuitable materials, such as low plastic silts or cohesionless sands, are incorporated only in general landscape areas (above HWL), where low permeability is not a requirement.

The composition and consistencies of the soils encountered on the property are such that conventional hydraulic excavators should be able to remove these materials. Cobbles and boulders may be present within the clay till matrix, albeit infrequently. General recommendations regarding backfill materials and compaction as well as construction excavations are given in Appendix C.

8.2.2 Remolded Clay Liner

The following recommendations for the design and construction of remolded clay liners are based on compliance with Alberta Environment's publication, "Stormwater Management Guidelines for the Province of Alberta", dated January 1999. This publication does not specifically provide permeability recommendations for wet ponds, however, it does provide a guideline in Figure 6.10, Wet Detention Pond Plan Sections, for "suitable subgrade to prevent infiltration below permanent depth (Max = 1.2 m/Min = 0.6 m).

Two laboratory constant head permeability tests were conducted on a remolded sample of the native clay and clay till site soils. The composite clay and clay till samples were taken from one borehole within the initial pond area and from a borehole in the final pond footprint from between approximately 0.3 m to 3.0 m below ground level (to model that excavated from within the lake footprint and proposed for use as a clay liner).

The samples were compacted to approximately 98 percent of SPD at a moulding moisture content of approximately the optimum moisture content (OMC) for the soil samples (15.5 percent in the initial footprint and 18.0 percent in the revised footprint) (See Appendix D). The measured steady state permeability (K) was 2.58E-08 cm/sec in the initial location and 1.58E-08 cm/sec in the revised location. Therefore, the design field liner permeability for both locations assumed for the remolded clay and clay till soil is 2.58E-07 cm/sec and 1.58 E-07 cm/sec respectively (one order of magnitude larger than the laboratory K value).

Based upon the site soil conditions and the above noted permeability value, it is recommended that the thickness of remolded clay liner be 0.6 m along the base of the wet pond and 1.0 m along the sidewalls up to normal water elevation. The sidewall liner thickness may be reduced to 0.6 m from normal water level to high water level. In other areas termed as 'dry pond', which will normally not be below the water level, the liner thickness may be reduced to 0.3 m. These thicknesses account of the potential of desiccation of the upper 0.2 m during the initial periods when the wet pond is empty. They also account for potential disturbance (primarily of the sidewalls) during storm events or during periods of shore maintenance.

Recommendations for the pond base and sidewall preparation have been provided in the previous section. The plan dimensions of the excavation should exceed the final "toe to toe" interior basin dimensions to provide an overlap between the pond floor liner and berm or sideslope liner. The subgrade should be relatively level and proof-rolled to provide a good base for compacting the first liner lift to the specified density. Soft pockets that would prevent sufficient compaction of the liner must be overexcavated and replaced with compacted cohesive clay fill materials. In lieu of satisfying the compaction requirements, a geotextile fabric (such as Armtec 200) may be required on or about the elevation of any encountered soft subgrade, although this is not anticipated for the current site conditions.

Careful site observation and testing will be required to avoid incorporating low or non-plastic materials into the liner. It is recommended that materials with a liquid limit of less than 30 not be incorporated into the liner. However, low plastic clays, silt or sands not meeting liner requirements, may be used in the top area of the embankment above HWL or outside the liner zone for berms.

Soil moisture contents for the lacustrine clay at the pond site vary generally between approximately 20 percent and 26 percent, which is significantly wet of the optimum moisture content for this material. Soil moisture contents for the clay till at the pond site vary generally between approximately 17 percent and 21 percent with an average of

approximately 19 percent, which is several percent wet of the optimum moisture content for the clay till material. Moisture conditioning consisting of drying may be required during liner construction. Expressively wet clay soils may have to be removed from the area if drying conditions are not available. Appropriate methods of moisture conditioning should be reviewed with qualified construction personnel prior to final design of the liner system.

Subsequent to the preparation of the pond floor, the excavated clay soils (liner borrow material) should be moisture conditioned to between –1 percent of the optimum and +2 percent over the optimum moisture content as determined by the Standard Proctor Test. Each lift should then be compacted to a minimum of 98 percent of SPD in lifts of maximum 150 mm compacted thickness to a total placed liner thickness of 0.6 m for the base, as recommended above.

A maximum "clod" size of 100 mm during moisture conditioning (prior to compaction) will produce a relatively uniform moisture content throughout the soil matrix and a relatively homogenous compacted soil structure. The size of the "clods" can be controlled with agricultural equipment such as a disk. As far as practical, the liner should be built up in a uniform fashion over the containment basin area, in order to avoid sections of "butted fill" where seepage paths may develop. Compaction should be carried out utilizing "kneading" type compaction equipment such as vibratory padfoot or sheepsfoot type compactors. Completed liner areas should have the surface smoothed by a vibratory smooth drum roller.

Sideslope liners in "cut" areas should have a minimum thickness (perpendicular to the slope face) of 1.0 m, as noted. The cohesive materials for the sideslope liners should be moisture conditioned and compacted as indicated above for the pond bottom.

If a lift of liner soil is allowed to become dry and desiccated prior to the placement of the next lift, the exposed surface should be scarified, re-moisture conditioned, and recompacted. Prior to lake filling and during maintenance periods when the pond is empty, the pond bottom should be prevented from drying out beyond 0.2 m as accounted for in the design liner thickness.

9.0 DESIGN AND CONSTRUCTION GUIDELINES

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

- Shallow Foundations (1 page)
- Construction Excavations (1 page)
- Floor Slabs-on-Grade (2 pages)
- Backfill Materials and Compaction (4 pages)
- Proof-Rolling (2 pages)

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.

10.0 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.

11.0 LIMITATIONS

Recommendations presented herein are based on a geotechnical evaluation of the findings in thirty four geotechnical boreholes and a review of existing information. 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.

This report has been prepared for the exclusive use of Associated Engineering Alberta Ltd., The City of Lethbridge, and their agents, for specific application to the development described in Section 2.0 of this report. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No warranty is either express or implied.

For further limitations, reference should be made to the General Conditions in Appendix A of this report.

12.0 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 do not hesitate to contact our office.

Respectfully submitted,
EBA Engineering Consultants Ltd.

Prepared by:

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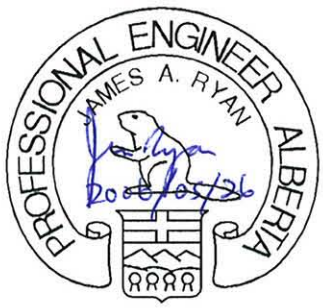
Reviewed by:



J.A. (Jim) Ryan, M.Eng., P.Eng.
Project Director

/cld

PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature Jim Ryan
Date May 26, 2006
PERMIT NUMBER: P245
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

FIGURES

EBA Engineering Consultants Ltd.	CLIENT: ASSOCIATED ENGINEERING ALBERTA LIMITED	PROJECT: BENTON CROSSING RESIDENTIAL SUBDIVISION	
DWN. LCH / CHKD. MC		TITLE: SITE PLAN SHOWING BOREHOLE LOCATIONS	
EBA JOB NO. 4400840	FILE: 4400840s02.dwg / REVISION NO. 2	DATE: May 23, 2006	FIGURE 1

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.

8.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

9.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

10.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

11.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

12.0 SAMPLES

EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the client's expense upon written request, otherwise samples will be discarded.

13.0 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 practising 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.

14.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

15.0 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

APPENDIX C RECOMMENDED GENERAL DESIGN AND CONSTRUCTION GUIDELINES

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."

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.

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.

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.

APPENDIX

APPENDIX D LABORATORY TEST RESULTS

EBA Engineering Consultants Ltd.

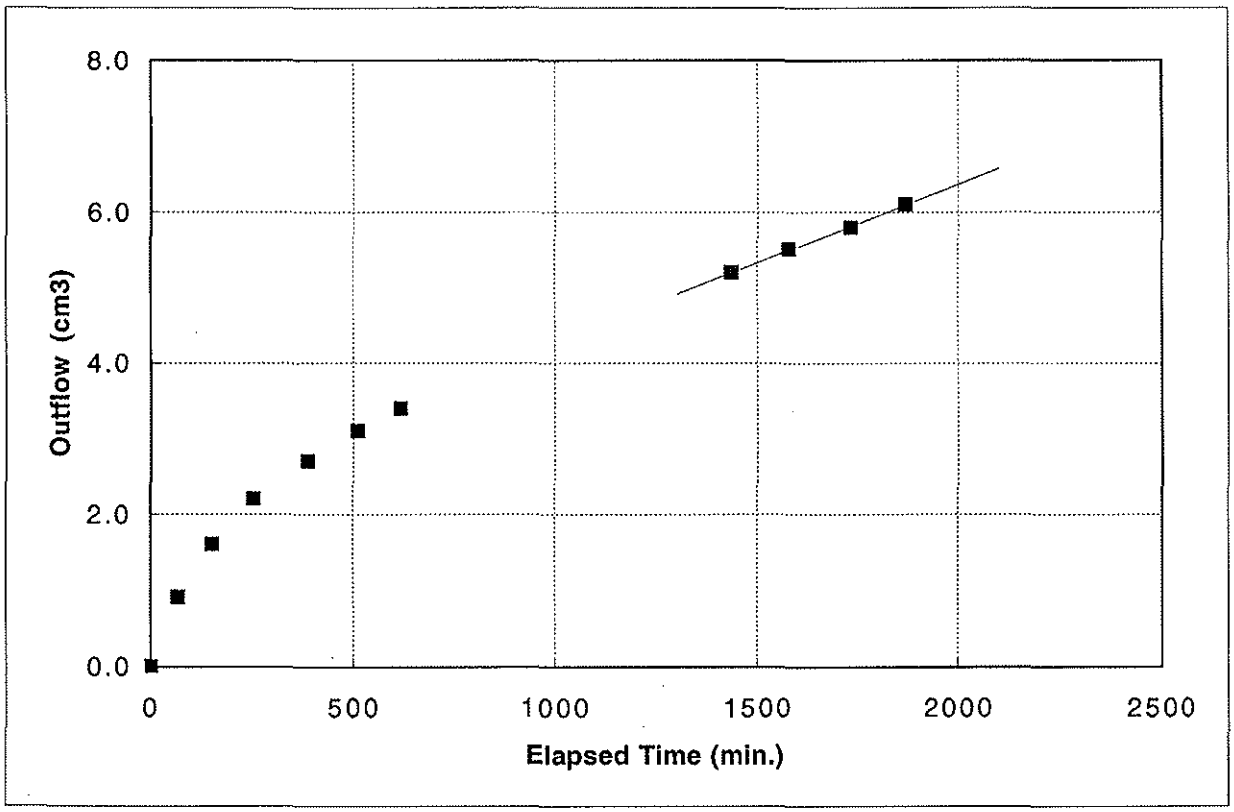
CONSTANT HEAD PERMEABILITY TEST — **LANDS WEST OF BENTON**

Job Number: 4400840
Test Hole: BH031 Depth: 0.0-1.5 m

Date: 06-03-25
Test No: P-2

Time	Buret (cc)	Elap. (min)	Outflow (cc)
6:58	13.4	0	0.0
8:05	14.3	67	0.9
9:29	15.0	151	1.6
11:12	15.6	254	2.2
13:24	16.1	386	2.7
15:29	16.5	511	3.1
17:16	16.8	618	3.4
6:54	18.6	1436	5.2
9:18	18.9	1580	5.5
11:50	19.2	1732	5.8
14:08	19.5	1870	6.1

Diameter=	71.22	mm
Height=	25.58	mm
Volume=	101.90	cm^3
Head Diff.=	2	psi
Q=	3.46E-05	cm^3/sec
i=	54.99	
A=	39.84	cm^2
K=	**1.58E-08 cm/sec**	



EBA Engineering Consultants Ltd.

CONSTANT HEAD PERMEABILITY TEST **LANDS WEST OF BENTON**

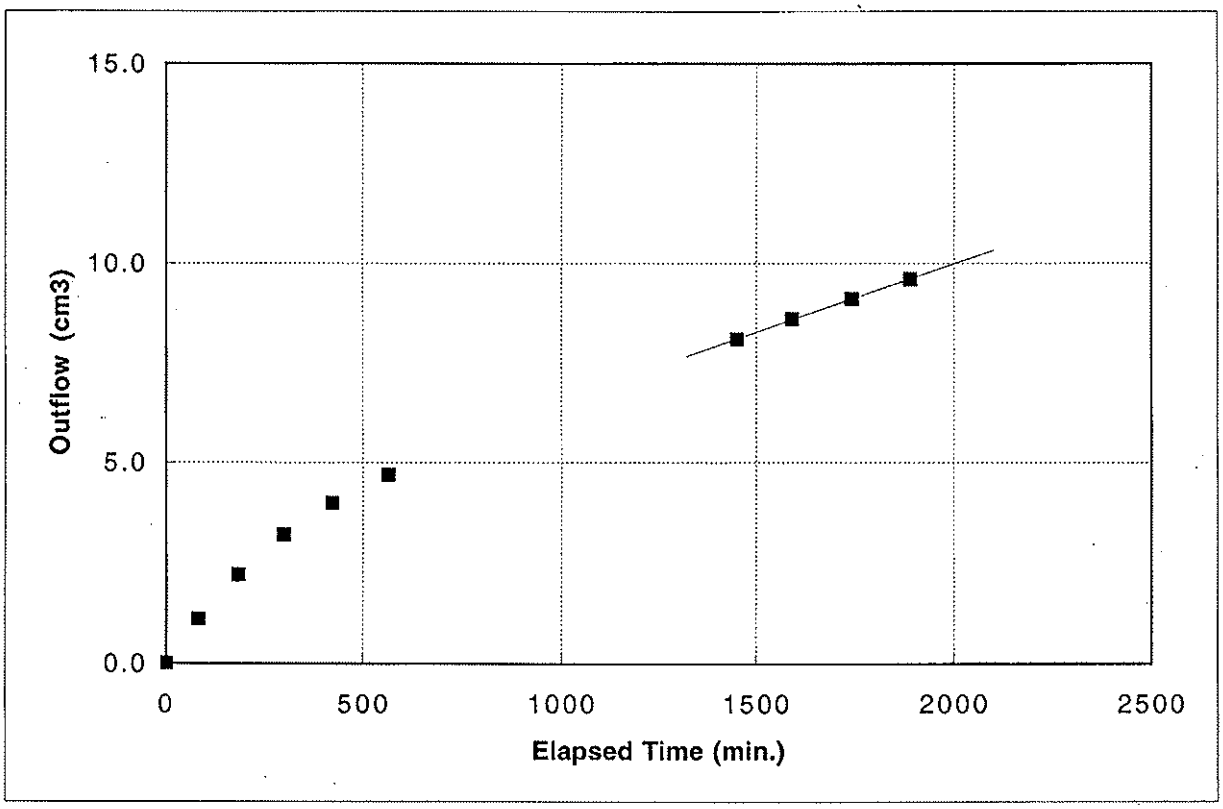
Job Number: 4400840
Test Hole: 029 Depth: 1.5-3.0 m

Date: 05-12-09
Test No: P-1

Time	Buret (cc)	Elap. (min)	Outflow (cc)
6:48	12.2	0	0.0
8:11	13.3	83	1.1
9:52	14.4	184	2.2
11:49	15.4	301	3.2
13:51	16.2	423	4.0
16:14	16.9	566	4.7
6:59	13.5	1451	8.1
9:20	13.0	1592	8.6
11:52	12.5	1744	9.1
14:18	12.0	1890	9.6

Diameter=	71.15	mm
Height=	25.30	mm
Volume=	100.59	cm^3
Head Diff.=	2	psi
Q=	5.69E-05	cm^3/sec
I=	55.60	
A=	39.76	cm^2

K= 2.58E-08 cm/sec



EBA Engineering Consultants Ltd.

MOISTURE - DENSITY RELATIONSHIP

ASTM D698, D1557, or D2049

PROJECT: Lands West of Benton - Geotechnical Evaluation

SAMPLE NUMBER: S-1585

PROJECT NO.: 0404-4400840

DATE TESTED: 28-Nov-05

CLIENT: Associated Engineering Alberta Ltd.

MOISTURE CONTENT (as Received) : 18.4%

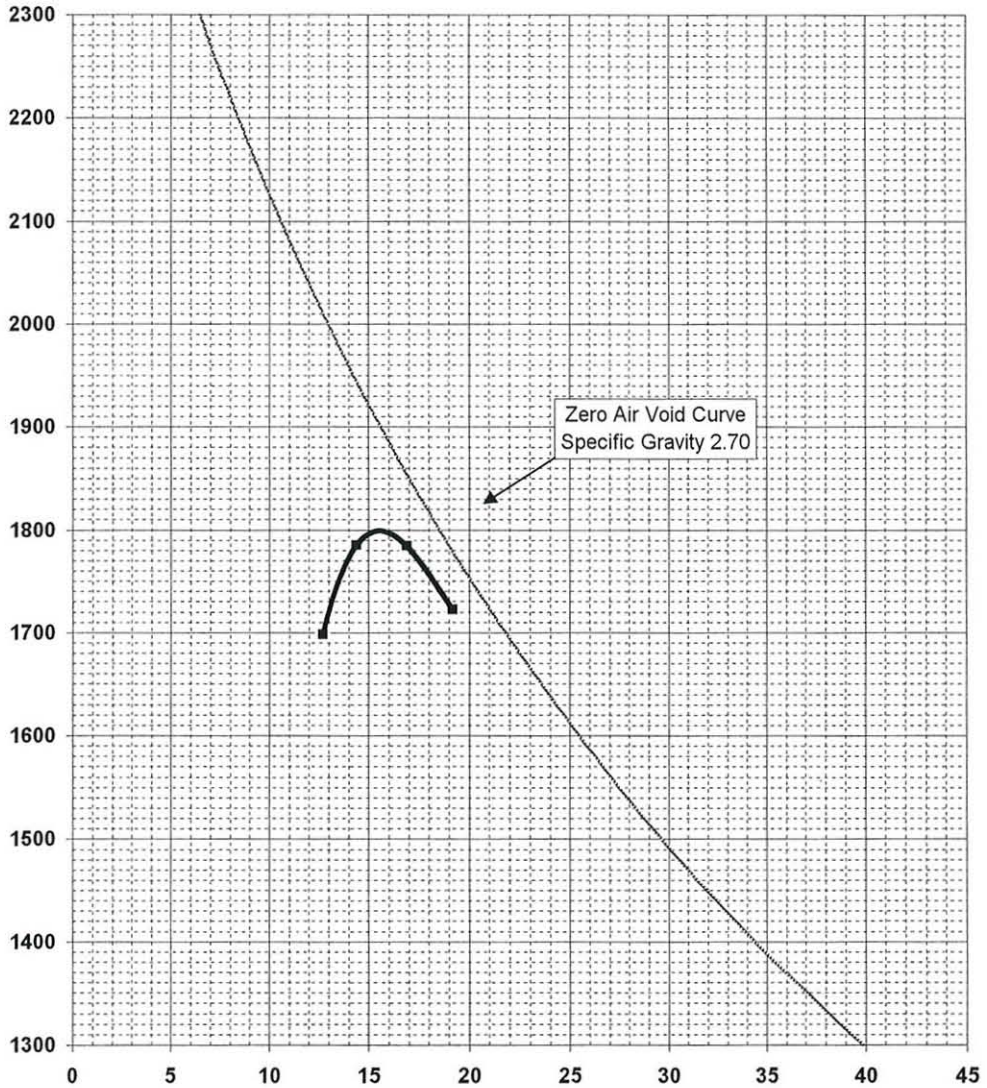
DESCRIPTION: Clay, silty, some sand

MAXIMUM DRY DENSITY: 1800kg/cu.m.

SAMPLE LOCATION: Borhole #029 from 1.5m to 3.0

OPTIMUM MOISTURE CONTENT: 15.5%

REMARKS: Atterberg Limit - PL = 12, LL = 38, PI = 26



STANDARD PROCTOR

ASTM D698

Hammer Mass: 2.494 kg

Hammer Drop: 304.8 mm

Number of Layers: 3

Number of Blows/Layer: 25

Diameter of Mould: 101.4 mm

Height of Mould: 116.6 mm

Mould Volume: 0.000942 cu.m

Compactive Effort: 593.5 kJ/cu.m

REVIEWED BY:

P.Eng.

EBA Engineering Consultants Ltd.

MOISTURE - DENSITY RELATIONSHIP

ASTM D698, D1557, or D2049

PROJECT: Lands West of Benton Geotechnical Evaluation

PROJECT NO.:0404-4400840

CLIENT: Associated Engineering Alberta Ltd.

DESCRIPTION: Clay, silty, some sand

SAMPLE LOCATION: Bulk Sample 0-1.5m BH031

REMARKS:

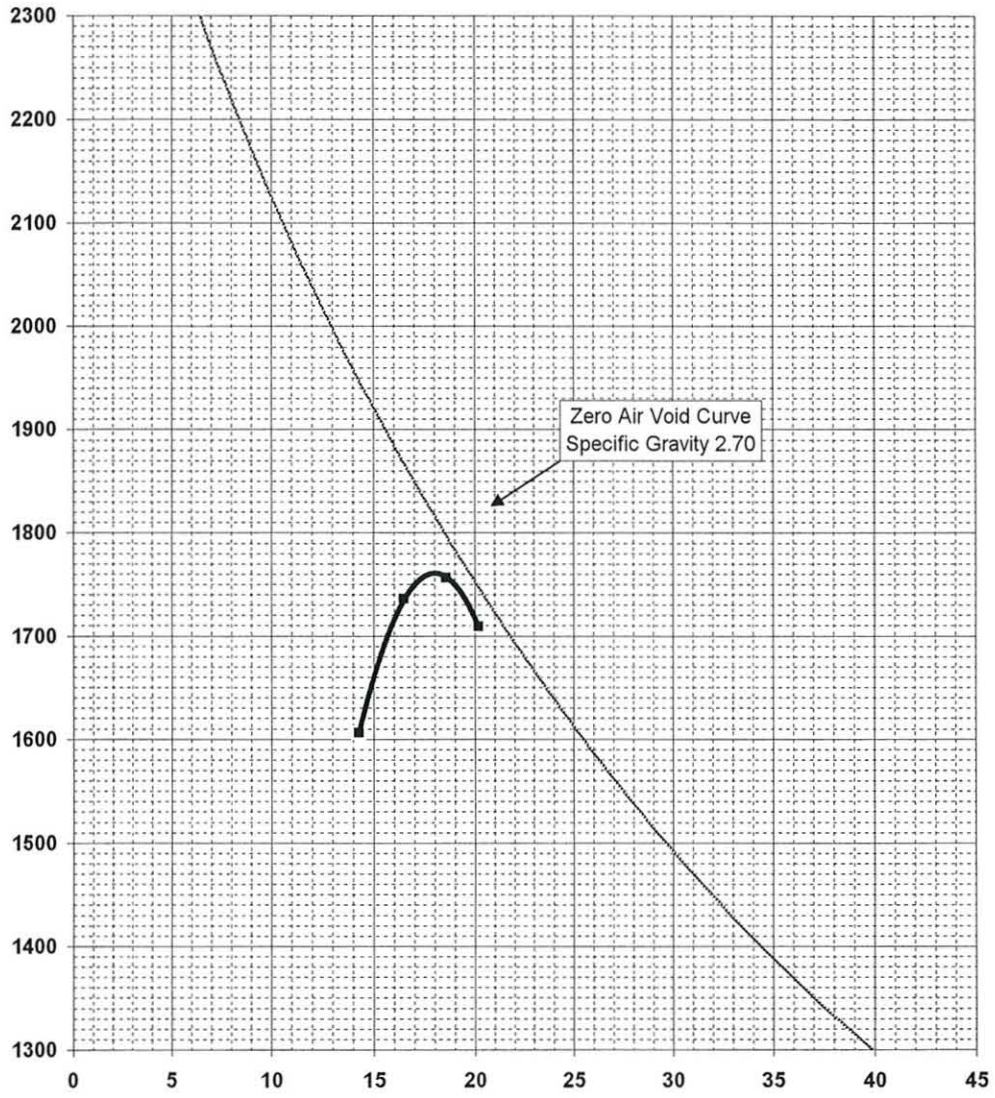
SAMPLE NUMBER: T - 206

DATE TESTED: 10-Mar-06

MOISTURE CONTENT (as Received): 22.2%

MAXIMUM DRY DENSITY: 1760kg/cu.m.

OPTIMUM MOISTURE CONTENT: 18.0%



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REVIEWED BY:

P.Eng.

APPENDIX C

Environmental Site Assessment

PHASE I
ENVIRONMENTAL SITE ASSESSMENT
PORTIONS OF 27 – 8 – 22 W4M
LETHBRIDGE, ALBERTA

0404-4400840.001

Submitted to:

ASSOCIATED ENGINEERING ALBERTA LTD.
300, 410 STAFFORD DRIVE SOUTH
LETHBRIDGE, ALBERTA
T1J 2L2

May 2005

EXECUTIVE SUMMARY

FOREWORD

Associated Engineering Alberta Ltd. (Associated) to conduct a Phase I Environmental Site Assessment (ESA) retained EBA Engineering Consultants Ltd. (EBA) of properties located in a proposed subdivision located west of Benton Drive West Lethbridge, Alberta. The legal land descriptions and municipal addresses include portion of the following.

LEGAL LAND DESCRIPTION	MUNICIPAL ADDRESS
NW ¼ 27-8-22 W4M (portion)	1415 – 30 Street West
SW ¼ 27-8-22 W4M	2225 – 30 Street West
NE ¼ 27-8-22 W4M (portion)	1212 – 25 Street West
SE ¼ 27-8-22 W4M (portion)	2030 Benton Drive West

These properties are reviewed within this report and are referred to as the "site".

The objective of the Phase I ESA was to comment on whether any past or present site use, either on-site or off-site, may have a potential to cause environmental impairment of the subject properties.

It is understood that this area is in the planning stage and a community core development that includes schools, public library and other recreations facilities is planned for the site. This assessment is to determine any potential environmental impairments prior to the development of this area.

FINDINGS AND CONCLUSIONS

EBA has obtained and reviewed select historical information pertaining to the site and adjacent lands back to 1912. EBA also performed a site reconnaissance.

There was one potential off-site source of environmental impairment to the site. An abandoned oil/gas lease is present to the south of the site. This area can be addressed in an environmental assessment on that area prior to development.

There are two potential sources of impairment related to the site.

The first potential source of impairment to the site is the abandoned oil/gas well lease located on the site at SW ¼ 27-8-22 W4M. There was no information available at the time of this report release to indicate if environmental work has been conducted relating to the well site (i.e. Upstream Phase I ESA). Further, the well abandonment details are unknown for this well. The presence of this abandoned well should be considered during development planning and construction activities. The soil and groundwater quality in the area of the well site should be investigated.

The second on-site source is the stockpiled soil material. The origin and quality of the stockpiled soil could not be verified during this investigation. Chemical testing and field screening is recommended.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont)

1.0 INTRODUCTION

1.1 General

Associated Engineering Alberta Ltd. (Associated) to conduct a Phase I Environmental Site Assessment (ESA) retained EBA Engineering Consultants Ltd. (EBA) of properties located in a proposed subdivision located west of Benton Drive West Lethbridge, Alberta. The legal land descriptions and municipal addresses include portion of the following.

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These properties are reviewed within this report and are referred to as the "site".

The objective of the Phase I ESA was to comment on whether any past or present site use, either on-site or off-site, may have a potential to cause environmental impairment of the subject properties.

It is understood that this area is in the planning stage and a community core development that includes schools, public library and other recreations facilities is planned for the site. This assessment is to determine any potential environmental impairments prior to the development of this area.

1.2 Authorization

Verbal authorization to proceed with the present study was given by Mr. Greg Kaupp, of Associated to Mandi Parker of EBA on May 4, 2005.

1.3 Scope of Work

To meet the objectives stated in Section 1.1 EBA conducted the following scope of work.

- Initiated the project and conducted a pre-job hazard assessment.

- Conducted a site visit and personnel interviews to evaluate the potential extent and manner that present and surrounding activities may impact upon the site and the environment. There is no sampling included in a Phase I ESA.

- Investigated and collected relevant information pertaining to environmental concerns at the site from the; Petroleum Tank Management Association of Alberta (PTMAA); Alberta Energy and Utilities Board (AEUB); City of Lethbridge Development Service, and Alberta Infrastructure and Transportation (AIT).

- Reviewed available historical information for the site and the immediate surrounding areas, including business directories, and land titles. It should be noted that only the site land titles were reviewed during this assessment.

- Obtained and reviewed historical aerial photographs for previous land use of the site and the immediate surrounding areas.

- Reviewed available published geological information such as geological and soils reports and maps in EBA company files.

- Prepared this report discussing the site history and identifying the potential for environmental impairment resulting from past or present land use on site and in the surrounding area.

1.4 Qualifications of Assessors

Ms. Mandi Parker, P.Ag. of EBA conducted the records review, site reconnaissance, interviews, and prepared the report. Ms. Parker is an Environmental Scientist and has conducted environmental site assessments for over five years.

Mr. Darrell Haight, B.Sc., A.Ag., assisted with interpretation of the findings and reviewed the report. Mr. Haight is a Project Director for EBA's environmental practice in Calgary and is an environmental scientist with over six years of ESA experience.

Mr. Marc Sabourin, P.Eng., conducted the final review of the report. Mr. Sabourin is a Senior Project Director and has experience in conducting ESAs.

2.0 SITE DESCRIPTION

A description of the site and surrounding land use is provided in this section, as well as the regional geology and hydrogeology. Location plans and a general site plan are presented as Figure 1 and Figure 2, respectively.

This section also summarizes EBA's observation made during a site reconnaissance on May 6, 2005. The reconnaissance included a walk and observations of the site and observations of adjacent properties to identify evidence of impairment or potential sources of impairment, which may adversely affect the site. There were no buildings on the site.

Portion of NW ¼ 27-8-22 W4M – 1415 – 30 Street West

Only the south half of this quarter section is part of the site (see Figure 2). During the site inspection this portion of the site was stubble from last year's crop. The land is hummocky and water can collect in the low areas. There was no stressed vegetation areas noted during the site inspection, however, the inspection was at the beginning of the growing season. There are aboveground power lines that are orientated north-south along the east portion of this part of the site.

Portion of NE ¼ 27-8-22 W4M – 1212 – 25 Street West.

There is only a small portion of this quarter section that is part of the site (see Figure 2). This portion of the site is vacant and undeveloped. There were stockpiles of fill material, sod and topsoil. The origin and quality of the fill could not be verified.

Portion of SW ¼ 27-8-22 W4M – 2225 – 30 Street West

This quarter section was assessed except a portion in the southeast corner (see Figure 2). During the site inspection this portion of the site was stubble from last year's crop. The land is hummocky and water can collect in the low spots. There was no stressed vegetation noted during the site inspection, however, the inspection was at the beginning of the growing season. There are aboveground power lines that was oriented north-south along the east side of this quarter section and east-west along the south boundary of the quarter section.

Portion of SE ¼ 27-8-22 W4M – 2030 – Benton Drive West

Only the northwest portion of this quarter is part of the site (see Figure 2). During the site inspection this portion of the site was stubble from last year's crop. The land is hummocky and water can collect in the low spots. There was no stressed vegetation noted during the site inspection, however, the inspection was at the beginning of the growing season. There was an area in the southeast portion of this part of the site where topsoil has been stockpiled since the early 1980s. This area has been used as biking dirt hills for the children that reside in the area. Since approximately 2000 the topsoil has slowly been removed and only 50% of the stockpiles remain. The origin of the topsoil could not be verified.

2.1 Site Ownership

There are various owners for each portion of the site. The current land title information is included below. The land title information has been included in Appendix B.

LEGAL LAND DESCRIPTION	OWNER
NW ¼ 27-8-22 W4M (portion)	The City of Lethbridge (2004)
SW ¼ 27-8-22 W4M	The City of Lethbridge (1984)
NE ¼ 27-8-22 W4M (portion)	838 Land Developments Ltd. (2003)
SE ¼ 27-8-22 W4M (portion)	Walter J. Willms and Clara B. Willms (1996)

2.2 Site Location

The site is located on the west side of Indian Battle Heights and Varsity Village located in West Lethbridge which is also east of 30 Street West and North of 24 Avenue West. The site extends from Whoop Up Drive and west of the future Benton Drive.

2.2.1 Legal Description

The legal descriptions are as follows.

LEGAL LAND DESCRIPTION	MUNICIPAL ADDRESS
NW ¼ 27-8-22 W4M (portion)	1415 – 30 Street West
SW ¼ 27-8-22 W4M	2225 – 30 Street West
NE ¼ 27-8-22 W4M (portion)	1212 – 25 Street West
SE ¼ 27-8-22 W4M (portion)	2030 Benton Drive West

2.3 Surrounding Land Uses

The surrounding land uses are discussed for each portion of the site.

Portion of NW ¼ 27-8-22 W4M – 1415 – 30 Street West

To the north of this area is agricultural cropland, then an abandoned farm yard and a survey benchmark. To the east is Indian Battle Heights residential development. West of the site is 30 Street West then agricultural cropland.

Portion of NE ¼ 27-8-22 W4M – 1212 – 25 Street West

To the north and east of this portion of the site is Indian Battle Heights residential development. To the south of this area is the SE ¼ of the site and to the west is the SW ¼ of the site.

Portion of SW ¼ 27-8-22 W4M – 2225 – 30 Street West

To the north is the NW ¼ of the site and to the east is the SE ¼ of the site. South of this area is 24 Avenue West then agricultural cropland. To the west is 30 Street West then agricultural cropland.

Portion of SE ¼ 27-8-22 W4M – 2030 – Benton Drive West

North of this area is the NE ¼ of the site and to the west is the SW ¼ of the site. South is the remaining portion of the SE ¼ which is agricultural cropland then 24 Avenue West. To the east is Varsity Village residential development, Whoop Up Drive and Indian Battle Heights residential development.

The following table summarizes the general surrounding land use for the area.

General Surrounding Land Use

North of Site	South of Site	West of Site	East of Site
Agricultural cropland	Agricultural cropland	Agricultural cropland	Residential development

There are oil and gas leases in the vicinity of the site (>100 m) however; they are not immediately adjacent to the site. There were no concerns related to the adjacent properties based on the site inspection.

2.4 Geology

The following geological summary is based on published reports and EBA's experience on previous projects located in the vicinity of the site.

The stratigraphy of the Lethbridge area is generally comprised of 65 m to 70 m of surficial deposits overlying bedrock. Bedrock in the Lethbridge area consists of strata from the upper Oldman formation and the lower Bearspaw Formation, both of the late Cretaceous age. The bedrock has a relatively flat surface dipping slightly to the northwest and is locally encountered at the approximate geodetic elevation 843 m. The bedrock strata consists of thin beds of predominantly weak mudstones, siltstones, and sandstones with occasional bentonite and coal seams.

Surficial soils, in ascending order, consist of a preglacial gravel stratum typically found between geodetic elevations 849 m and 843 m, glacial tills and some glaciofluvial and glaciolacustrine sands, silts, and clays. Prairie levels in the site area are approximately at the geodetic elevation 930 m.

The till in the area has been heavily overconsolidated by the weight of the glacial ice. Geological reports indicate that the area was subjected to several stages of glaciation during the Pleistocene period. The geological reports also estimate that the maximum thickness of the ice may have reached 670 m. As the glaciers retreated, the Oldman River Valley was created by meltwater cutting through the till and the underlying gravel into bedrock strata.

The direction of regional groundwater flow is westward towards the Oldman River. (O. Tokarsky, 1974, hydrogeology of the Lethbridge and Fernie Area, Alberta, 74-1, Alberta Research Council, Edmonton, Alberta). Perched groundwater tables have also been encountered in many areas of Lethbridge. The depth to these perched tables can vary from approximately 2.0 m below ground level to considerable depths within sand and/or silt seams. The flow of these perched tables can also vary in any direction or be still, dependent on the horizontal to vertical dip and the extent of the sand and/or silt seams.

2.5 Hydrogeology

Groundwater is of significance as a potential means of contaminant transport. Regional groundwater flow is the overall direction of groundwater flow in a given region. There may be local groundwater flow, within a region, that is in a different direction from the regional flow and that is controlled by topography.

The general topography of the site area is relatively hummocky with local, relief east towards the Oldman River. Shallow groundwater flow is assumed to be in an easterly direction toward the Oldman River.

3.0 SITE RECONNAISSANCE

3.1 On-Site Observations

The observations were made during the site reconnaissance on May 6, 2005. Access to the site was not granted prior to the release of this report; however the site was visible from the surrounding roadways. The assessor was also familiar with this area.

3.1.1 Surficial Staining

There was no surficial staining observed during the site inspection, however, as described above a site walk-over was not conducted.

3.1.2 Vegetation

The vegetation observed was stubble. There was no other vegetation noted or stressed vegetation observed as the site inspection was at the beginning of the growing season and the vegetation was only emerging.

3.1.3 Ponding of Water

There was no ponding of water observed on the site.

3.1.4 Washouts / Erosion

There were no washouts or indications of erosion observed during the site visit.

3.1.5 Fill Areas

There was evidence of fill material stockpiled in the NE ¼ 27-8-22 W4M and in the SE corner of the SE ¼ 27-8-22 W4M. The fill is suspected to be stockpiled topsoil from residential developments in the area, however the origin and quality of the fill could not be verified during this study.

3.1.6 Oil / Gas Wells

There are oil and gas wells visible in the vicinity of the site however no existing wells were observed on the site.

The AEUB database search results for the site indicated an abandoned well is located in the SW ¼ 27-8-22 W4M (see Figure 3). A second abandoned well was located south of the SW ¼ 27-8-22 W4M, in NW ¼ 22-8-22 W4M, noted on Figure 2.

The AEUB results are included in Appendix C and discussed in section 5.3.

3.1.7 Drums / Chemical Storage

There were no drums or chemical storage areas on the site during the site inspection.

3.1.8 Transformers

There were no transformers noted on the site during the site inspection.

3.1.9 Vent Pipes / USTs/ ASTs

There were no vent pipes, USTs or ASTs were observed during the site inspection, however a site walk-over was not conducted.

3.1.10 General Housekeeping

The site areas were noted to be tidy during EBA's site reconnaissance with the exception of NE ¼ 27-8-22 W4M where there was piles of sod, grass clippings, small amounts of concrete, wood and topsoil piles.

3.2 Off-Site Observations

There were no apparent environmental impacts identified with respect to immediate adjacent properties and land uses during the site reconnaissance.

4.0 PERSONNEL INTERVIEWS

EBA collected Information pertaining to the site through conversations with Mr. Kel Hansen of the City of Lethbridge Land Sales Department and Mr. George Kuhl of the City of Lethbridge Development Services. Steve Roth of Thunder Energy Ltd. was queried about the abandoned lease on the site. There were no other reliable sources available to interview prior to the release of this report. Information collected through these interviews appears throughout this report.

5.0 RECORDS REVIEW

EBA conducted a historical review of the subject site based on the following documents.

- Alberta Land Titles Records from 1912 to the present.
- Regulatory inquiries: Petroleum Tank Management Association of Alberta (PTMAA).
- Alberta Energy and Utilities Board (AEUB)
- Alberta Environment water well database
- Selected aerial photographs from 1922 to 2001.
- Alberta Infrastructure and Transportation (AIT).
- Fire insurance maps (FIPs)
- Henderson Business Directories (HBDs)
- Archival Information
- Previous Reports

A Phase I ESA Information Source Checklist is included in Appendix E.

5.1 Land Title Records

The land titles were reviewed for all four legal land descriptions of the site. The NW ¼ 27-8-22 W4M was owned by various individuals since 1912. The names include Robert Cranford, Daniel Easter, Bessie Marnoch, Mary Falconer, Alexander Marnoch, Blue Willow Homes Ltd., Astro Property Management Ltd., Raymond Marnoch, Allan/Judith

Willms, Barry/Linda Willms, Melissa Fereisen, Sharlene Christie and The City of Lethbridge.

The SW ¼ 27-8-22 W4M is owned by the City of Lethbridge and was previously owned by Nu-Mode Homes Ltd., Alpine Drywall and Plastering Lethbridge Ltd. and Treco Apartments Ltd., Jenny Skinner, Harrison Hubbard and Fred Senior. The records date back to 1917. After a review of the land titles for this quarter section there were no caveats or right of ways listed for any drilling companies or oil and gas companies (this is the portion of the site with the abandoned well).

The SE ¼ 27-8-22 W4M Has been owned by individuals and companies dating back to 1922. They include Walter and Clara Willms, J.M. Look Holdings Ltd., West Valley Investments (1979) Ltd., Jack Look, Margaret Look and Bruce Look, Glen Hill Farms Ltd., Genstar Properties Limited, Engineered Homes Limited, Aubern Hubbard and Harry Wilhenson.

The NE ¼ 27-8-22 W4M had land title records dating back to 1924. The historical owners include 8338 Land Development Ltd., White Pine Investments Ltd., Glenhill Farms Ltd., Genstar Properties Limited, Aubern Hubbard, Ada Culham, Ada Hubbard, Harry Hubbard and the Canadian Mortgage Investment Company. There were no caveats or right of ways listed for potential oil and gas leases on the land titles. The historical land title information is summarized in Appendix B.

5.2 Aerial Photographs

Aerial photographs provide visual evidence of site occupancy, operational activities and general site details. Aerial photographs capture a view of the subject site and the surrounding areas at a given time.

EBA reviewed aerial photographs (various scales) of the site and area for the years 1922, 1950, 1961, 1971, 1984, 1994 and 2001. A summary of the findings from the aerial photograph review is below.

Historical Aerial photo Summary

Year	Site	North	East	South	West
1922	Pasture or uncultivated land, low lying area in centre of site appears to have had water present at one time, agricultural cropland in bottom SW corner of site, borrow area or excavation to the east of cropland, no gravel roads, dirt roads mark section lines.	Pasture land or uncultivated land then a farmyard in the SE corner of 34-8-22 W4M.	Agricultural cropland and uncultivated land then an irrigation canal and a lake (Nicholas Sheridan Lake)	Agricultural cropland and uncultivated land.	Pasture or uncultivated land.
1950	Agricultural cropland with the low-lying area still present and appears to still have water.	Agricultural cropland and the farmyard further north remain present.	Agricultural cropland with the canal and farmyards and dugouts sporadic to the east.	Agricultural cropland.	Agricultural cropland.
1961	Similar to previous.	Similar to previous.	Similar to previous.	Similar to previous.	Similar to previous.
1971	Similar to previous however the low-lying area is no longer visible.	Similar to previous.	Similar to previous.	Similar to previous.	Similar to previous.
1984	Similar to previous. There is soil stockpiled in the southeast corner of the site.	Similar to previous with development in the north portion of the NE ¼.	Agricultural cropland in NE ¼, dugout and low-lying area. Pivot irrigations system with a farmyard then the developed West Lethbridge. Whoop Up Drive and University Drive interchange is under construction.	Similar to previous.	Similar to previous.
1994	Similar to previous.	Similar to previous with additional development of the West Lethbridge.	West Lethbridge has been developed and only some agricultural cropland and the dugout remain east of the site.	Similar to previous.	Similar to previous.
2001	Similar to previous.	Similar to previous with more development of West Lethbridge.	Similar to previous.	Similar to previous.	Similar to previous.

5.3 Regulatory Inquiries

5.3.1 PTMAA

EBA inquired on the potential presence of USTs and/or ASTs with the Petroleum Tank Management Association of Alberta (PTMAA). A copy of these inquiries is provided in Appendix C. PTMAA responded there are no records in PTMAA files of active or abandoned petroleum storage tanks for the above noted location.

5.3.2 AEUB

The AEUB database search indicated there is a record of an abandoned well site on the site. The well was identified in 4-27-8-22 W4M as shown in Figure 3. The well ID was 00/04-27-008-22 W4M/0 (license number 0193331) held by Thunder Energy. EBA contacted Thunder Energy however; Thunder had no records on file. Thunder intended to investigate the location of information pertaining to this well. This information was not available prior to the release of the report. The well was drilled between November 15, 1996 and November 22, 1996 to a depth of 1170 m deep. The status was indicated as abandoned. Additional information was requested from the AEUB pertaining to the license and a site drawing. The well license was initially issued to Stade Exploration Inc. This additional information as well as the initial EUB search is included in Appendix C.

Discussions with the City of Lethbridge staff indicated that they recall the drilling on this site, however they have no records of the drilling or any lease agreements. The City of Lethbridge indicated that they did not start keeping records until approximately 1999. The wells that the City does have on file are located in NW ¼ 22-8-22 W4M, NE ¼ 21-8-22 W4M and SE ¼ 28-8-22 W4M (west and south of the site).

There was a list of other oil and gas wells in the vicinity of the site. The active and abandoned wells include 12-22-8-22 W4M, 14-22-8-22 W4M and 7-28-8-22 W4M.

5.3.3 AENV

Alberta Environment groundwater well database has a listing of two wells located on the site. The first well was drilled for Lethbridge Collieries #4 in 12-27-8-22 W4M, to a depth of 337 feet (103 m). The well ID is 0118437. The drilling date is unknown. The second well was drilled in 13-27-8-22 W4M to a depth of 25 feet (8 m). There is no record of the driller, owner or date drilled. The well ID is 0118440.

5.3.4 AIT

Alberta Infrastructure and Transportation (AIT) was contacted for information pertaining to dangerous goods incidents that may have occurred near or on the subject site. The AIT response indicated that no dangerous good incidents occurred at or near the subject site.

5.4 Business Directories

There were no Henderson Business Directories available for the site.

5.5 Fire Insurance Maps

There were no Fire Insurance Maps available for the site.

5.6 Archival Records

There were no archival records available for the subject site.

5.7 Previous Reports

There were no previous environmental reports provided to EBA related to the site.

5.8 Other Information Sources

City of Lethbridge development services provided information regarding the municipal addresses for the site.

The Coal Mine Atlas was reviewed and there are no mapped coal mines in the vicinity of the sites.

6.0 DISCUSSION

6.1 General

In general terms, there are two distinct types of potential environmental risk to any property. The first type of risk is from potential impairment from on-site land use. This would include potential accidental spills or site practices that may impair the property directly, also included in this risk is the potential of hazardous building materials. The

second type of risk is from impairment caused by adjacent property owners, which might then be transported through the subsurface soils by groundwater, or in overland runoff onto the subject site.

6.2 Potential for Impairment from On-Site Source(s)

There are two potential sources of impairment related to the site. The first potential source of impairment to the site is the abandoned oil/gas well lease located on the site at SW ¼ 27-8-22 W4M. There was no information available at the time of this report release to indicate if environmental work has been conducted relating to the well site (i.e. Upstream Phase I ESA). Further, the well abandonment details are unknown for this well. The presence of this abandoned well should be considered during development planning and construction activities. The soil and groundwater quality in the area of the well site should be investigated. The second on-site source is the stockpiled soil material. The origin and quality of the stockpiled soil could not be verified during this investigation. Chemical testing and field screening is recommended.

6.3 Potential for Impairment from Off-Site Source(s)

There was one potential off-site source of environmental impairment to the site. An abandoned oil/gas lease is present to the south of the site. This area can be addressed in an environmental assessment on that area prior to development.

6.3.1 Landfill Sources

There are no known landfill sources in the immediate vicinity of the subject site.

6.3.2 Fuelling Facility Sources

There were no fueling facilities observed in the vicinity of the site.

6.3.3 Other Contaminated Sites

There was no information on contaminated sites within the vicinity of the subject site was revealed this study.

7.0 FURTHER ACTION / RENDERING AN OPINION

EBA has obtained and reviewed select historical information pertaining to the site and adjacent lands back to 1912. EBA also performed a site reconnaissance.

There was one potential off-site source of environmental impairment to the site. An abandoned oil/gas lease is present to the south of the site. This area can be addressed in an environmental assessment on that area prior to development.

There are two potential sources of impairment related to the site.

The first potential source of impairment to the site is the abandoned oil/gas well lease located on the site at SW ¼ 27-8-22 W4M. There was no information available at the time of this report release to indicate if environmental work has been conducted relating to the well site (i.e. Upstream Phase I ESA). Further, the well abandonment details are unknown for this well. The presence of this abandoned well should be considered during development planning and construction activities. The soil and groundwater quality in the area of the well site should be investigated.

The second on-site source is the stockpiled soil material. The origin and quality of the stockpiled soil could not be verified during this investigation. Chemical testing and field screening is recommended.

8.0 LIMITATIONS OF LIABILITY

Recommendations presented herein are based on a Phase I Environmental Site Assessment as described in Section 1.0. This report has been prepared for the exclusive use of Associated Engineering Alberta Ltd. for the specific application described in Section 1.0 of this report. It has been prepared in accordance with generally accepted geo-environmental engineering practices. No other warranty is made, either express or implied. Engineering judgment has been applied in developing the recommendations of this report.

For further limitations, reference should be made to the General Conditions in Appendix A.

9.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

Respectfully Submitted
EBA Engineering Consultants Ltd.

Prepared by:

Mandi Parker, P.Ag.
Environmental Scientist

Reviewed by:

Darrell Haight, B.Sc., A.Ag.
Project Engineer

Reviewed By:

PROFESSIONAL ENGINEER ALBERTA
MARC J. SABOURIN
May 27, 2005

Marc Sabourin, P.Eng.
Senior Project Director

PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature
Date May 27, 2005
PERMIT NUMBER: P245
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

MEP:cld

FIGURES

Figure 1

NOT TO SCALE

Site Location Plan

4400840S01B.dwg

CIRCA 2001

LEGEND

SITE BOUNDARY

ABANDONED OIL/GAS WELLS

APPROXIMATE SCALE 1:1250

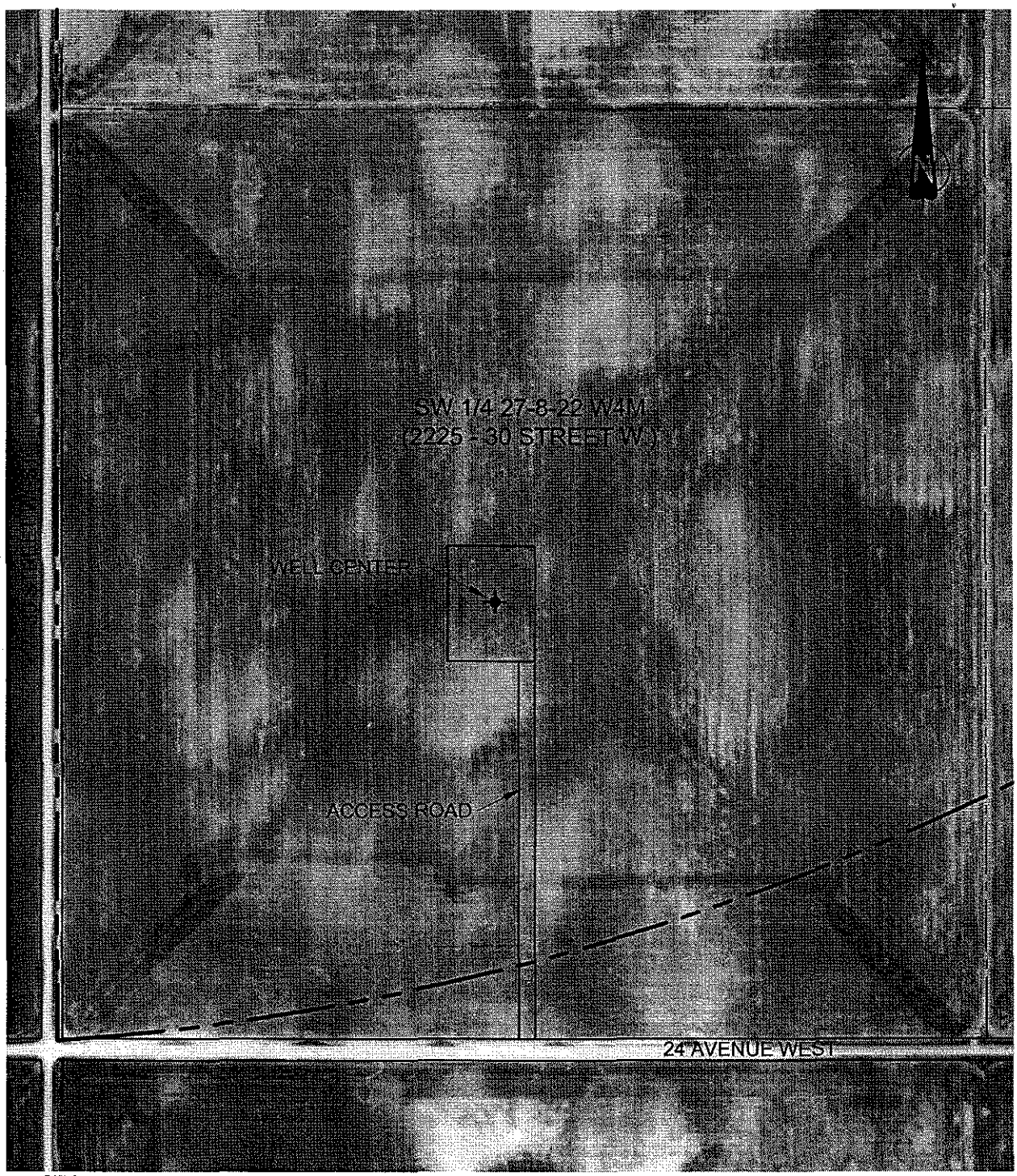
0 20 50

Figure 2

Site Plan

4400840S01C.dwg

eba



CIRCA 2001

LEGEND

SITE BOUNDARY

0 50 100 150 200 250m

APPROXIMATE SCALE 1:5000

Figure 3

Site Plan Showing Abandoned Gas Lease Details (On-Site)

4400840S01B.dwg

APPENDIX A

ENVIRONMENTAL REPORT – GENERAL CONDITIONS

EBA Engineering Consultants Ltd. (EBA)
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 B

LAND TITLES

Historical Land Title Information
SW ¼ 27-8-22 W4M

Date of Registration	Title Number	Registered Owners	Comments
May 4, 1984	841 077 241	The City of Lethbridge	
July 24, 1981	811 140 926	Nu-Mode Homes Ltd. and Alpine Drywall and Plastering (Lethbridge) Ltd. and Treco Apartments Ltd.	
March 31, 1976	761 038 276	Jenny Ann Skinner	
September 17, 1945	68 N 60	Harrison Hubbard	
January 13, 1917	14 U 130	Fred Senior	

Historical Land Title Information
SE ¼ 27-8-22 W4M

Date of Registration	Title Number	Registered Owners	Comments
June 30, 2003	031 220 099	Walter J Willms and Clara B Willms	Subdivision Plan
June 26, 2001	031 216 679	Walter J Willms and Clara B Willms	Transfer of Land
February 6, 2003	031 045 228	Walter J Willms and Clara B Willms	Subdivision Plan
February 6, 2003	031 044 577	Walter J Willms and Clara B Willms	Transfer of Land
June 24, 2002	021 218 923	Walter J Willms and Clara B Willms	Subdivision Plan
June 24, 2002	021 218 809	Walter J Willms and Clara B Willms	Transfer of Land
April 19, 2002	021 131 906	Walter J Willms and Clara B Willms	Subdivision Plan
April 18, 2002	021 131 468	Walter J Willms and Clara B Willms	Transfer of Land
February 14, 2002	021 054 965	Walter J Willms and Clara B Willms	Road Plan
October 2, 1996	961 229 241	Walter J Willms and Clara B Willms	Transfer of Land

Date of Registration	Title Number	Registered Owners	Comments
May 20, 1993	931 114 799	J.M. Look Holdings Ltd., West Valley Investments (1979) Ltd., Jack M Look, Margaret A Look, Bruce R Look, Florence	Transfer of Land
February 4, 1987	871 018 190	Glenhill Farms Ltd.	
February 18, 1977	771 019 374	Genstar Properties Limited	
February 18, 1988	771 019 374	Engineered Homes Limited	
June 30, 1944	63 W 174	Aubern P. Hubbard	
November 20, 1922	27 Z 226	Harry Wilhenson	

Historical Land Title Information
NE ¼ 27-8-22 W4M

Date of Registration	Title Number	Registered Owners	Comments
September 5, 2003	031 301 862	838 Land Developments Ltd.	Subdivision Plan
June 30, 2003	031 220 099	838 Land Developments Ltd.	Subdivision Plan
February 6, 2003	031 045 228	838 Land Developments Ltd.	Subdivision Plan
February 6, 2003	031 044 576	838 Land Developments Ltd.	Transfer of Land
July 15, 2002	021 242 920	White Pine Investments Ltd.	Subdivision Plan
June 27, 2002	021 223 926	White Pine Investments Ltd.	Transfer of Land
June 24, 2002	021 218 923	White Pine Investments Ltd.	Subdivision Plan
June 24, 2002	021 218 781	White Pine Investments Ltd.	Transfer of Land
April 19, 2002	021 131 906	White Pine Investments Ltd.	Subdivision Plan
April 18, 2002	021 131 443	White Pine Investments Ltd.	Transfer of Land
March 7, 2002	021 077 998	White Pine Investments Ltd.	Subdivision Plan

Date of Registration	Title Number	Registered Owners	Comments
February 4, 1987	871 018 189	Glenhill Farms Ltd.	
June 24, 1982	821 111 637	Genstar Properties Limited	
July 29, 1954	97 Y 220	Aubern P. Hubbard	
July 19, 1954	97 Y 219	Ada P. Culham	
September 6, 1949	81 E 117	Ada P. Hubbard	
September 6, 1949	81 E 116	Ada P. Hubbard	
August 5, 1949	79 W 194	Ada P. Hubbard executrix of the will of Harry Hubbard	
June 2, 1932	49 T 126	Harry Hubbard and Ada P. Hubbard	
May 14, 1924	31 K 169	The Canadian Mortgage Investment Company	
August 28, 1912	TV 71	Harry Wilhenson	

Historical Land Title Information
NW ¼ 27-8-22 W4M

Date of Registration	Title Number	Registered Owners	Comments
April 22, 2004	041 141 053	The City of Lethbridge	Transfer of Land LSD 11 and 12
July 31, 2002	021 265 560	Allan and Judith Willms, Barry and Linda Willms, Melissa Friesen and Sharlene Christie	Transfer of Land LSD 13 and 14
February 24, 1988	881 029 179	Raymond Gerald Keith Marnoch	LSD 11 and 12
June 17, 1981	811 114 265	Astro Property Management Ltd. and Ben H Reimer	LSD 13 and 14
June 17, 1981	811 114 265	Blue Willow Homes Ltd. and Ben H Reimer	LSD 13 and 14
December 10, 1975	751 139 967 A	Alexander K. Marnoch	LSD 11 and 12
April 8, 1958	109 A 190	Mary Falconer	LSD 13 and 14

Date of Registration	Title Number	Registered Owners	Comments
April 8, 1958	109 A 189	Bessie Marnoch	LSD 11 and 12
January 20, 1958	109 U 10	British Canadian Trust Company executor of the will of Daniel Robert Easter	
November 24, 1952	92 Y 87	Daniel R Easter	
October 31, 1952	92 A 44	Robert Cranford	
September 6, 1912	TT 62	Robert Cranford	

APPENDIX C

REGULATORY INQUIRIES

Petroleum Tank Management
Association of Alberta
Suite 980, 10303 Jasper Avenue
Edmonton, Alberta T5J 3N6
PH: (780)425-8265 or 1-866-222-8265
FAX: (780)425-4722

May 5, 2005

Mandi Parker
EBA Engineering Consultants Ltd.
442 10 Street N
Lethbridge, AB
T1H 2C7

Dear Mandi Parker:

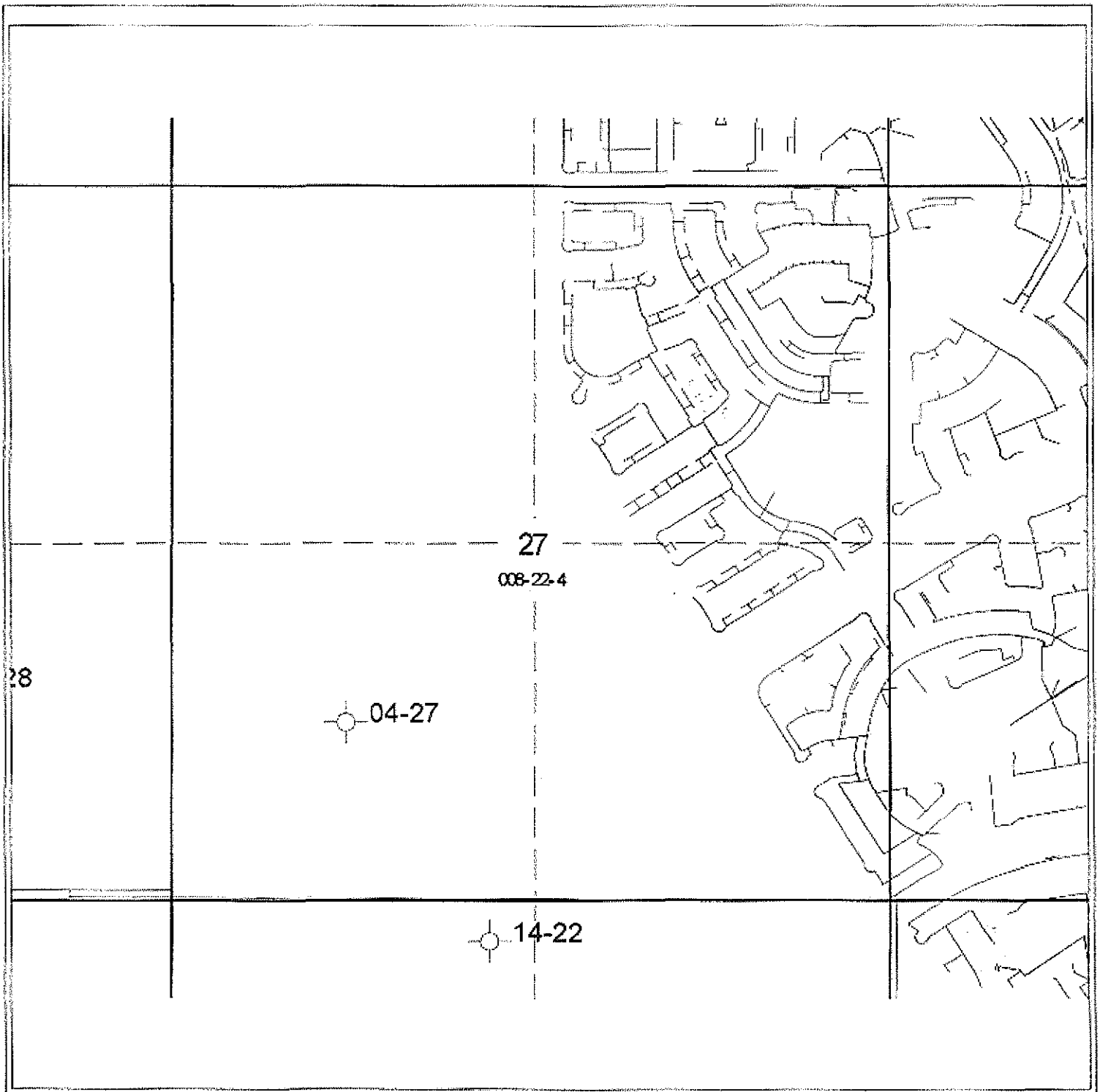
As per your request, the PTMAA has checked the registration of active tank sites and inventory of abandoned tank sites and there are no records for the property with the legal land description:

27-8-22-W4M, Lethbridge

Please note that both databases are not complete. The main limitation of these databases is that they only include information reported through registration or a survey of abandoned sites completed in 1992 and should not be considered as a comprehensive inventory of all past or present storage tank sites. The PTMAA **cannot** guarantee that tanks do not or have not existed at this location. Information in the databases is based on information supplied by the owner and the PTMAA cannot guarantee its accuracy. Information on storage tanks or on past or present contaminant investigations may be filed with the local Fire Department or Alberta Environment.

Yours truly,

Connie Jacobsen
PTMAA



Well Legend

- Location
- Drilling
- Suspended
- Service
- Oil
- Gas
- Dry & Abandoned
- Heavy Oil
- Suspended Oil
- Abandoned Oil
- Suspended Gas
- Abandoned Gas
- Abandoned Service
- Oil/Gas
- Suspended Heavy Oil
- Abandoned Heavy Oil
- Abandoned Oil/Gas
- Suspended Oil/Gas
- Test Well
- Injection
- Surface Location

DRADER LOCATING INC.

PH: (403) 363-0009
FAX: (403) 362-2009
E-mail: dlocate@telus.net

EUB CBID: CB566
Client Name: MANDI
Description: WELLS
****

DDN0604-01 ALBERTA ENERGY AND UTILITIES BOARD 05 MAY 2005
DATA DISSEMINATION - GENERAL QUERY

WELL ID : 00/12-22-008-22W4/0 BONAVISTA PENNY 12-22-8-22
LICENSE NO. : 0201406 LICENSEE: 0MD60 BONAVISTA PETR
LICENSE DATE: 16 MAY 1997 AGENT :
CONTRACTOR CODE: 0ZG2 RIG NO : 0003

BASIC DRILLHOLE DATA

FIELD : 1203 PENNY
POOL : 213062 BI A,B,C,F,G,SS&TT
OS AREA :
DEPOSIT :
LAHEE CLASS: 00 DEVELOPMENT
WELL STATUS: 02 10 00 00
GAS FLOW
STATUS DATE: 29 SEP 1997

DEPTHS (M)
TOTAL: 1160.00 SS: -219.50
PB : SS:
TVD : SS:
CONF : (NC)

DATES
SPUD : 9 JUL 1997
FIN-DRILL: 13 JUL 1997
RIG REL. : 14 JUL 1997
ON PROD. : 29 SEP 1997
ON INJ. :

--CO-OR--	---LONGITUDE----	---LATITUDE---	--ELEV (M)---
S 750.0	ACT: 112.910060	ACT: 49.662463	GRD: 936.30
E 314.9	THE:	THE:	KB : 940.50
			CF :

BOTTOM HOLE CO-ORDINATES = SURFACE CO-ORDINATES

DATA DISSEMINATION - GENERAL QUERY

```
WELL ID     : 00/12-22-008-22W4/2        BONAVISTA PENNY 12-22-8-22
LICENSE NO. :  0201406                   LICENSEE: 0MD60 BONAVISTA PETR
LICENSE DATE: 16 MAY 1997                AGENT   :
CONTRACTOR CODE: 0ZG2                    RIG NO  : 0003
--------------------------- BASIC DRILLHOLE DATA -----------------------------
FIELD      : 1203 PENNY                   -------- DEPTHS (M) ---------
POOL       :  213062 BI A,B,C,F,G,SS&TT   TOTAL:  1160.00 SS:   -219.50
OS AREA    :                              PB    :          SS:
DEPOSIT    :                              TVD   :          SS:
LAHEE CLASS: 00 DEVELOPMENT               CONF  : (NC)
WELL STATUS: 02     10     00     00
             GAS    FLOW                        ------- DATES --------
STATUS DATE: 29 SEP 1997                        SPUD     :  9 JUL 1997
                                                FIN-DRILL: 13 JUL 1997
--CO-OR-- ---LONGITUDE---- ---LATITUDE--- --ELEV (M)---  RIG REL. : 14 JUL 1997
S   750.0 ACT:  112.910060 ACT: 49.662463 GRD:   936.30  ON PROD. : 29 SEP 1997
E   314.9 THE:             THE:          KB :   940.50  ON INJ.  :
                                          CF :
BOTTOM HOLE CO-ORDINATES = SURFACE CO-ORDINATES
```

****

****

LICENSE NO. : X0000185 LICENSEE: 07040 172746 CANADA
LICENSE DATE: 1 JAN 1932 AGENT :
CONTRACTOR CODE: RIG NO :

BASIC DRILLHOLE DATA

FIELD : 1203 PENNY
POOL :
OS AREA :
DEPOSIT :
LAHEE CLASS: 06 NEW FIELD WILDCAT
WELL STATUS: 00 02 00 00
ABD
STATUS DATE: 31 MAY 1932

DEPTHS (M)
TOTAL: 1395.40 SS: -457.50
PB : SS:
TVD : SS:
CONF : (NC)

DATES
SPUD : 20 NOV 1930
FIN-DRILL: 28 FEB 1932
RIG REL. :
ON PROD. :
ON INJ. :

--CO-OR--	---LONGITUDE----	---LATITUDE---	--ELEV (M)---
S 99.1	ACT: 112.904640	ACT: 49.668313	GRD: 937.90
E 705.6	THE:	THE:	KB : 937.90
			CF :

BOTTOM HOLE CO-ORDINATES = SURFACE CO-ORDINATES

****

****

WELL ID : 00/04-27-008-22W4/0 STADE PENNY 4-27-8-22
LICENSE NO. : 0193331 LICENSEE: 0E340 THUNDER ENERGY
LICENSE DATE: 8 NOV 1996 AGENT :
CONTRACTOR CODE: 0Y34 RIG NO : 0033

```
---------------------------- BASIC DRILLHOLE DATA -------------------------------
FIELD      : 1203 PENNY                                  -------- DEPTHS (M) ---------
POOL       :                                             TOTAL:  1170.00 SS:   -229.40
OS AREA    :                                             PB   :          SS:
DEPOSIT    :                                             TVD  :          SS:
LAHEE CLASS: 04 DEEPER-POOL TEST                         CONF : (NC)
WELL STATUS: 00     02     00     00
                    ABD                                   ------- DATES --------
STATUS DATE: 22 NOV 1996                                  SPUD     : 15 NOV 1996
                                                          FIN-DRILL: 20 NOV 1996
--CO-OR-- ---LONGITUDE---- ---LATITUDE--- --ELEV (M)---   RIG REL. : 22 NOV 1996
N   380.0 ACT:  112.909145 ACT: 49.672807 GRD:   936.60   ON PROD. :
E   378.3 THE:            THE:           KB :   940.60   ON INJ.  :
                                          CF :
BOTTOM HOLE CO-ORDINATES = SURFACE CO-ORDINATES
```

****

****

DDN0604-01 ALBERTA ENERGY AND UTILITIES BOARD 05 MAY 2005
DATA DISSEMINATION - GENERAL QUERY

```
WELL ID     : 00/07-28-008-22W4/0      BONAVISTA PENNY 7-28-8-22
LICENSE NO. :  0169686                 LICENSEE: 0MD60 BONAVISTA PETR
LICENSE DATE: 19 AUG 1994              AGENT   :
CONTRACTOR CODE: 0Y34                  RIG NO  : 0002
---------------------------- BASIC DRILLHOLE DATA -------------------------------
FIELD      : 1203 PENNY                                  -------- DEPTHS (M) ---------
POOL       :                                             TOTAL:  1177.00 SS:   -234.00
```

```
OS AREA    :                                          PB   :          SS:
DEPOSIT    :                                          TVD  :          SS:
LAHEE CLASS: 05 NEW POOL WILDCAT                      CONF : (NC)
WELL STATUS: 00     07     00     00
                    DRL&C                                      ------- DATES --------
STATUS DATE: 27 SEP 1994                                       SPUD     : 27 AUG 1994
                                                               FIN-DRILL:  2 SEP 1994
--CO-OR-- ---LONGITUDE---- ---LATITUDE--- --ELEV (M)---        RIG REL. :  3 SEP 1994
N   458.6 ACT:  112.921963 ACT: 49.673515 GRD:   939.50        ON PROD. :
W   525.4 THE:             THE:          KB :   943.00        ON INJ.  :
                                          CF :
BOTTOM HOLE CO-ORDINATES = SURFACE CO-ORDINATES
```

****

****

DDN0604-01 ALBERTA ENERGY AND UTILITIES BOARD 05 MAY 2005
DATA DISSEMINATION - GENERAL QUERY

```
WELL ID     : 00/07-28-008-22W4/2        BONAVISTA PENNY 7-28-8-22
LICENSE NO. :  0169686                   LICENSEE: 0MD60 BONAVISTA PETR
LICENSE DATE: 19 AUG 1994                AGENT   :
CONTRACTOR CODE: 0Y34                    RIG NO  : 0002
---------------------------- BASIC DRILLHOLE DATA ------------------------------
FIELD      : 1203 PENNY                                 -------- DEPTHS (M) ---------
POOL       :  213062 BI A,B,C,F,G,SS&TT                 TOTAL:  1177.00 SS:   -234.00
OS AREA    :                                            PB   :          SS:
DEPOSIT    :                                            TVD  :          SS:
LAHEE CLASS: 05 NEW POOL WILDCAT                        CONF : (NC)
```

```
WELL STATUS: 02      10      00      00
             GAS     FLOW                                        ------- DATES --------
STATUS DATE:  6 JUN 1997                                         SPUD      : 27 AUG 1994
                                                                 FIN-DRILL:  2 SEP 1994
--CO-OR-- ---LONGITUDE---- ---LATITUDE--- --ELEV (M)---          RIG REL. :  3 SEP 1994
N   458.6 ACT:  112.921963 ACT: 49.673515 GRD:   939.50          ON PROD. :  6 JUN 1997
W   525.4 THE:             THE:          KB :   943.00          ON INJ.  :
                                          CF :
BOTTOM HOLE CO-ORDINATES = SURFACE CO-ORDINATES
```

****

****

---------- DATA EXCEPTIONS ----------

****

****

--- PRINT SUMMARY ---
Pages Printed : 6
Wells Captured: 6
DDN Screens   : 6

****

---------- DISCLAIMER ----------

this data within these materials.

The EUB makes no representation, warranties, or guarantees, expressed or implied, for the suitability of the data with respect to the intended use. The EUB accepts no responsibility whatsoever for any inaccuracies, errors, or omissions in the data files and the EUB shall not be responsible for any costs incurred by a company for the conversion, installation, or improvement of the data files.

Alberta Energy and Utilities Board

Information Request

Company Name: EBA ENGINEERING
Date: May 5, 2005

Requested Information on the well(s) listed below has not been supplied. Please see code index for reason.

LE	LSD	SEC	TWP	RGE	M	E	CODE
		34	008	22	4		16

Additional Information:

Details (If Necessary):

1	Well Identifier Not On file
2	Confidential
3	Well Not on Production
4	No Cores Cut
5	Core Cut, Not Analyzed
6	Prior to 1962, DST Not Requested by Board
7	No Charge- Poor Copy
8	No Completion
9	No DST Run
10	No Pressure Tests Recorded
11	No Fluid Analyses Done
12	Log Not Recorded as Run
13	No Pipeline Recorded
14	File Out for Internal Use
15	Requested Information not on file at this time
16	No wells in this location
17.	No Environmental Records for this location
18.	No Directional Survey

Prepared By: Melanie

EUB Alberta Energy and Utilities Board

Calgary Office 640 – 5 Avenue SW Calgary, Alberta Canada T2P 3G4 Tel 403 297-8311 Fax 403 297-7336

Facsimile

Date May 16, 2005

Number of pages including cover 7

To ~~EBA~~ Mandi Parker

Company/Address EBA

Telephone 780 451 2130

Fax 403 328 8877

From Ley Lucamussi

Division/Group Corp Services

Telephone 297 8190

Fax 297 2096

Comments

If all pages are not received, please phone sender.

EUB Alberta Energy and Utilities Board
640 - 5 Avenue SW, Calgary, Alberta Canada T2P 3G4

WELL LICENCE

LICENCE NO.: 0193331
WELL NAME : STADE PENNY 54-27-8-22
LICENSEE : STADE EXPLORATION INC.
PURPOSE : OBTAIN PRODUCTION FROM THE BASAL COLORADO OR BOW ISLAND
SURFACE LOCATION : LSD 04-27-008-22 W4M
SURFACE CO-ORDINATES: 380.0 METRES NORTH 378.3 METRES EAST
(AS MEASURED OR CALCULATED FROM THE EXTERIOR BOUNDARIES OF THE QUARTER SECTION)

UNIQUE ID : 100/04-27-008-22W4/00
FIELD : UNDEFINED
LAHEE CLASS: DPT (C)
AREA OFFICE: MEDICINE HAT
(Ph 403-527-3385)
SURFACE RIGHTS : FREEHOLD
MINERAL RIGHTS : FREEHOLD
PROJECTED DEPTH : 1170 METRES
TERMINATING ZONE: BLAIRMORE GRP
GROUND ELEVATION: 936.6 METRES

THIS LICENCE IS GRANTED IN ACCORDANCE WITH AND SUBJECT TO THE PROVISIONS OF THE OIL AND GAS CONSERVATION ACT AND REGULATIONS PURSUANT THERETO, AND SUBJECT TO THE FOLLOWING SPECIAL PROVISIONS OR SUCH FURTHER REQUIREMENTS AS MAY BE DIRECTED BY A BOARD REPRESENTATIVE:

- CASING PROGRAM:

SURFACE	180 - 0M
PRODUCTION	1170 - 0M

- THIS WELL SHALL NOT BE DRILLED BEYOND THE BLAIRMORE AT A DEPTH OF APPROXIMATELY 1170 METRES.

- ALL USEABLE GROUND WATER AQUIFERS IN THIS WELL SHALL BE ISOLATED BEHIND SURFACE CASING OR ADEQUATELY COVERED BY THE CEMENTING OF THE NEXT CASING STRING OR, IF THE WELL IS TO BE ABANDONED, WITH THE APPROPRIATE OPEN-HOLE ABANDONMENT PLUG(S).

- THE PRODUCTION CASING SHALL BE CEMENTED TO AT LEAST 100 METRES ABOVE THE TOP OF THE SECOND WHITE SPECKS AND TO AT LEAST 100 METRES ABOVE ANY SHALLOWER HYDROCARBON BEARING ZONE.

- SAMPLE REQUIREMENT: DRILL CUTTING SAMPLES SHALL BE TAKEN AT 5 METRE INTERVALS FROM 30 METRES ABOVE THE BOW ISLAND TO TOTAL DEPTH.

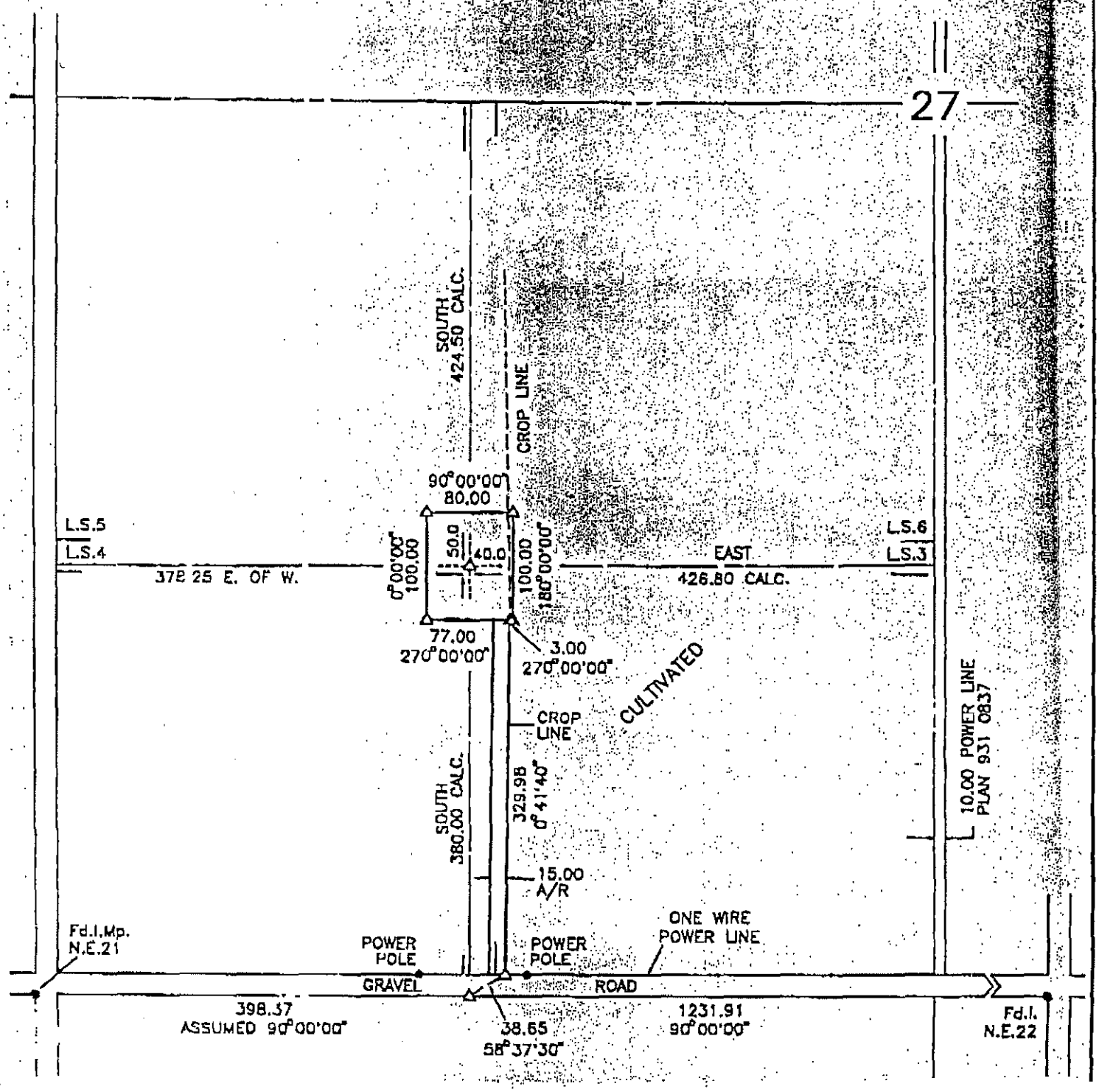
- SAMPLE REQUIREMENT: THE DRILL CUTTINGS SHALL BE DELIVERED AS PRESCRIBED IN SECTION 11.010(2) OF THE OIL AND GAS CONSERVATION REGULATIONS TO THE CORE RESEARCH CENTRE, 3545 RESEARCH WAY N.W., CALGARY, AB.

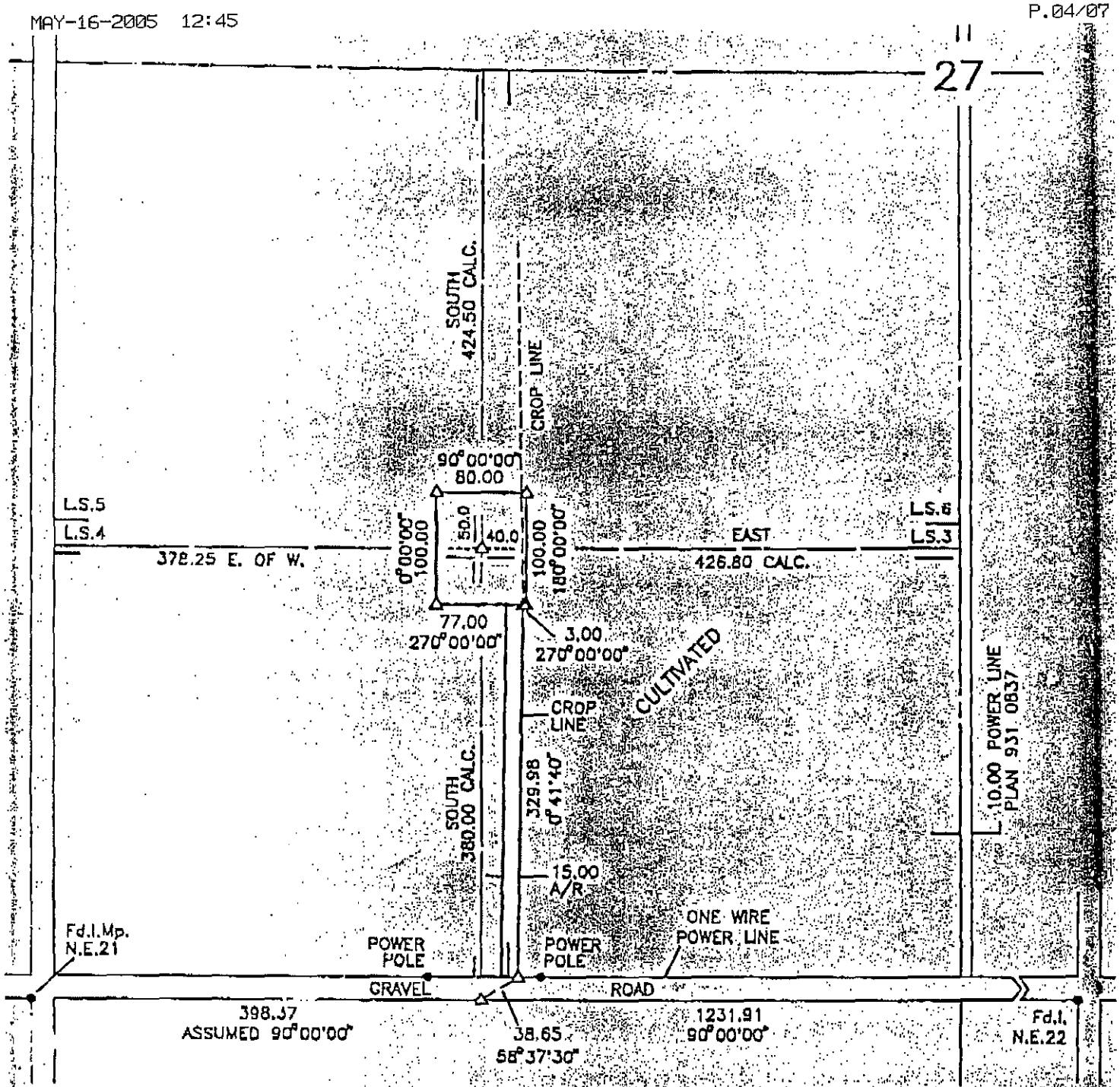
DATED AT CALGARY, ALBERTA THIS
08TH DAY OF NOVEMBER 1996

Valerie Vest

FOR ALBERTA ENERGY AND UTILITIES BOARD

STADE ET AL PENNY 4-27-8-22 (PAGE 2 OF 2)

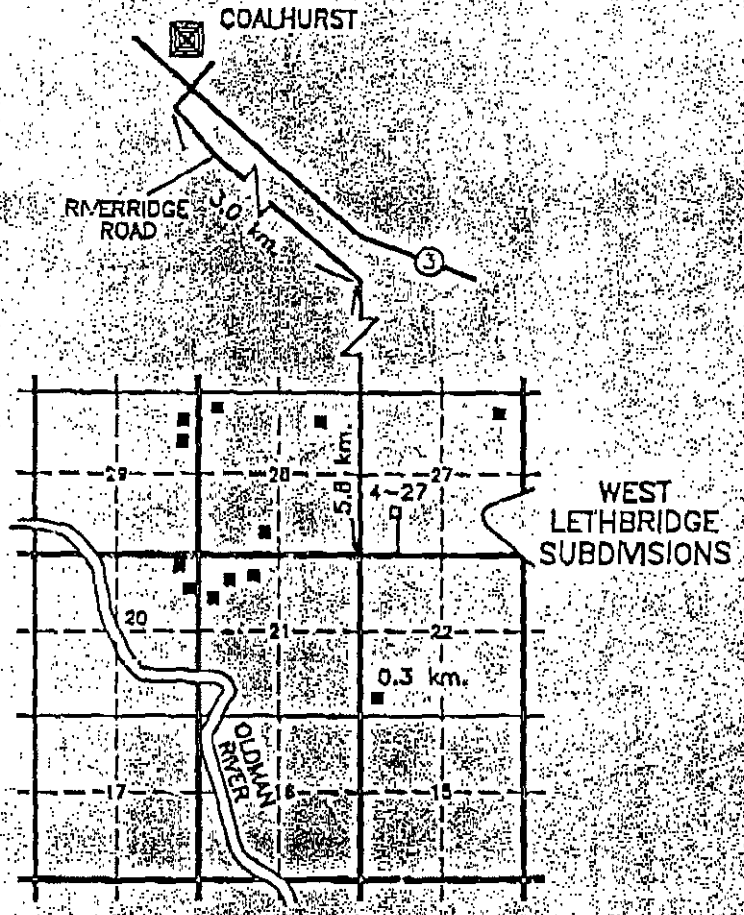




NOTE :

1. The Proposed Well Is At Least 1.5 km From The Corporate Limit Of A City, Town Or Village. ☐ Yes ☒ No
2. The Proposed Well is At Least 5.0 km From A Lighted Airport. ☒ Yes ☐ No
3. The Proposed Well Is At Least 1.6 km From An Unlighted Airport. ☒ Yes ☐ No

STADE ET AL PENNY 4-27-8-22 (PAGE 1 OF 2)



ROUTE SKETCH
SCALE : 1 : 75000
RESIDENCE SHOWN THUS ■

STADE EXPLORATION INC.

PLAN OF WELLSITE AND ACCESS ROAD

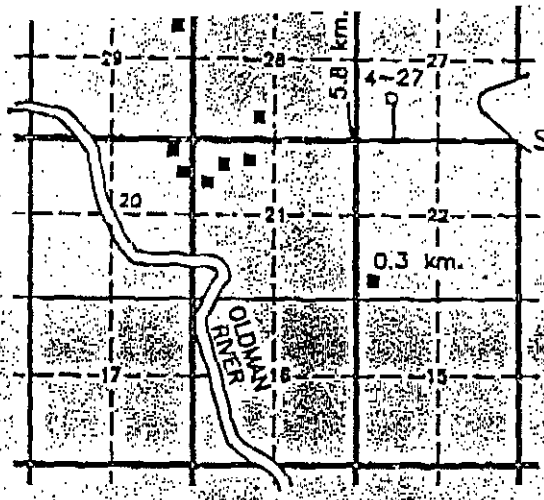
STADE ET AL PENNY 4-27-8-22

IN

L.S.D. 4 , SEC. 27 , TWP. 8 , RGE. 22 , W.4 M.

STADE EXPLORATION INC.

I, Jerald E. Rasmuson, Alberta Land Surveyor, of The City of Calgary, Alberta, certify that the survey represented by this plan is true and correct to the best of my knowledge, has been carried out in accordance with the Alberta



ROUTE SKETCH
SCALE : 1 : 75000
RESIDENCE SHOWN THUS ■

STADE EXPLORATION INC.

PLAN OF WELLSITE AND ACCESS ROAD

STADE ET AL PENNY 4-27-8-22

IN

L.S.D. 4 , SEC. 27 , TWP. 8 , RGE. 22 , W. 4 M.

STADE EXPLORATION INC.

PRESIDENT

I, Jerald E. Rasmuson, Alberta Land Surveyor, of The City of Calgary, Alberta, certify that the survey represented by this plan is true and correct to the best of my knowledge, has been carried out in accordance with the Alberta Land Surveyors' Association Manual of Good Practice, and was completed on the 2nd day of October , 1996.

ALBERTA LAND SURVEYOR

WITNESS - J. FONG

ELEVATION	CO-ORDINATES	AREAS
On Ground In Center Of Wellsite : 936.6	Well is Located :	
N.W. Cor. : 936.2 N.E. Cor. : 935.8	360.00 N. of S. Bdy. } Sec. 27 - 8 - 22 - W.4M.	
S.W. Cor. : 939.5 S.E. Cor. : 939.5	378.25 E. of W. Bdy. }	

AREAS	Hectares	Acres
Well Site	= 0.800	1.98
Access Road	= 0.495	1.22
Total	= 1.295	3.20

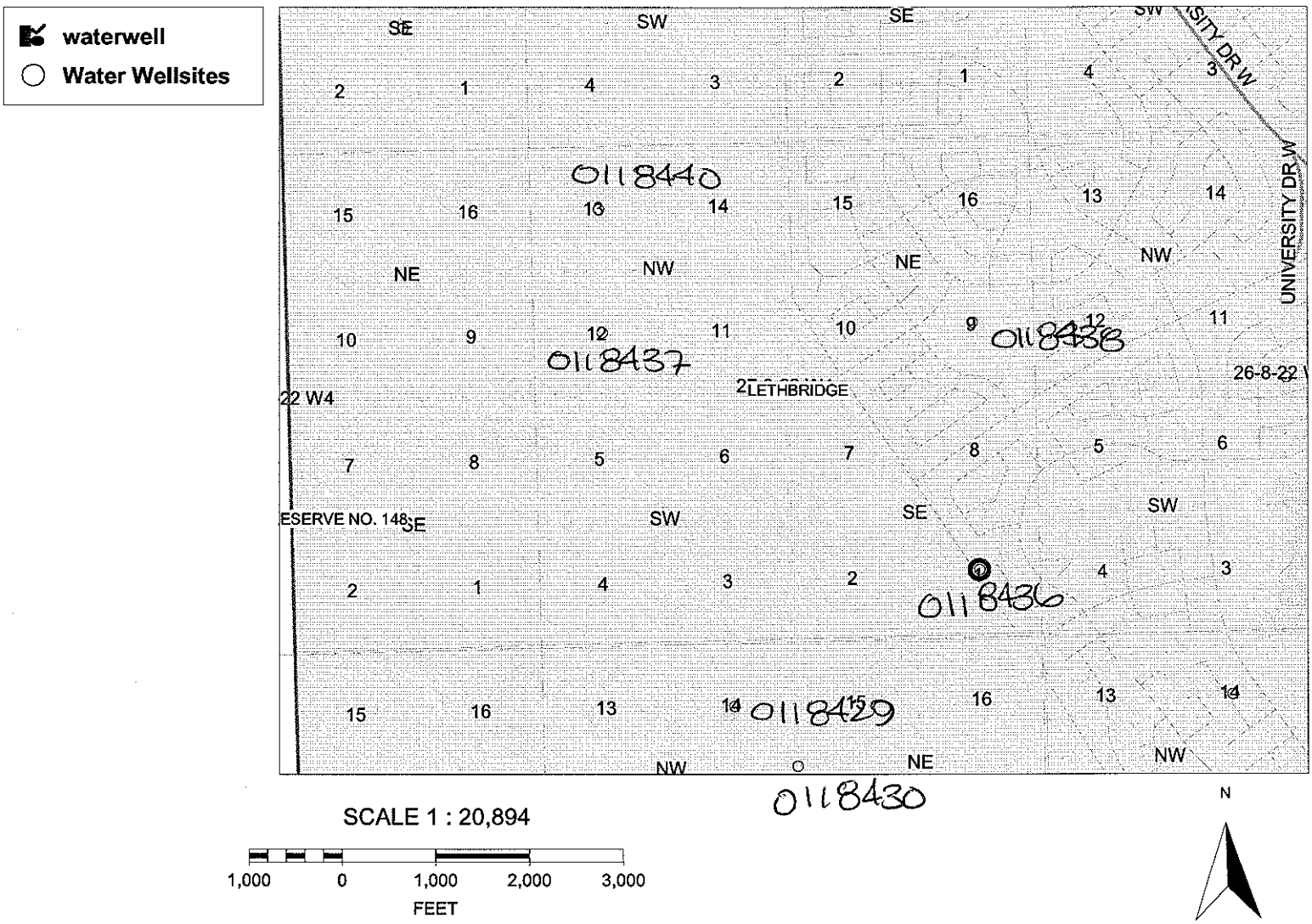
JERALD E. RASMUSON
ALBERTA LAND SURVEYOR - PROFESSIONAL ENGINEER

JOB NO : 96-041 | DATE : OCTOBER 2 , 1996 | CHK'D : J.R.

LEGEND

Scale :- 1 : 5000
Iron Bar Placed Shown Thus △
Survey Monument Found Shown Thus ●
Distance are in Metres & decimals thereof
There are no surface improvements within 200 m. of lease other than shown.

TELUS Geomatics - Alberta Map



Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.:	0118429
Map Verified:	Field
Date Report Received:	1937/01/01
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: UNKNOWN DRILLER		Drilling Company Approval No.: 99999
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code:
WellOwner's Name: IMPERIAL OIL	Well Location Identifier:	
P.O. Box Number:	Mailing Address:	Postal Code:
City:	Province:	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	Westof M
14	22	008	22	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: 3077 FT
How Obtain: Estimated

3. Drilling Information

Type of Work: Federal Well Survey Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Materials Used:
Method of Drilling: Drilled
Flowing Well:
Gas Present: No
Rate: Gallons
Oil Present: No
Proposed well use: Industrial
Anticipated Water Requirements/day 0 Gallons

4. Formation Log

Depth from ground level (feet)	Lithology Description

5. Well Completion

Date Started(yyyy/mm/dd):	Date Completed (yyyy/mm/dd):
Well Depth: 4578 FT	Borehole Diameter: 0 Inches
Casing Type:	Liner Type:
Size OD: 0 Inches	Size OD: 0 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT

Perforations / Perforations Size:
from: 0 FT to: 0 FT — 0 Inches x 0 Inches
from: 0 FT to: 0 FT — 0 Inches x 0 Inches
from: 0 FT to: 0 FT — 0 Inches x 0 Inches
Perforated by:

Seal: from: 0 FT to: 0 FT
Seal: from: 0 FT to: 0 FT
Seal: from: 0 FT to: 0 FT

Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches

Screen Installation Method:
Fittings Top: Bottom:
Pack: Grain Size: Amount:
Geophysical Log Taken:
Retained on Files:
Additional Test and/or Pump Data
Chemistries taken By Driller: No
Held: 0 Documents Held: 1
Pitless Adapter Type:
Drop Pipe Type:
Length: Diameter:
Comments:

6. Well Yield

Test Date (yyyy/mm/dd): Start Time:
Test Method:
Non pumping static level: FT
Rate of water removal: Gallons/Min
Depth of pump intake: FT
Water level at end of pumping: FT
Distance from top of casing to ground level: Inches

Depth To water level (feet)
Elapsed Time Drawdown Minutes:Sec Recovery

Total Drawdown: FT
If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: Gallons/Min
Recommended pump intake: FT
Type pump installed
Pump type:
Pump model:
H.P.:
Any further pumptest information?

7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.:
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.
Signature Yr Mo Day

Water Well Drilling Report

Alberta Environment

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.:	0118430
Map Verified:	Field
Date Report Received:	1965/02/01
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: UNKNOWN DRILLER		Drilling Company Approval No.: 99999
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code:
WellOwner's Name: ARC	Well Location Identifier:	
P.O. Box Number:	Mailing Address:	Postal Code:
City:	Province:	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	West of M
NH	22	008	22	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: 3078 FT
How Obtain: Estimated

3. Drilling Information

Type of Work: Well Inventory
Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Materials Used:
Method of Drilling: Drilled
Flowing Well:
Gas Present: No
Rate: Gallons
Oil Present: No
Proposed well use: Unknown
Anticipated Water Requirements/day 0 Gallons

4. Formation Log

Depth from ground level (feet)	Lithology Description
335	Glacial Drift
1030	Unknown
1450	Formost Formation
1560	Pakowki Formation
1823	Unknown
3243	Shale
3735	Sandy Shale
4551	Unknown

5. Well Completion

Date Started(yyyy/mm/dd):	Date Completed (yyyy/mm/dd): 1932/02/27
Well Depth: 4580 FT	Borehole Diameter: 0 Inches
Casing Type:	Liner Type:
Size OD: 0 Inches	Size OD: 0 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT
Perforations	Perforations Size:
from: 0 FT to: 0 FT	0 Inches x 0 Inches
from: 0 FT to: 0 FT	0 Inches x 0 Inches
from: 0 FT to: 0 FT	0 Inches x 0 Inches
Perforated by:	
Seal: from: 0 FT	to: 0 FT
Seal: from: 0 FT	to: 0 FT
Seal: from: 0 FT	to: 0 FT
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Installation Method:	
Fittings Top:	Bottom:
Pack: Grain Size:	Amount:
Geophysical Log Taken: Retained on Files:	
Additional Test and/or Pump Data Chemistries taken By Driller: No Held: 0	Documents Held: 1
Pitless Adapter Type: Drop Pipe Type: Length:	Diameter:
Comments:	

6. Well Yield

Test Date (yyyy/mm/dd):
Start Time:
Test Method:
Non pumping static level: FT
Rate of water removal: Gallons/Min
Depth of pump intake: FT
Water level at end of pumping: FT
Distance from top of casing to ground level: Inches

Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery

Total Drawdown: FT
If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: Gallons/Min
Recommended pump intake: FT
Type pump installed
Pump type:
Pump model:
H.P.:
Any further pumptest information?

7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.:
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.
Signature Yr Mo Day

Water Well Drilling Report

Alberta Environment

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.:	0118436
Map Verified:	Field
Date Report Received:	
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: UNKNOWN DRILLER		Drilling Company Approval No.: 99999
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code:
WellOwner's Name: LETHBRIDGE COLL #5	Well Location Identifier:	
P.O. Box Number:	Mailing Address:	Postal Code:
City:	Province:	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	West of M
01	27	008	22	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: 3045 FT
How Obtain: Estimated

3. Drilling Information

Type of Work: Test Hole
Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Materials Used:
Method of Drilling: Drilled
Flowing Well:
Gas Present: No
Rate: Gallons
Oil Present: No
Proposed well use: Unknown
Anticipated Water Requirements/day 0 Gallons

4. Formation Log

Depth from ground level (feet)	Lithology Description
290	Glacial Drift
305	Pebbly Shale
313	Soft Sand & Shale
315	Gray Sandstone
320	Yellow Sandy Shale
334	Gray Sandstone

5. Well Completion

Date Started(yyyy/mm/dd):	Date Completed (yyyy/mm/dd):
Well Depth: 334 FT	Borehole Diameter: 0 Inches
Casing Type:	Liner Type:
Size OD: 0 Inches	Size OD: 0 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT
Perforations	Perforations Size:
from: 0 FT to: 0 FT	0 Inches x 0 Inches
from: 0 FT to: 0 FT	0 Inches x 0 Inches
from: 0 FT to: 0 FT	0 Inches x 0 Inches
Perforated by:	
Seal: from: 0 FT	to: 0 FT
Seal: from: 0 FT	to: 0 FT
Seal: from: 0 FT	to: 0 FT
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Installation Method:	
Fittings Top:	Bottom:
Pack: Grain Size:	Amount:
Geophysical Log Taken: Retained on Files:	
Additional Test and/or Pump Data Chemistries taken By Driller: No Held: 0	Documents Held: 1
Pitless Adapter Type: Drop Pipe Type: Length:	Diameter:
Comments:	

6. Well Yield

Test Date (yyyy/mm/dd):
Start Time:
Test Method:
Non pumping static level: FT
Rate of water removal: Gallons/Min
Depth of pump intake: FT
Water level at end of pumping: FT
Distance from top of casing to ground level: Inches

Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery

Total Drawdown: FT
If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: Gallons/Min
Recommended pump intake: FT
Type pump installed
Pump type:
Pump model:
H.P.:
Any further pumptest information?

7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.:
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.
Signature Yr Mo Day

Water Well Drilling Report

Alberta Environment

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.:	0118437
Map Verified:	Field
Date Report Received:	
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: UNKNOWN DRILLER		Drilling Company Approval No.: 99999
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code:
WellOwner's Name: LETHBRIDGE COLL #4	Well Location Identifier:	
P.O. Box Number:	Mailing Address:	Postal Code:
City:	Province:	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	Westof M
12	27	008	22	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: 3075 FT
How Obtain: Estimated

3. Drilling Information

Type of Work: Test Hole
Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Materials Used:
Method of Drilling: Drilled
Flowing Well:
Gas Present: No
Rate: Gallons
Oil Present: No
Proposed well use: Unknown
Anticipated Water Requirements/day 0 Gallons

4. Formation Log

Depth from ground level (feet)	Lithology Description
317	Glacial Drift
320	Pebbly Shale
326	Blue Soft Shale
329	Coal
330	Shale
337	Gray Silty Sandstone

5. Well Completion

Date Started(yyyy/mm/dd):
Date Completed (yyyy/mm/dd):

Well Depth: 337 FT
Borehole Diameter: 0 Inches

Casing Type:	Liner Type:
Size OD: 0 Inches	Size OD: 0 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT

Perforations
from: 0 FT to: 0 FT
from: 0 FT to: 0 FT
from: 0 FT to: 0 FT
Perforations Size:
0 Inches x 0 Inches
0 Inches x 0 Inches
0 Inches x 0 Inches

Perforated by:

Seal:
from: 0 FT to: 0 FT
Seal:
from: 0 FT to: 0 FT
Seal:
from: 0 FT to: 0 FT

Screen Type:	Screen ID: 0 Inches
from: 0 FT to: 0 FT	Slot Size: 0 Inches
Screen Type:	Screen ID: 0 Inches
from: 0 FT to: 0 FT	Slot Size: 0 Inches

Screen Installation Method:

Fittings
Top: Bottom:

Pack:
Grain Size: Amount:

Geophysical Log Taken:
Retained on Files:

Additional Test and/or Pump Data
Chemistries taken By Driller: No
Held: 0 Documents Held: 1

Pitless Adapter Type:
Drop Pipe Type:
Length: Diameter:

Comments:

6. Well Yield

Test Date (yyyy/mm/dd):
Start Time:
Test Method:
Non pumping static level: FT
Rate of water removal: Gallons/Min
Depth of pump intake: FT
Water level at end of pumping: FT
Distance from top of casing to ground level: Inches

Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery

Total Drawdown: FT
If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: Gallons/Min
Recommended pump intake: FT
Type pump installed
Pump type:
Pump model:
H.P.:
Any further pumptest information?

7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.:
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.
Signature Yr Mo Day

Water Well Drilling Report

Alberta Environment

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.:	0118438
Map Verified:	Field
Date Report Received:	
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: UNKNOWN DRILLER		Drilling Company Approval No.: 99999
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code:
WellOwner's Name: MCLEOD, M.	Well Location Identifier:	
P.O. Box Number:	Mailing Address:	Postal Code:
City:	Province:	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	Westof M
09	27	008	22	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: 3055 FT
How Obtain: Estimated

3. Drilling Information

Type of Work: Structure Test Hole
Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Materials Used:
Method of Drilling: Drilled
Flowing Well:
Gas Present: No
Rate: Gallons
Oil Present: No
Proposed well use: Industrial
Anticipated Water Requirements/day 0 Gallons

6. Well Yield

Test Date (yyyy/mm/dd):
Start Time:
Test Method:
Non pumping static level: FT
Rate of water removal: Gallons/Min
Depth of pump intake: FT
Water level at end of pumping: FT
Distance from top of casing to ground level: Inches

Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery

Total Drawdown: FT
If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: Gallons/Min
Recommended pump intake: FT
Type pump installed
Pump type:
Pump model:
H.P.:
Any further pumptest information?

4. Formation Log

Depth from ground level (feet)	Lithology Description

5. Well Completion

Date Started(yyyy/mm/dd):	Date Completed (yyyy/mm/dd): 1953/05/08
Well Depth: 478 FT	Borehole Diameter: 0 Inches
Casing Type:	Liner Type:
Size OD: 0 Inches	Size OD: 0 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT
Perforations from: 0 FT to: 0 FT from: 0 FT to: 0 FT from: 0 FT to: 0 FT	Perforations Size: 0 Inches x 0 Inches 0 Inches x 0 Inches 0 Inches x 0 Inches
Perforated by:	
Seal: from: 0 FT Seal: from: 0 FT Seal: from: 0 FT	to: 0 FT to: 0 FT to: 0 FT
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Installation Method:	
Fittings Top:	Bottom:
Pack: Grain Size:	Amount:
Geophysical Log Taken: ELECTRIC Retained on Files: ELECTRIC yes	
Additional Test and/or Pump Data Chemistries taken By Driller: No Held: 0	Documents Held: 1
Pitless Adapter Type: Drop Pipe Type: Length:	Diameter:
Comments:	

7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.:
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.
Signature Yr Mo Day

Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.:	0118440
Map Verified:	Field
Date Report Received:	
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: UNKNOWN DRILLER		Drilling Company Approval No.: 99999
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code:
WellOwner's Name:	Well Location Identifier:	
P.O. Box Number:	Mailing Address:	Postal Code:
City:	Province:	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	West of M
13	27	008	22	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: 3075 FT
How Obtain: Estimated

3. Drilling Information

Type of Work: Well Inventory
Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Materials Used:
Method of Drilling: Unknown
Flowing Well:
Gas Present: No
Rate: Gallons
Oil Present: No
Proposed well use: Unknown
Anticipated Water Requirements/day 0 Gallons

4. Formation Log

Depth from ground level (feet)	Lithology Description

5. Well Completion

Date Started(yyyy/mm/dd):	Date Completed (yyyy/mm/dd):
Well Depth: 25 FT	Borehole Diameter: 0 Inches
Casing Type:	Liner Type:
Size OD: 0 Inches	Size OD: 0 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT
Perforations from: 0 FT to: 0 FT from: 0 FT to: 0 FT from: 0 FT to: 0 FT	Perforations Size: 0 Inches x 0 Inches 0 Inches x 0 Inches 0 Inches x 0 Inches
Perforated by:	
Seal: from: 0 FT Seal: from: 0 FT Seal: from: 0 FT	 to: 0 FT to: 0 FT to: 0 FT
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Installation Method:	
Fittings Top:	 Bottom:
Pack: Grain Size:	 Amount:
Geophysical Log Taken: Retained on Files:	
Additional Test and/or Pump Data Chemistries taken By Driller: No Held: 0	 Documents Held: 1
Pitless Adapter Type: Drop Pipe Type: Length: FT	 Diameter: Inches
Comments:	

6. Well Yield

Test Date (yyyy/mm/dd): 1964/08/01	Start Time: 11:00 AM
Test Method:	
Non pumping static level:	24 FT
Rate of water removal:	Gallons/Min
Depth of pump intake:	0 FT
Water level at end of pumping:	FT
Distance from top of casing to ground level:	Inches

Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery
Total Drawdown: 0 FT

If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: 0 Gallons/Min
Recommended pump intake: 0 FT
Type Pump Installed
Pump Type:
Pump Model:
H.P.:
Any further pumptest information?

7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.:
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.
Signature Yr Mo Day

EBA Engineering Consultants Ltd.

Creating and Delivering Better Solutions

Fax: (780) 427-1044

May 5, 2005

Alberta Infrastructure and Transportation
Dangerous Goods Control Branch
Traffic Safety Services Division
Main Floor, Twin Atria Building
4999 – 98 Avenue
Edmonton AB T6B 2X3

EBA File: 0404-4400840.001

Attention: Duty Officer

Dear Sir/Madam:

Subject: Request for Information

EBA Engineering Consultants Ltd. (EBA) has been commissioned to conduct an Environmental Site Assessment of a property with the legal site description of 27-8-22 W4M, located in the west portion of Lethbridge, Alberta. The nearest roadways are Whoop-up Drive and Benton Drive West.

We would be grateful if you would kindly provide any information or concerns that Alberta Environment may have regarding these sites pertaining to current or former underground storage tanks, any spills or release of contaminants and/or any contaminant investigation on or around the subject property.

Thank you for your assistance in this matter.

Yours truly,
EBA Engineering Consultants Ltd.

Mandi Parker, P.Ag.
Environmental Scientist

MEP:cld

NO DANGEROUS GOODS INCIDENTS
OCCURRED AT OR NEAR THE
LOCATION(S) SPECIFIED BY YOU.
YOUR REF: May 6/05

442 – 10 Street North, Lethbridge, Alberta T1H 2C7 - Tel: (403) 329-9009 - Fax: (403) 328-8817
Email: lethbridge@eba.ca - Web Site: www.eba.ca

APPENDIX D

SITE PHOTOGRAPHS

Photo 1
Looking northeast across the SW 1/4 27-8-22 W4M.

Photo 2
Looking north along the western property line from the southwest corner of the site.

Photo 3
Looking east across the SW 1/4 27-8-22 W4M.

Photo 4
Looking east across the NW 1/4 27-8-22 W4M.

Photo 5
Looking east across the NW 1/4 27-8-22 W4M.

Photo 6
Looking south along the future Benton Drive - eastern property boundary.

Photo 7
Looking south at the NE 1/4 27-8-22 W4M.

Photo 8
View of the stockpiles in the NE 1/4 27-8-22 W4M.

Photo 9
Looking south at the stockpile located in the southeast corner of the site.

Photo 10
Looking northwest across the SE 1/4 27-8-22 W4M.

Photo 11
View of the southern adjacent property from the southwest corner of the site.

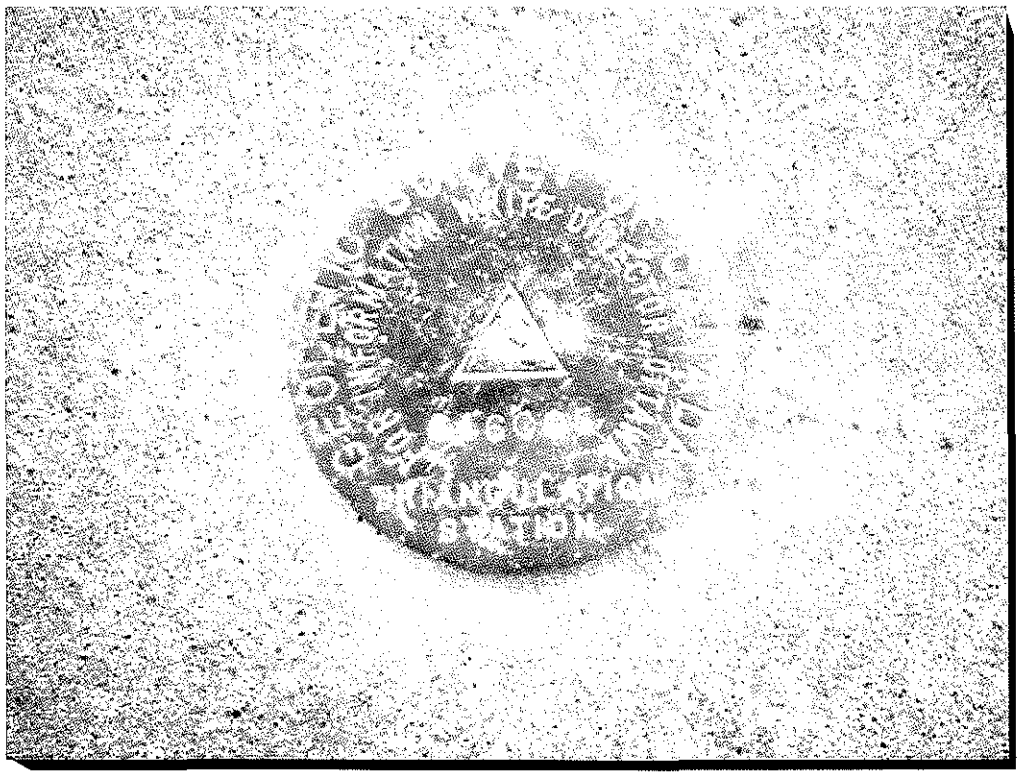


Photo 12
View of the survey benchmark located north of the site.

APPENDIX E

INFORMATION SOURCE CHECKLIST

PHASE I INFORMATION SOURCE CHECKLIST

Resource Materials

- ☒ Quaternary Geology Map
- ☒ Surficial Geology Map
- ☐ Geology Highway Map of Alberta (Bedrock Map)
- ☐ Maps and Air Photo Library - University of Lethbridge
- ☒ Maps Alberta (Government of Alberta - Air Photos)
- ☒ Galt Museum Archives
- ☐ Fire Underwriters Survey Maps
- ☒ ERCB Coal Mine Atlas
- ☒ Water Well Database

Provincial Records

- ☒ Alberta Attorney General Land Title Office
- ☐ Environmental Law Centre (ELC)
- ☒ Alberta Energy and Utility Board (AEUB)
- ☐ Canadian Mortgage and Housing Corporation (CMHC)
- ☒ Petroleum Tank Management Association of Alberta (PTMAA)
- ☒ Alberta Infrastructure and Transportation (AIT)

Municipal Records

- ☒ City of Lethbridge - Municipal Archives
- ☒ City of Lethbridge - Planning and Development Department
- ☐ City of Lethbridge - Fire Department
- ☐ City of Lethbridge - By-Law Enforcement
- ☐ City of Lethbridge - Solid Waste Disposal Department

EBA Records

- ☒ Maps and Air Photo Library
- ☒ Geotechnical/Environmental Site Assessment Files
- ☐ Borehole Database - Southern Alberta
- ☐ Materials Testing Files

July 25, 2005

EBA File: 4400840.001

Associated Engineering Alberta Ltd.
300, 410 Stafford Drive South
Lethbridge, Alberta T1J 2L2

Via Fax: 403.329.4745

Attention: Mr. Greg Kaupp

Dear Sir:

Subject: Addendum 1.0 - Phase I Environmental Site Assessment, Portions of 24-8-22 W4M, Lethbridge, AB, EBA File 0404-4400840.001, Issued May 2005

EBA Engineering Consultants Ltd. (EBA) conducted a Phase I Environmental Site Assessment of a property located in portions of 27-8-22 W4M in Lethbridge, Alberta. Due to insufficient information pertaining to an abandoned well at the time of the release of the aforementioned report, a letter requesting information from Thunder Energy Inc. (Thunder) was released on May 30, 2005 (attached).

In June 2005 EBA received a phone call from Thunder Energy indicating that they had very little information on this well as it was licensed to Thunder through acquisition. It was further indicated that the wellhead was cut and capped approximately 1 m below grade.

A letter was received from Thunder Energy on July 20, 2005 in response to the May 30, 2005 letter (attached). There was a reclamation certificate issued on June 6, 2000 by Alberta Environment. This letter indicated that Thunder had no information on the drilling waste disposal or whether there was a sump located on the site. It is also understood that a Phase I /II Environmental Site Assessment was not conducted to determine potential environmental concerns.

Thunder also lists EUB references with respect to set back requirements on abandoned wells. The minimum site back noted in General Bulletin 99-04 is 5 m, however recommends that a workspace of about 10-15 m is maintained for access to the bore.

Based on this additional information the following is recommended above those recommendations initially provided in the aforementioned report:

- The referenced information listed in the Thunder letter should be reviewed pertaining to the development setbacks.

- Environmental Assessments for Upstream Oil and Gas sites are typically completed by the owner (licensee) of the well. Thunder should be requested to ensure that there are no environmental issues on the lease. This will warrant further assessment and possibly a Phase II ESA.

Should you have any questions or comments please feel free to contact me at your convenience.

Yours truly,
EBA Engineering Consultants Ltd.

Mandi Parker, P.Ag.
Environmental Scientist

/cld

Attachments

Cores

EBA Engineering Consultants Ltd.

Creating and Delivering Better Solutions

VIA FAX: (403) 232-1317 (1 page)

May 30, 2005

Thunder Energy Inc.
799, 400 – 3 Avenue SW
Calgary AB T2P 4H2

EBA File: 0404-4400840.001

Attention: Mr. Steve Roth

Dear Sir:

Subject: Request for Well Information – 4-27-8-22 W4M

EBA Engineering Consultants Ltd. (EBA) has conducted an Environmental Site Assessment of a property located at 27-8-22 W4M in Lethbridge, Alberta. Included in this project was a search EUB information. An abandoned well located at 4-27-8-22 W4M was registered to Thunder Energy Inc. Originally the well was drilled for Stade Exploration Inc. (November 20, 1996 – License No. 0193331, Well ID 00/04-27-008-22W4/0) and the reclamation certificate was issued to Encounter Energy Inc. (June 12, 2000).

The City of Lethbridge is finalizing the staging plan and will be developing this area as a residential development. Additional information required on this abandoned well site is indicated below.

- Does the site meet the G50 guidelines, was the sump assessed or can further details be provided about the site such as a Phase I ESA or Phase II ESA report?

- Can the abandonment details please be provided? It has been indicated by development officials that the well should be completely removed to prevent any complications to the residential development.

The development of this area is scheduled to proceed this field season and we would request that this information be provided as quickly as possible.

Should you have any questions or comments please feel free to contact me at your convenience.

Yours truly,
EBA Engineering Consultants Ltd.

Mandi Parker, P.Ag.
Environmental Scientist

MEP:cld
cc: Greg Kaupp, Associated Engineering Alberta Ltd., fax 329-4745
George Kuhl, City of Lethbridge, fax 327-6571
Murray Riddell, Genesis Environmental Ltd., fax 320-5444

4400840.001

Phone: (403) 294 1635
Fax: (403) 232 1317
Email: thunder@thunderenergy.com

Thunder ENERGY INC

Suite 700, 400 - 3 Avenue SW
Calgary Alberta T2P 4H2
Website: www.thunderenergy.com

EBA Engineering Consultants Ltd.
442-10 Street North,
Lethbridge, Alberta
T1H 2C7

RE: **Well Information for 00/04-27-008-22W4/00**
EBA File: 0404-4400840.001

Attention: **Mandi Parker, P. Ag.**
Environmental Scientist

In response to your recent letter, Thunder is providing information in regard to the above noted well. Thunder became the licensee for the 00/04-27-008-22W4/00 well through an acquisition. The well was originally drilled by licensed and drilled by Stade Exploration Inc. The spud date for the well was on November 15, 1996 and the well was then abandoned shortly thereafter. The site was then reclaimed and a reclamation certificate (#39817) was issued by Alberta Environment on June 6, 2000.

A well file review did not locate a G-50 compliant drilling waste disposal notification form. Handwritten notes in the well file indicate the well may have been drilled without a sump. However, no additional drilling waste handling information is in the well file to support this comment. Given the time when the site was certified, a Phase 1 and Phase 2 ESA were not completed to confirm or refute the presence of a drilling sump or other potential environmental concerns.

We understand Mr. Roger Christianson of Thunder has already provided you with abandonment information on this well. If you require any additional information about the abandonment, please contact the undersigned.

With respect to constructing developments on or near this reclaimed lease, we reference the following EUB information;

- EUB EnerFAQ No. 5 - Explaining EUB Setbacks
- EUB Informational Letter IL 95-7
- EUB General Bulletin GB-99-04
- EUB Interim Directive ID 97-6 (Sour Wells)
- EUB ID 91-3 (Sour Wells)

On page 5 of the GB 99-04 document, the EUB recommends permanent structures have a minimum 5 m setback from abandoned wells. The document also recommends a working space of at least 10 by 15 meters be maintained around the well and an access route of at least 8 m be maintained. The working spaces are necessary if a service rig is ever required to get back on the well bore. Ideally, Thunder would recommend a 30 m+ setback in all directions should be left around the abandoned well to provide adequate workspace, should operations ever be required on the well.

Phone: (403) 294 1635
Fax: (403) 232 1317
Email: thunder@thunderenergy.com

Thunder ENERGY INC

Suite 700, 400 - 3 Avenue SW
Calgary Alberta T2P 4H2
Website: www.thunderenergy.com

We trust this information is sufficient for your present needs. If you require any clarification of more information, please do no hesitate to contact the undersigned.

Steve Roth
Senior Surface Landman
(403) 294-1635
stever@thunderenergy.com

c.c. Thunder Well file

APPENDIX D

Letter from Alberta Community Development

Alberta
COMMUNITY DEVELOPMENT

Cultural Facilities and
Historical Resources
Heritage Resource Management

Old St. Stephen's College
8820 - 112 Street
Edmonton, Alberta
Canada T6G 2P8
www.cd.gov.ab.ca/hrm

Telephone 780/431-2300
Fax 780/427-5598

August 3, 2004

Project File: 4835-04-134

Mr. Armin Preiksaitis
Armin A. Preiksaitis & Associates Ltd.
#408 The Boardwalk
10310 – 102 Avenue
Edmonton, AB T5J 2X6

Dear Mr. Preiksaitis:

SUBJECT: ARMIN A. PREIKSAITIS & ASSOCIATES LTD.
WEST LETHBRIDGE AREA STRUCTURE PLAN
SECTIONS 21, 22, 23, 27, 28, 33, & 34, TOWNSHIP 8, RANGE 22, W4M
***HISTORICAL RESOURCES ACT* REQUIREMENTS**

The Cultural Facilities and Historical Resources Division ("CFHRD") of Alberta Community Development has completed the review of the WEST LETHBRIDGE AREA STRUCTURE PLAN. **A Historical Resources Impact Assessment is not required.** Therefore, Armin A. Preiksaitis & Associates Ltd. has *Historical Resources Act* clearance for the WEST LETHBRIDGE AREA STRUCTURE PLAN.

HISTORICAL RESOURCES ACT REQUIREMENTS

Pursuant to Section 31 of the *Historical Resources Act*, should any historic resources be encountered during construction activities, please contact George Chalut, Resource Management Planner, Cultural Facilities and Historical Resources Division, Alberta Community Development, 8820 – 112 Street, Edmonton, Alberta, T6G 2P8; telephone at (780) 431-2329 or fax (780) 427-3956. It will then be necessary for the CFHRD to issue further instructions regarding the documentation of these resources. On behalf of the Cultural Facilities and Historical Resources Division, I would like to thank you and officials of the Armin A. Preiksaitis & Associates Ltd. for your continued cooperation in our endeavour to conserve Alberta's past.

Sincerely,

George Chalut
Resource Management Planner
Protection & Stewardship Section

APPENDIX E

Design Guidelines from West Lethbridge Phase II Area Structure Plan

Design Guidelines from West Lethbridge Phase II Area Structure Plan, Bylaw 5321

Mixed Use

A mixed-use Community Core provides opportunities to live, work, shop, learn and play. The following should be considered:

- A diversity of uses should be encouraged to support activity to create a safe and lively Community Core.
- A mix of land uses should be integrated both horizontally (i.e. locating compatible uses beside one another, for example a library and high schools) and vertically within the same building.
- Compact development should be promoted so that services and amenities are within an approximate radius of 400 meters, or within a 5-minute walk radius.
- The mix of land uses should function in a mutually supportive fashion to minimize land use conflicts while maximizing synergies.
- Housing forms that facilitate work/live opportunities should be encouraged.

A 'high street' provides opportunities to vertically integrate uses by placing retail uses at grade with office and residential uses on the upper floors.
Source: Bohl, 2002.

Walkability

In order to develop an attractive and safe pedestrian environment, the following should be considered:

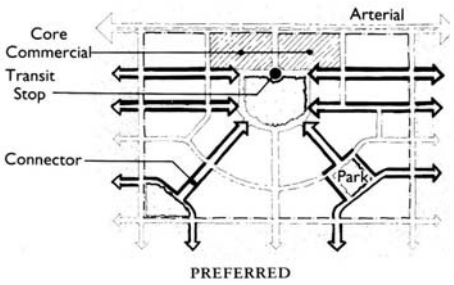
- Linkages with surrounding neighbourhoods, including walkways, trails and roadways should be created to ensure connectivity and ease of pedestrian movement.
- Street-oriented retail should be provided along the high street of shopping centres to create a visually stimulating pedestrian experience and promote walking instead of driving.
- Street crossings should be clearly marked so they are convenient and safe for pedestrians and visible to motorists.
- The public realm should be designed as barrier-free space intended for universal access.
- Landscaping, street furniture (e.g. lighting, canopies and awning, etc.) and conveniently located seating areas should be included in the streetscape design.

A safe and attractive streetscape showing the provision of street-oriented retail, street trees and ample sidewalk space.

Street and Block Patterns

To provide an attractive street network for pedestrian and vehicular circulations, the following should be considered:

- The street pattern should be designed as a grid or modified grid in order to achieve efficient connections and direct paths for pedestrians and bicyclists.
- The street system should be designed to maintain convenient vehicle circulation without compromising the safety and attractiveness of the pedestrian environment.
- The street system should provide multiple, parallel, and inter-connected routes between commercial and residential areas.
- The street system should be simple, memorable, accentuate landmarks, and encourage pedestrian activity.

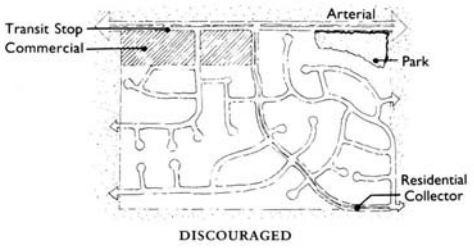


A simple, grid-based street system with landmarks is memorable, easy to navigate, and encourage pedestrian activity.
Source: Calthorpe 1993.

Built Form

To create a high quality, attractive built environment the following should be considered:

- Building height and massing should transition from a taller, dense mixed-use Community Core to high-density residential housing to medium density residential housing and finally, to surrounding lower density villages.
- Where possible, the built form should preserve views, create attractive rooflines and minimize shadowing.
- The height and massing buildings should define and enclose public streets and spaces.
- Landmarks, theming, wayfinding and public art should be provided.

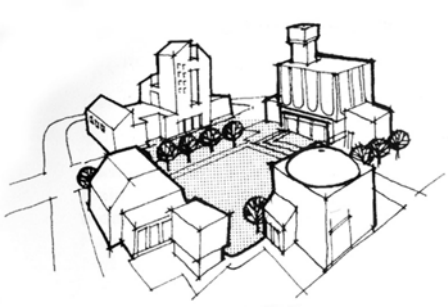


A circuitous, complex street pattern with cul-de-sacs discourages pedestrian activity.
Source: Calthorpe 1993.

Active Streetfronts

Commercial and residential streetfronts should be designed to create street-level pedestrian activity. The following should be considered:

- Where possible, commercial buildings should be encouraged to build to the property line and residential uses should have reduced front yards and defined street edge.
- Primary entrances of buildings and individual ground-floor residential entrances should be oriented to the street.
- Housing should address the street and sidewalk with entries, balconies, porches, architectural features, and activities, which help create safe, pleasant walking environments.



Building height and massing showing suitable transition and enclosure of a public square.
Source: Bohl, 2002.

- Blank walls should be avoided, corner buildings should face both streets.
- Street trees should be planted, and lighting and other street furniture should be at a human scale to enhance the character of the pedestrian realm.

Whyte Avenue in Edmonton, AB. - active streetfronts contribute to an animated sidewalk and street trees create a spatial sense of enclosure. Source: Cooper, Carry & Associates, 2002.

Parking Requirements and Configuration for Commercial and Multi-Unit Residential

The following should be considered when developing parking facilities for commercial and multi-unit residential uses:

- Several small parking lots spread throughout are preferred, rather than one single large parking lot.
- Opportunities for shared parking facilities should be encouraged to minimize the amount of land devoted to parking.
- Surface parking lots should be landscaped and parking entrances and loading should be screened to maintain an attractive pedestrian-oriented environment.
- The parking layout of arterial commercial centres should be designed to provide safe, convenient and attractive pedestrian access.
- Parking and loading access should be oriented to the rear or side of buildings and utilize lanes for access.
- The development of structured parking should be hidden from the street, preferably placed in the interior of blocks.
- Clear signage for parking should be provided.

Southlake Town Centre, Texas - parking lots are screened by buildings, preserving street frontages for street-oriented retail. Source: Bohl, 2002.

Transit

Adhering to the following design guidelines supports transit-oriented development.

- Transit facilities should be placed at the heart of the Community Core and, if possible, adjacent to the village square.
- The transit facilities should contribute to a strong sense of place.
- Higher density residential development should be promoted in proximity to transit facilities.
- Pedestrian connections between all parts of the Community Core and adjacent villages should be clearly defined to provide safe and attractive access to transit facilities.

Transit should be centred at the heart of the Community Core.

Residential Areas

The Community Core will create a vibrant residential community by:

- A variety of housing forms (e.g. apartments, townhouses, duplexes, and single-family units) and types of tenure should be made available to accommodate a broad range of income and age groups.
- Townhouses and apartments should be located at the sidewalk with parking behind and interior to the block.
- Single-family houses should be set close to the street.
- Residential blocks should provide alleys for utilities and garage access.
- Street trees and plantings should be provided where possible on residential streets.
- Sidewalks should be provided on both sides of all streets, preferably separated from the roadway by a boulevard/street trees.
- Front porches should be encouraged to create an active street environment.

Parks and Open Space

A system of parks and public spaces should be integrated into the Community Core. The following should be considered in the provision of parks and open space:

- A village square should act as a focal point within the Community Core and should be lined with retail shops, restaurants, and cafés to create a lively, pedestrian-friendly atmosphere;
- A village square should be defined by the mass and height of surrounding buildings to provide a strong street wall.
- Parks should be linked to an overall open space system via pedestrian linkages or pathways.
- Parks will provide amenity value for residents by providing a combination of playground opportunities, informal play areas, as well as passive use and seating areas.
- Parks should be designed with access and visibility from public streets and to ensure universal accessibility.

Princeton Forrestal Village – a well-defined public square.
Source: Bohl, 2002.

Place-Making

To create a sense of place, foster informal social gathering spaces, add visual interest and develop a legible wayfinding system, the following should be considered:

- Civic building, places of worship and/or other buildings on prominent sites should be designed to be architecturally distinctive.
- The street network layout should be designed to maximize focal point opportunities.
- Views and vistas should be aligned with key buildings and should terminate with key landmarks.
- Prominent pedestrian nodes and transport interchanges should be emphasized (e.g. by marking their location with a prominent landmark and / or gateway).
- Architectural differentiation of buildings and rooflines should be encouraged to create visual interest and assist wayfinding.

Edmonton's Multi-Use Trail - an example of a gateway to define and introduce a public space. Source: GBLA, 2004.

Crime Prevention Through Environmental Design

Crime Prevention Through Environmental Design (CPTED) aims to enhance safety and security by managing the built environment. Developers should work with local agencies to advocate that CPTED principles are incorporated into subdivision design. CPTED principles include the following:

- Methods to achieve natural surveillance should be implemented by providing clear sight lines from within buildings (e.g. installing street-oriented windows, lighting and removing obstructions, as well as focusing the flow of street activity in or near potential crime areas).
- The creation of areas hidden from view and isolated spaces should be avoided.
- Spaces should be designed such that people naturally take ownership, which discourages potential offenders because of users' familiarity with each other and the surroundings.
- Spaces should be designed using high quality durable materials to facilitate easy maintenance over time, as well-maintained, attractive spaces are less likely to be misused.
- Properly located entrances, exists, fencing, landscaping and lighting should be designed to subtly direct pedestrian and vehicular traffic in ways that decrease illicit activities without hindering user mobility.

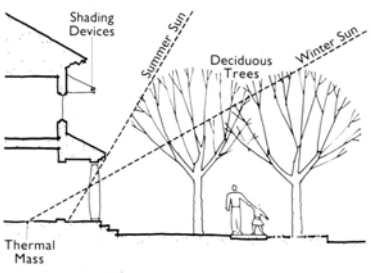
Active streetfronts put "eyes on the street" and manicured street plantings do not create hiding spaces - the public realm becomes a defensible space.

- Public spaces should be designed to promote year-round and day-long usage.

Climatic Considerations

To minimize adverse local climatic conditions, the following should be considered:

- Drought resistant landscaping and nature should be encouraged.
- Compact development to minimize the impact of prevailing west winds should be encouraged.



Deciduous trees can be used to shade interior spaces in the summer and allow direct sunlight in the winter.

APPENDIX F

Land Use and Population Statistics

OVERALL LAND USE AND POPULATION STATISTICS

BENTON CROSSING OUTLINE PLAN

	Ha	% of GDA
GROSS AREA	110.3	
Circulation		
Arterial Roadways	8.0	
GROSS DEVELOPABLE AREA	102.3	100%
Non-Residential Uses		
Circulation		
Collectors	8.8	9%
Local Roadways	6.3	6%
Lanes	0.5	0%
Subtotal	15.6	15%
Stormwater Management Facilities		
Dry Pond/Playfields	8.2	8%
Wet Pond	5.7	5%
Subtotal	13.9	14%
Parks/School/Open Space		
Combined School Site	16.6	16%
Walkways	0.5	1%
Village Square	1.1	1%
Subtotal	18.2	18%
Recreation/Community Services		
Institutional	0.7	1%
Library	1.2	1%
Swing Site	12.5	12%
Subtotal	14.4	14%
Commercial		
Commercial	11.5	11%
High Street	0.3	0%
Mixed Use	0.6	1%
Office Commercial Mixed Use	2.4	2%
Subtotal	14.7	14%
Total Non-Residential Uses	76.8	75%
Residential Uses		
Low Density Residential	15.5	15%
Comprehensive Residential / Seniors	5.4	5%
High Density Residential	2.4	2%
*High Street	0.5	1%
**Mixed Use	1.7	2%
Subtotal Residential Uses	25.5	25%
TOTAL	102.3	100%

RESIDENTIAL LAND USE ANALYSIS

	Area (Ha)	Density (Units/Ha)	Units	Persons /Unit	Population
Low Density Residential	15.5	19	295	2.8	825
Comprehensive Residential / Seniors	5.4	37	200	2.8	559
High Density Residential	2.4	150	360	2.0	720
*High Street	0.5	150	80	2.0	160
**Mixed Use	1.7	150	248	2.0	495
TOTAL	**25.5**	**598**	**1182**	**15.5**	**2759**

*Residential uses in the high street area will consist of upper floor residential units located above commercial uses. Approximately 66% of the high street area will consist of residential uses.

**Residential uses in the mixed use area will consist of upper floor residential units located above commercial/office/institutional uses. Approximately 75% of mixed use area will consist of residential uses. In areas where local circulation is not shown, 30% of the total site area has been factored out to accomodate roads and lanes.

Note to Reader: The Land Use Statistics summary does not form part of the Outline Plan Bylaw and may be subject to change over time. (August, 2006)

APPENDIX G

Water Distribution System – Water Demands Summary

Water Demand Analysis

Zone	Catchment No.	Population	Water Demands (MLD) Average Day	Maximum Day	Peak Hour	Water Demands (L/s) Average Day	Maximum Day	Peak Hour	Fire Flow
A	Off-Site *	1373	0.961	2.134	3.384	11.13	24.70	39.17	
A	A-K **	398	0.278	0.618	0.980	3.22	7.16	11.35	
A	A-J **	311	0.218	0.483	0.766	2.52	5.59	8.87	
A	A-I	392	0.274	0.609	0.966	3.17	7.05	11.18	
A	A-H	0	0.000	0.000	0.000	0.00	0.00	0.00	
A	A-G	0	0.000	0.000	0.000	0.00	0.00	0.00	
A	A-F	0	0.000	0.000	0.000	0.00	0.00	0.00	
A	A-E	80	0.056	0.124	0.197	0.65	1.44	2.28	
A	A-D	427	0.299	0.663	1.052	3.46	7.68	12.17	
A	A-C	118	0.083	0.184	0.291	0.96	2.13	3.37	
A	A-B	0	0.000	0.000	0.000	0.00	0.00	0.00	
A	A-A	0	0.000	0.000	0.000	0.00	0.00	0.00	
A	Subtotal	3099	2.169	4.816	7.636	25.11	55.74	88.38	
B	Off-Site *	3616	2.531	5.619	8.909	29.29	65.03	103.12	
B	B-G	0	0.000	0.000	0.000	0.00	0.00	0.00	
B	B-F **	477	0.334	0.742	1.176	3.87	8.59	13.62	
B	B-E	0	0.000	0.000	0.000	0.00	0.00	0.00	
B	B-D	39	0.027	0.061	0.097	0.32	0.71	1.12	
B	B-C	80	0.056	0.124	0.197	0.65	1.44	2.28	
B	B-B	291	0.204	0.452	0.717	2.36	5.23	8.30	
B	B-A	0	0.000	0.000	0.000	0.00	0.00	0.00	
B	Subtotal	4504	3.152	6.998	11.097	36.49	81.00	128.43	

Zone	Demand Area Node	Demand Area (ha)	Model Demands per Node (L/s) ADD	MDD	PHD
A	Off-Site	28.8518	11.13	24.70	39.17
A	A-1	3.9645	1.17	2.59	4.11
A	A-2	4.5216	1.33	2.96	4.69
A	A-3	3.2277	0.95	2.11	3.34
A	A-4	2.5392	0.75	1.66	2.63
A	A-5	1.7555	0.52	1.15	1.82
A	A-6	4.7512	1.40	3.11	4.92
A	A-7	2.9229	0.86	1.91	3.03
A	A-8	2.5335	0.75	1.66	2.63
A	A-9	1.939	0.57	1.27	2.01
A	A-10	2.1876	0.64	1.43	2.27
A	A-11	1.6888	0.50	1.10	1.75
A	A-12	2.2505	0.66	1.47	2.33
A	A-13	3.0205	0.89	1.97	3.13
A	A-14	2.4286	0.71	1.59	2.52
A	A-15	1.5762	0.46	1.03	1.63
A	A-16	1.221	0.36	0.80	1.27
A	A-17	2.3183	0.68	1.52	2.40
A	A-18	2.6446	0.78	1.73	2.74
A	Subtotal	76.343	25.11	55.74	88.38
B	Off-Site	75.9614	29.29	65.03	103.12
B	B-1	4.5252	1.47	3.26	5.16
B	B-2	1.3536	0.44	0.97	1.54
B	B-3	1.9578	0.63	1.41	2.23
B	B-4	7.5941	2.46	5.47	8.67
B	B-5	6.7542	2.19	4.86	7.71
B	B-6	0	0.00	0.00	0.00
B	B-7	0	0.00	0.00	0.00
B	B-8	0	0.00	0.00	0.00
B	B-9	0	0.00	0.00	0.00
B	Subtotal	98.1463	36.49	81.00	128.43

ADD	L/c/d	700	From ASP
MDF		2.22	From ASP
MDD	L/c/d	1554	
PHF		3.52	From ASP
PHD	L/c/d	2464	

	ADD per Area (L/s/ha) Off Site	OPA	MDD per Area (L/s/ha) Off Site	OPA	PHD per Area (L/s/ha) Off Site	OPA
Zone A	0.39	0.29	0.86	0.65	1.36	1.04
Zone B	0.39	0.32	0.86	0.72	1.36	1.14
Zone C						
Total	0.77	0.62	1.71	1.37	2.71	2.18

APPENDIX H

Sanitary Flows in Outline Plan Area

Land Use Analysis

		Area (ha)													Population						
Zone	Catchment No.	Total Area	Low Density Residential	Medium Density Residential	High Density Residential	Multi Family Residential	Commercial	Mixed Use (Commercial/ Residentail)	Seniors Housing	Open Space	SWM Facility	School	Library	Recreation Facility/ Church	Total	Low Density Residential	Medium Density Residential	High Density Residential	Multi Family Residential	Mixed Use (Commercial/Residentail)	Seniors Housing
A	Off-Site *	28.8518	28.8518												1373	1373	0	0	0	0	0
A	A-K **	8.3574	8.3574												398	398	0	0	0	0	0
A	A-J **	6.534	6.534												311	311	0	0	0	0	0
A	A-I	4.1249							4.1249						392	0	0	0	0	0	392
A	A-H	0.7												0.7	0	0	0	0	0	0	0
A	A-G	17.8479										17.8479			0	0	0	0	0	0	0
A	A-F	1.9544					0.8389			1.1155					0	0	0	0	0	0	0
A	A-E	2.5074					1.4261	1.0813							80	0	0	0	0	80	0
A	A-D	1.4228			1.4228										427	0	0	427	0	0	0
A	A-C	6.9423							1.244		5.6983				118	0	0	0	0	0	118
A	A-B	3.9105					3.9105								0	0	0	0	0	0	0
A	A-A	3.6642					3.6642								0	0	0	0	0	0	0
A	Subtotal	86.8176	43.7432	0	1.4228	0	9.8397	1.0813	5.3689	1.1155	5.6983	17.8479	0	0.7	3099	2082	0	427	0	80	510
B	Off-Site *	75.9614	75.9614												3616	3616	0	0	0	0	0
B	B-G	0													0	0	0	0	0	0	0
B	B-F **	10.0304	10.0304												477	477	0	0	0	0	0
B	B-E	8.963									8.963				0	0	0	0	0	0	0
B	B-D	0.8238	0.8238												39	39	0	0	0	0	0
B	B-C	2.0923					1.0104	1.0819							80	0	0	0	0	80	0
B	B-B	0.970			0.9701										291	0	0	291	0	0	0
B	B-A	3.965					3.9647								0	0	0	0	0	0	0
B	Subtotal	102.8057	86.8156	0.000	0.9701	0	4.9751	1.0819	0	0	8.963	0	0	0	4504	4132	0	291	0	80	0

* Catchment area includes roadways and lanes

** Catchment area includes lanes

	Units/ha	Persons/Unit	Density (Persons/ha)
Low Density Residential	17	2.8	47.6
Medium Density Residential	37	2	74
High Density Residential	150	2	300
Multi Family Residential	75	1.9	142.5
Mixed Use (Commercial/Residential)	37	2	74
Seniors Housing	50	1.9	95

Wastewater Flow Analysis

		Area (ha)						Flow (m3/d)																				
Zone	Catchment No.	Commercial	Mixed Use (Commercial/Residentail)	School	Library	Recreation Facility	Population	Res DWF	Com DWF	Mixed DWF	School DWF	Library DWF	Rec DWF	Total DWF	Peaked DWF	Res WWF	Com WWF	Mixed WWF	School WWF	Library WWF	Rec WWF	Total WWF	Res Infiltration	Com Infiltration	Mixed Infiltration	School Infiltration	Library Infiltration	Rec Infiltration	Total Infiltration	Total Flow
A	Off-Site *	0	0	0	0	0	1373	549	0	0	0	0	0	549	1703	687	0	0	0	0	0	687	206	0	0	0	0	0	206	2596
A	A-K **	0	0	0	0	0	398	159	0	0	0	0	0	159	493	199	0	0	0	0	0	199	60	0	0	0	0	0	60	752
A	A-J **	0	0	0	0	0	311	124	0	0	0	0	0	124	386	156	0	0	0	0	0	156	47	0	0	0	0	0	47	588
A	A-I	0	0	0	0	0	392	157	0	0	0	0	0	157	486	196	0	0	0	0	0	196	59	0	0	0	0	0	59	741
A	A-H	0	0	0	0	0.7	0	0	0	0	0	0	7	7	22	0	0	0	0	0	1.75	2	0	0	0	0	0	1.575	2	25
A	A-G	0	0	17.8479	0	0	0	0	0	0	356.958	0	0	357	1107	0	0	0	133.8593	0	0	134	0	0	0	40.157775	0	0	40	1281
A	A-F	0.8389	0	0	0	0	0	0	16.778	0	0	0	0	17	52	0	6.29175	0	0	0	0	6	0	1.887525	0	0	0	0	2	60
A	A-E	1.4261	1.0813	0	0	0	80	32	28.522	21.626	0	0	0	82	255	40	10.69575	8.10975	0	0	0	59	12	3.208725	2.432925	0	0	0	18	331
A	A-D	0	0	0	0	0	427	171	0	0	0	0	0	171	529	213	0	0	0	0	0	213	64	0	0	0	0	0	64	807
A	A-C	0	0	0	0	0	118	47	0	0	0	0	0	47	147	59	0	0	0	0	0	59	18	0	0	0	0	0	18	223
A	A-B	3.9105	0	0	0	0	0	0	78.21	0	0	0	0	78	242	0	29.32875	0	0	0	0	29	0	8.798625	0	0	0	0	9	281
A	A-A	3.6642	0	0	0	0	0	0	73.284	0	0	0	0	73	227	0	27.4815	0	0	0	0	27	0	8.24445	0	0	0	0	8	263
A	Subtotal	9.8397	1.0813	17.8479	0	0.7	3099	1240	196.794	21.626	356.958	0	7	1822	5648	1550	74	8	134	0	2	1767	465	22	2	40	0	2	531	7946
B	Off-Site *	0	0	0	0	0	3616	1446	0	0	0	0	0	1446	4484	1808	0	0	0	0	0	1808	542	0	0	0	0	0	542	6834
B	B-G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	B-F **	0	0	0	0	0	477	191	0	0	0	0	0	191	592	239	0	0	0	0	0	239	72	0	0	0	0	0	72	902
B	B-E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	B-D	0	0	0	0	0	39	16	0	0	0	0	0	16	49	20	0	0	0	0	0	20	6	0	0	0	0	0	6	74
B	B-C	1.0104	1.0819	0	0	0	80	32	20.208	21.638	0	0	0	74	229	40	7.578	8.11425	0	0	0	56	12	2.2734	2.434275	0	0	0	17	301
B	B-B	0	0	0	0	0	291	116	0	0	0	0	0	116	361	146	0	0	0	0	0	146	44	0	0	0	0	0	44	550
B	B-A	3.9647	0	0	0	0	0	0	79.294	0	0	0	0	79	246	0	29.73525	0	0	0	0	30	0	8.920575	0	0	0	0	9	284
B	Subtotal	4.9751	1.0819	0	0	0	4504	1801	99.502	21.638	0	0	0	1923	5960	2252	37	8	0	0	0	2297	676	11	2	0	0	0	689	8946

		DWF	WWF	Infiltration
Residential	L/c/d	400	500	150
Commercial	m3/ha/d	20	7.5	2.25
Mixed Use	m3/ha/d	20	7.5	2.25
School	m3/ha/d	20	7.5	2.25
Library	m3/ha/d	20	7.5	2.25
Rec. Facility	m3/ha/d	10	2.5	2.25

Harmon's Peaking Factor

PF =	$1+14/(4+P^{0.5})$

calculated

P =	7603
PF =	3.10

Set to match trunk

Sanitary Sewer Analysis

				Sanitary Flow (L/s)			Sewer Characteristics					Hydraulic Capacity			
Zone	Upstream Manhole	Downstream Manhole	Catchment No.	Catchment Flow	Upstream Flow	Total Flow	Length (m)	Nominal Pipe Dia.	Pipe ID (mm)	Material	Slope (m/m)	Manning's N	Capacity (m3/s)	Capacity (L/s)	Velocity (m/s)
A	A-10	A-9	A-Offsite	30.04	0.00	30.04		250	251.46	PVC	0.003	0.011	0.039	39.1	0.79
A	A-9	A-8	A-K	8.70	30.04	38.74		300	299.36	PVC	0.003	0.011	0.062	62.2	0.88
A	A-8	A-7	-		38.74	38.74		300	299.36	PVC	0.003	0.011	0.062	62.2	0.88
A	A-7	A-6	-		38.74	38.74		300	299.36	PVC	0.003	0.011	0.062	62.2	0.88
A	A-6	A-5	A-J	6.80	38.74	45.55		300	299.36	PVC	0.003	0.011	0.062	62.2	0.88
A	A-5	A-4	A-I, A-H	8.86	45.55	54.41		375	366.42	PVC	0.003	0.011	0.107	106.7	1.01
A	A-4	A-3	A-G, A-F, A-E	19.35	54.41	73.76		375	366.42	PVC	0.003	0.011	0.107	106.7	1.01
A	A-3	A-2	A-D, A-C	11.92	73.76	85.68		375	366.42	PVC	0.003	0.011	0.107	106.7	1.01
A	A-2	A-1	A-B, A-A	6.29	85.68	91.97		450	447.87	PVC	0.003	0.011	0.182	182.2	1.16
B	B-7	B-6	B-Offsite	79.09	0.00	79.09		375	366.42	PVC	0.003	0.011	0.107	106.7	1.01
B	B-6	B-5	B-F, B-E, B-D	11.30	79.09	90.40		375	366.42	PVC	0.003	0.011	0.107	106.7	1.01
B	B-5	B-4	-		90.40	90.40		375	366.42	PVC	0.003	0.011	0.107	106.7	1.01
B	B-4	B-3	B-C	3.49	90.40	93.89		450	447.87	PVC	0.003	0.011	0.182	182.2	1.16
B	B-3	B-2	B-B	6.37	93.89	100.25		450	447.87	PVC	0.003	0.011	0.182	182.2	1.16
B	B-2	B-1	B-A	3.29	100.25	103.54		450	447.87	PVC	0.003	0.011	0.182	182.2	1.16

APPENDIX I

Summary of Stormwater Management System

Draft Report

Associated Engineering
GLOBAL PERSPECTIVE. LOCAL FOCUS.

The City Of Lethbridge

Benton Crossing Outline Plan

Stormwater Management

September 2008

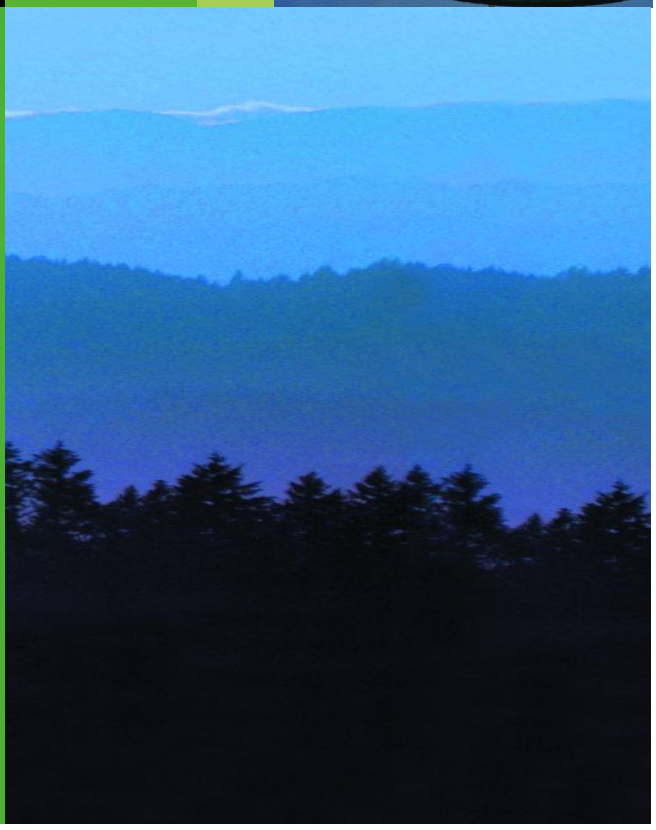


Table of Contents

1 Introduction

The Benton Crossing Outline Plan Area is situated in West Lethbridge, northwest of the Oldman River and south of Highway 3 (as shown in Figure J-1). The land is primarily owned by the City of Lethbridge and is currently leased for agricultural purposes. Figure J-2 shows a plan of the existing site.

The West Lethbridge Phase II Area Structure Plan (2005) presented a stormwater management concept for the entire West Lethbridge Phase II Area. The stormwater management system for the Outline Plan Area will generally conform to the stormwater management concept proposed in the Area Structure Plan. The Outline Plan Area is divided into two drainage catchments (see Figure J-3). A wet pond, located near the downstream end of the eastern drainage catchment, will provide stormwater quality enhancement and storage for stormwater runoff. A dry pond, located near the western boundary of the Outline Plan Area, will provide storage and attenuation for stormwater runoff. Stormwater flows released from the dry pond will be conveyed to the wet pond for additional water quality enhancement. Stormwater flows from future ponds, located to the west of the Outline Plan Area, will also be conveyed to the wet pond for additional water quality enhancement.

Stormwater from the Outline Plan Area will ultimately be discharged to the Oldman River via the existing storm sewer system. A new outfall is not required. The stormwater ponds will discharge only when there is available capacity in the existing downstream storm sewer system. It is proposed that the permanent water level in the wet pond be maintain through an irrigation water supply from the L.N.I.D. system. Water from the wet pond will be used to irrigate the dry pond / recreational site.

The stormwater system will utilize a dual drainage concept consisting of storm sewers to transport runoff from minor rainfall events and a major system to convey runoff from the extreme rainfall events.

2 Outline Plan Area

The Outline Plan Area totals approximately 110 ha. The existing terrain within the Outline Plan Area is hummocky. There are numerous local high points and low points ranging from elevations of 942 m to 930 m. The natural drainage path within the Outline Plan Area is generally to the east. A natural low area, located northwest of the proposed Benton Drive and Whoop-Up Drive intersection, collects most of the pre-development stormwater runoff from the area (see Figure J-2).

3 Drainage Catchments

In accordance with the Area Structure Plan, the Outline Plan Area is divided into two drainage catchments (see Figure J-3). The boundaries of the catchments were determined based on the natural topography, the preliminary road designs for Benton Drive and Whoop-Up Drive, and the proposed planning layout in the Outline Plan Area. Runoff generated in the western catchment will be conveyed to the proposed dry pond. Runoff generated in the eastern catchment will be conveyed to the proposed wet pond. Stormwater flow released from the dry pond will be conveyed to the wet pond for additional water quality enhancement

Table 3-1 compares the drainage catchments proposed in this Outline Plan to those presented in the Area Structure Plan. Note that in the Area Structure Plan, the western catchment was referred to as Catchment 4 and the eastern catchment was referred to as Catchment 5.

Table 3-1
Drainage Catchment Areas

	Outline Plan	Area Structure Plan
Western Catchment (Catchment 4)	69.0 ha	43 ha
Eastern Catchment (Catchment 5)	55.7 ha	100 ha
Total	124.7 ha	143 ha

As shown in Table 1, the total catchment area proposed in the Outline Plan is smaller than that presented in the Area Structure Plan due to a shift of the northern boundary of the catchments. This boundary shift is the result of the planning layout selected for the Outline Plan Area and site topography constraints. Stormwater runoff from lands developed north of the Outline Plan Area will be conveyed north. The net effect is that a larger stormwater management facility in Catchment 1 will be required.

4 Connection To Existing Stormwater System

A Stormwater Management Plan for the entire West Lethbridge area was originally developed in 1988 by MPE Engineering Ltd. and JNMackenzie Engineering Ltd. This plan states that stormwater runoff from the West Lethbridge Phase II area will be conveyed east to the Oldman River via existing storm sewers. In 2000, Stantec completed the City of Lethbridge Underground Infrastructure Master Plan (UIMP) Study. The UIMP identified that the existing storm sewer trunks are at sufficient depth to service the West Lethbridge Phase II area. However, the existing system has capacity restrictions. Given these restrictions, the UIMP states that any development connecting to existing infrastructure must be serviced by a 'zero discharge' storm sewer system. Releasing storm water to the downstream minor systems at off-peak times will prevent surcharging the existing system. During periods of stormwater discharge the rate of release must be controlled to not exceed the available capacity of the system.

In accordance with the Area Structure Plan and the UIMP, stormwater from the Outline Plan Area will be released into an existing 1200 mm storm sewer trunk located along Whoop-Up Drive. The discharge of stormwater to the existing minor storm system will be manually controlled to release at off-peak times. The downstream sewer system will be monitored by City of Lethbridge employees and stormwater will be manually released from the wet pond when downstream capacity is available.

5 Stormwater Pond Design Criteria

In accordance with the City of Lethbridge Design Standards and the Alberta Environment Stormwater Guidelines, the main design parameters for the stormwater management facilities are:

- Facilities will discharge only when there is available capacity in the existing downstream storm sewer system
- The volume of storage below the permanent water level (PWL) in the wet pond shall be equal or greater than 25 mm of runoff from the contributing area being serviced by the pond
- Minimum detention time of 24 hours
- All runoff, up to the 1:100 year event, is to be contained within the facility below the High Water Level (HWL)
- 85% of the Total Suspended Solids (TSS), greater than 75 um, shall be removed from the stormwater pollutant washoff from the contributing area.

6 Stormwater Ponds

Locations of the proposed stormwater management facilities in the Outline Plan Area are shown in Figure J-3.

Conceptual storage volumes of the stormwater management facilities were estimated using the Stormwater Management Hydrologic Model (SWMHYMO). SWMHYMO is a single event analysis tool that was developed to model watersheds for stormwater management, flood control and infiltration studies. In this analysis, the Standard Instantaneous Unit Hydrograph was used to compute the runoff from developed area (urban). The stormwater management facility volumes were computed using the Compute Volume routine.

The following parameters were utilized in the SWMHYMO model:

Design Storm: Chicago type with 24-hour duration, 1:100 year return period, and peak at 30 percent duration of the storm event. The City of Lethbridge design guidelines require that all stormwater management facilities be sized to accommodate the runoff from a 1:100 year return period storm event.

Rainfall Intensities: Determined using the Intensity-Duration-Frequency (IDF) data provided in the City of Lethbridge design guidelines.

$$i = \frac{a}{(t+b)^c}$$

Where i is intensity (mm/hr), a, b and c are IDF parameters and t is the time duration (minutes).

Table 6-1
IDF Curve Parameters From City of Lethbridge Design Standards

Parameter	1:100 Year
a	2067.5
b	7.067
c	0.840
Total Rainfall	109.9 mm

Computational Time Step: 1 minute

Runoff Curve Number: Pervious CN = 74 (Soil group C, open space - good conditions)
Impervious CN = 95

Initial Abstraction: Ia = 3.2 mm

The breakdown of the contributing area for each stormwater facility is shown in Table 6-2. The overall percent impervious and weighted CN value for each stormwater facility is shown in Table 6-3.

Table 6-2
Storm Pond Contributing Area

Areas (ha)						
Pond	**Green Space (10% Imp)**	**Benton Dr. & Whoop-Up Dr. ROWs [A] (30% Imp)**	**LDR & Road ROWs [B] (50% Imp)**	**Pond Site & School Site (75% Imp)**	**MDR, HDR, Commercial & Institutional (85% Imp)**	**Total**
Dry	0	4.5	20.0	25.5	18.9	69.0
Wet	0.7	17.2	13.2	5.7	18.9	55.7

Note [A] – Benton Drive and Whoop-Up Drive have 75 m wide ROWs. Four lanes have an imperious width of 22.6 m. This equates to 30% imperious.

Note [B] – Road ROWs within the Outline Plan Area are assumed to be 50% imperious.

LDR – Low Density Residential

MDR – Medium Density Residential

HDR – High Density Residential

ROW – Right-of-Way

Table 6-3
Storm Pond Percent Impervious and Weighted CN

Pond	Overall Percent Impervious	Weighted CN
Dry	67.5 %	88.18
Wet	57.8 %	86.13

The SWMHYMO model was developed for the ultimate build-out condition and the 1:100 year storm event. The input and output files are presented in Appendix B. Based on a near-zero discharge release, the required active storage of the stormwater facilities is shown in Table 6-4. The active storage volume is the volume of the pond measured above the permanent water level (PWL). The permanent storage volume is the volume of the pond below the PWL. This volume must be equal or greater than 25 mm of runoff from the contributing area to the facility.

Table 6-4
Conceptual Storage Requirements

Storage (m^3)			
Pond	**Permanent**	**Active**	**Total**
Dry	0	68,600	68,600
Wet	14,050	53,000	67,050

7 Minor Stormwater System

Urban stormwater management systems typically consist of both a major and minor stormwater system. As outlined in the Alberta Environment Stormwater Guidelines and the City of Lethbridge Design Standards, the minor stormwater system in the Outline Plan Area must provide a basic level of service by conveying flows from the one in five (1:5) year return period storm event. The proposed minor storm system consists of an underground pipe network and related structures. The minor flows will be directed to proposed stormwater management facilities, which will provide water quality treatment and storage of the stormwater flows before discharge to the Oldman River via the existing storm sewer system.

The Rational Formula was used to estimate the design runoff flows for the storm sewers in the Outline Plan Area. The formula is:

Q = 0.0028CiA
Where Q = peak runoff flow, in m^3/s
C = runoff coefficient, selected based on the type of development in the subcatchment area
A = subcatchment area, in ha
i = rainfall rate, in mm/hr, derived from City of Lethbridge IDF data and assuming an initial time of concentration of 10 minutes:

$$i = \frac{a}{(t+b)^c}$$

Table 7-1
IDF Curve Parameters from City of Lethbridge Design Standards

Parameter	1:5 Year
A	789.6
B	5.409
C	0.796

The Outline Plan Area was divided into subcatchments (see Figure J-4). For each subcatchment, the area and runoff coefficient was determined. A runoff coefficient of 0.4 was used in the primarily low density residential areas and a runoff coefficient of 0.8 was used in the primarily commercial areas. The storm sewers conveying flow from each subcatchment were sized to handle peak runoff flow calculated using the Rational Formula. For the purposes of the Outline Plan, a Manning's roughness coefficient of 0.013 and a slope of 0.005 were assumed for all sewers. The Rational Formula analysis is presented in Appendix C. Figure J-4 shows the alignment and pipe diameter of the proposed storm sewers in the Outline Plan Area.

A stormwater sewer system serving the Whoop-Up Drive ROW will convey stormwater flow into the Outline Plan Area at Manhole 304. This sewer system is sized to convey runoff from the 1:100 year return period storm. According to the Whoop-Up drive Extension Pre-Design Report (May 2005), the design flow from Whoop-Up Drive is 1.51 m^3/s. This flow is added to the Rational Formula analysis presented in Appendix C.

It is expected that stormwater runoff from the Benton Drive ROW will enter the Outline Plan Area (i.e., the wet pond) via swales.

Adjacent areas to the north and west of the Outline Plan Area will have separate stormwater management systems to handle the stormwater runoff from their areas. In accordance with the Area Structure Plan, controlled release of stormwater from the areas west of the Outline Plan Area will be conveyed through the Outline Plan Area to the existing 1200 mm storm trunk located on Whoop-Up Drive. This flow was not included in the above-mentioned analysis. During the design stage of the minor storm system, this flow must be included in the analysis.

8 Major Stormwater System

The major stormwater system accommodates the stormwater runoff resulting when the capacity of the minor storm system is exceeded. As outlined in the Alberta Environment Stormwater Guidelines and the City of Lethbridge Design Standards, the major stormwater system must convey flows from the one in one hundred (1:100) year return period storm event. The proposed major system in the Outline Plan Area consists primarily of roadways. The major storm system will provide a continuous flow route to the stormwater management facilities as shown on Figure J-5. The freeboard provided in the stormwater facilities will function as emergency storage. There is no emergency overland spill route out of the proposed storm ponds.

Currently, land to the west of the Outline Plan Area drains naturally through the Outline Plan Area to the low-lying area located northwest of the intersection of Whoop-Up Drive/Benton Drive. To prevent stormwater runoff from lands to the west of the Outline Plan Area from entering the Outline Plan Area, it is recommended that an interim berm be constructed along the western boundary of the Outline Plan Area. This will form a low-lying area, west of the Outline Plan Area, that will collect stormwater from the undeveloped land. Water will either infiltrate or evaporate from this low-lying area. When the lands west of the Outline Plan Area are developed, and a stormwater management system is constructed, then the interim berm may be removed.

Since the northern boundary of the Outline Plan Area is located roughly along a ridge, relatively small volumes of stormwater runoff from lands to the north are expected to enter the Outline Plan Area. This off-site runoff can be temporarily conveyed by the major storm system to the proposed ponds in the Outline Plan Area. When the lands north of the Outline Plan Area are developed, and a stormwater management system is constructed, the flows to the Outline Plan Area will be zero.

Alberta Environment Stormwater Guidelines state that during the 1:100 year return period storm event, the overland flow depths and velocities along the major storm routes must be in accordance with Table 8-1.

Table 8-1
Permissible Overland Depths and Velocities

Water Velocity (m/s)	Permissible Depth (m)
0.5	0.80
1.0	0.32
2.0	0.21
3.0	0.09

During the design stage of the major storm system, an analysis should be completed to confirm that the overland flow depths and velocities meet the above criteria.

9 Irrigation Water

To improve and maintain the aesthetic quality of the proposed wet pond in the Outline Plan Area it is important to turnover the permanent pool volume of the pond at least twice a year. This can be achieved by providing the pond with a natural base flow (minimum flow) from the facilities contributing area. It has been proposed by the City of Lethbridge that irrigation water, taken from the existing L.N.I.D irrigation system, be used as a freshwater supply source to supplement the natural runoff to the wet pond. This will increase the turnover rate of the permanent pool. The City of Lethbridge also proposes that the L.N.I.D. irrigation system provide irrigation water to the proposed dry pond/recreational site for turf irrigation purposes.

Based on the location of the existing irrigation system it is likely that pumping will be required to direct irrigation water to the wet pond in the Outline Plan Area. During the design phase of the Outline Plan Area, the pumping requirements as well as the alignment of the supply line will be determined and coordinated with L.N.I.D.

10 Development Plans

The Outline Plan Area will be developed in nine phases. The construction of both the dry pond and the wet pond will occur in the first phase of development. Construction of the minor system will occur as development proceeds (see Figure J-6).

References

City of Lethbridge, West Lethbridge Phase II Area Structure Plan (Armin A. Preiksaitis Ltd. & Associated Engineering, 2005)

City of Lethbridge Design Standards, 2004 Edition (City of Lethbridge, March 2004)

City of Lethbridge, Draft West Lethbridge Lands Development Review (Stantec, March 2004)

City of Lethbridge, Municipal Development Plan (City of Lethbridge, March 2003)

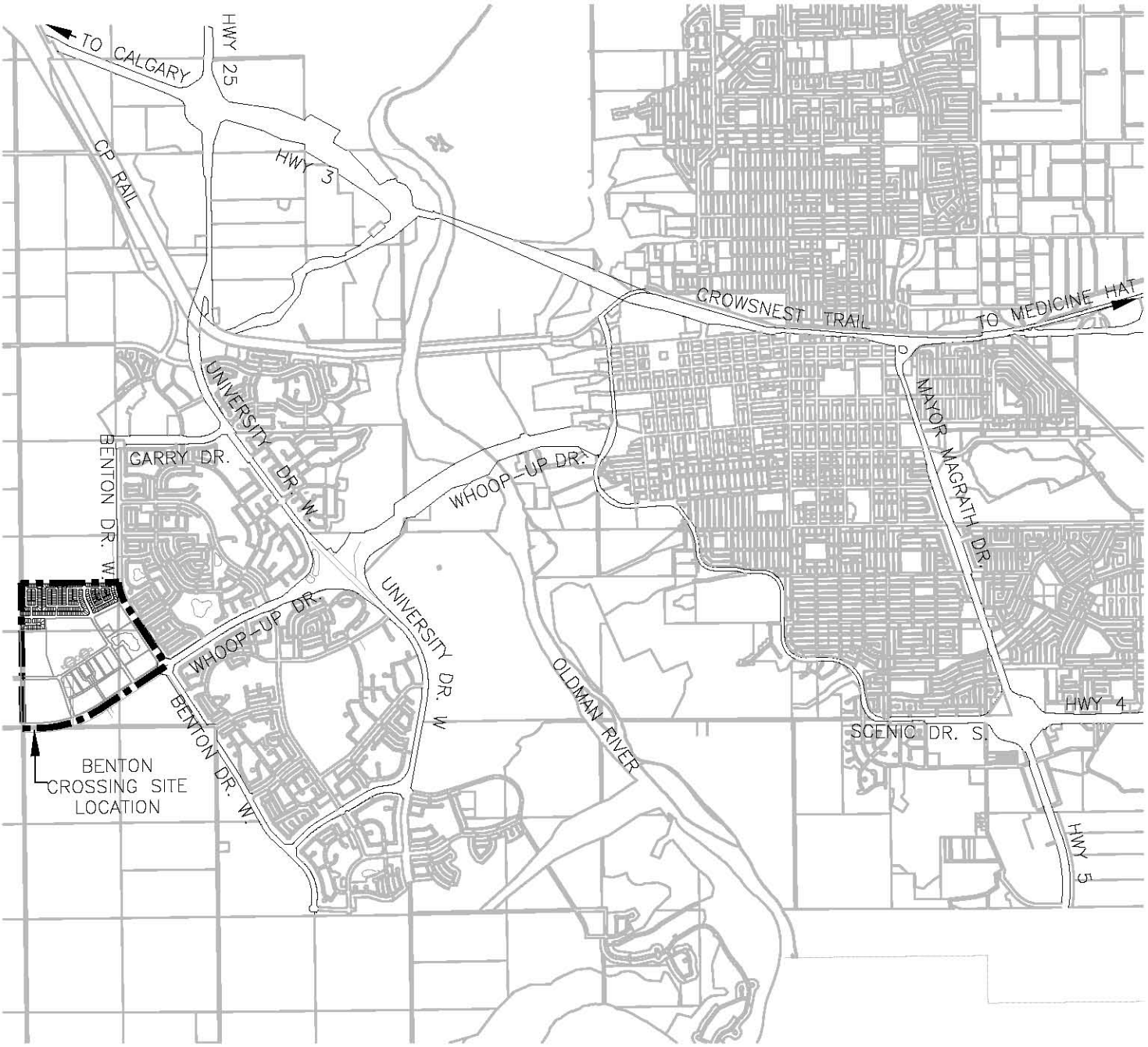
City of Lethbridge, Underground Infrastructure Master Plan (UIMP) Study (Stantec, 2000)

Stormwater Management Guidelines for the Province of Alberta (Alberta Environmental Protection, December 1997)

Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems (Alberta Environmental Protection, December 1997)

City of Lethbridge, Storm Water Management Study (MPE Engineering Ltd. & JNMackenzie Engineering Ltd., December 1988)

A Appendix A - Figures



LEGEND

▬ ▪ ▬ Outline Plan Boundary

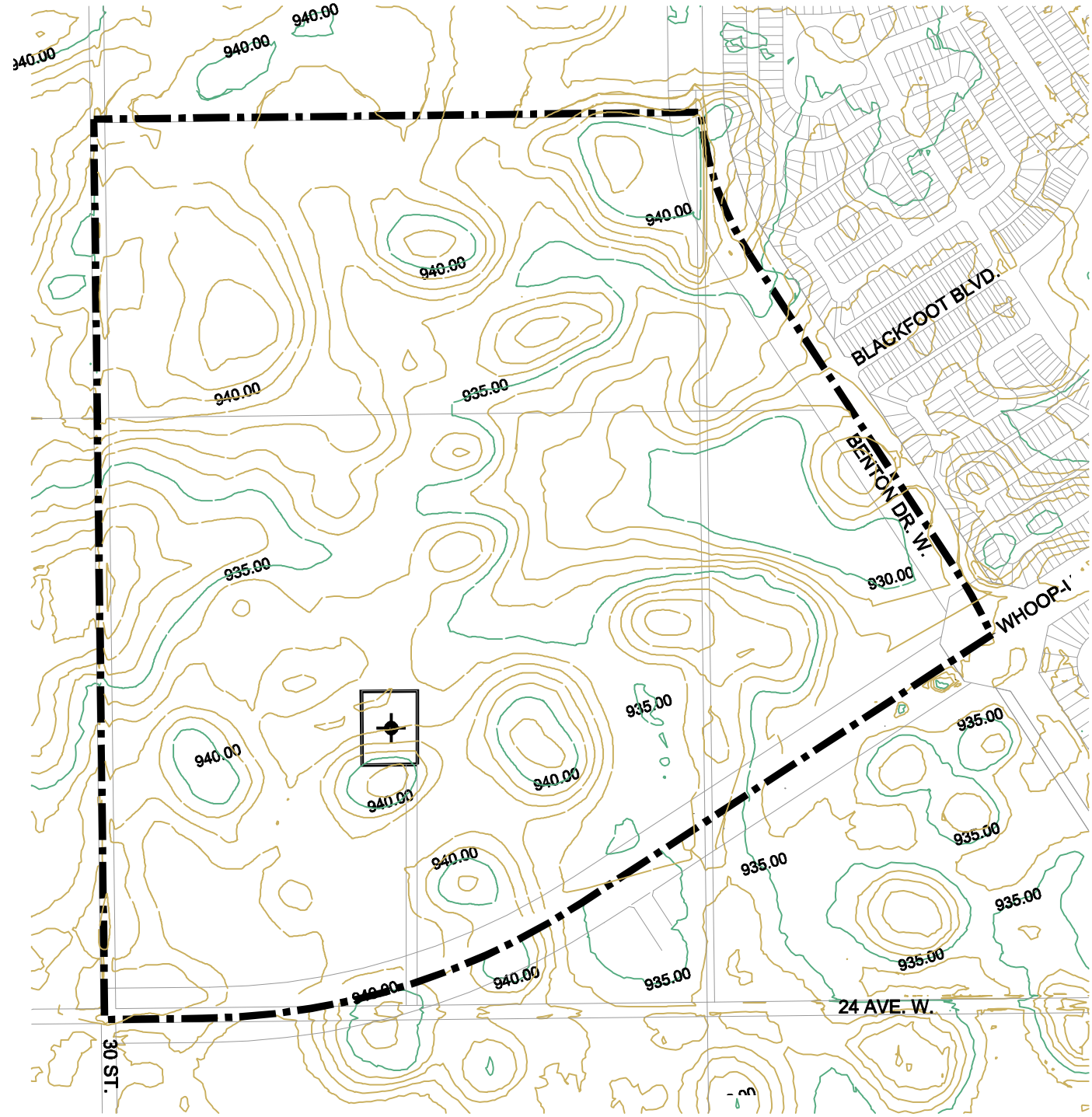
Appendix J-1
Location Plan

Associated Engineering

in association with:
Armin A. Preiksaitis & Associates Ltd.

N

Benton Crossing Outline Plan



LEGEND

Outline Plan Boundary

LEGEND

Outline Plan Boundary

Abandoned Gas Well

940 Countour Major 5.0m Interval

Countour Minor 1.0m Interval

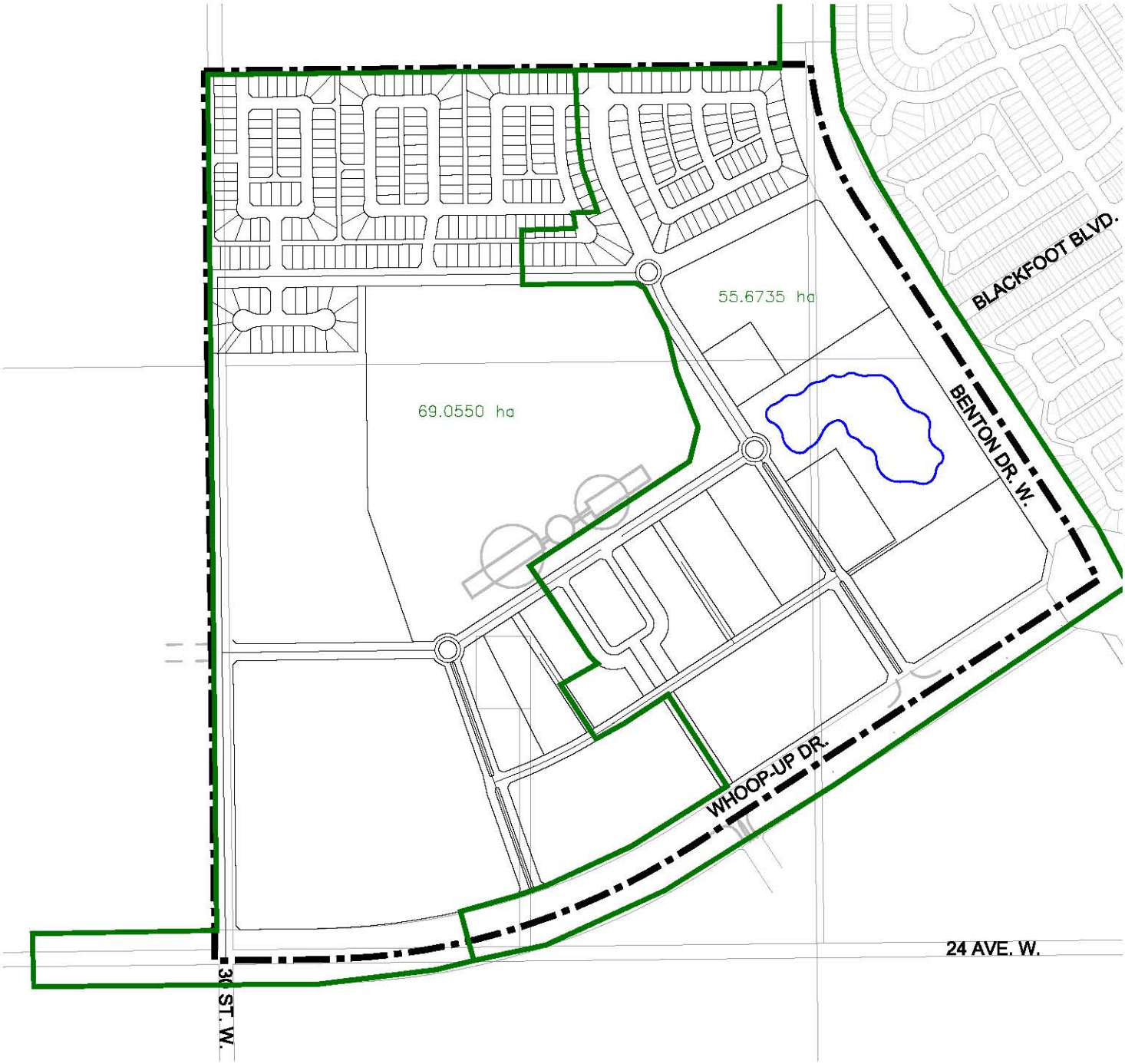
Appendix J-2
Site Plan

Associated Engineering

in association with:
ARMIN A. PREIKSAITIS & ASSOCIATES LTD.

N

Benton Crossing Outline Plan



LEGEND

- Outline Plan Boundary
- Stormwater Catchment Boundary
- Stormwater Management Facility

Appendix J-3
Drainage Catchments

Associated Engineering

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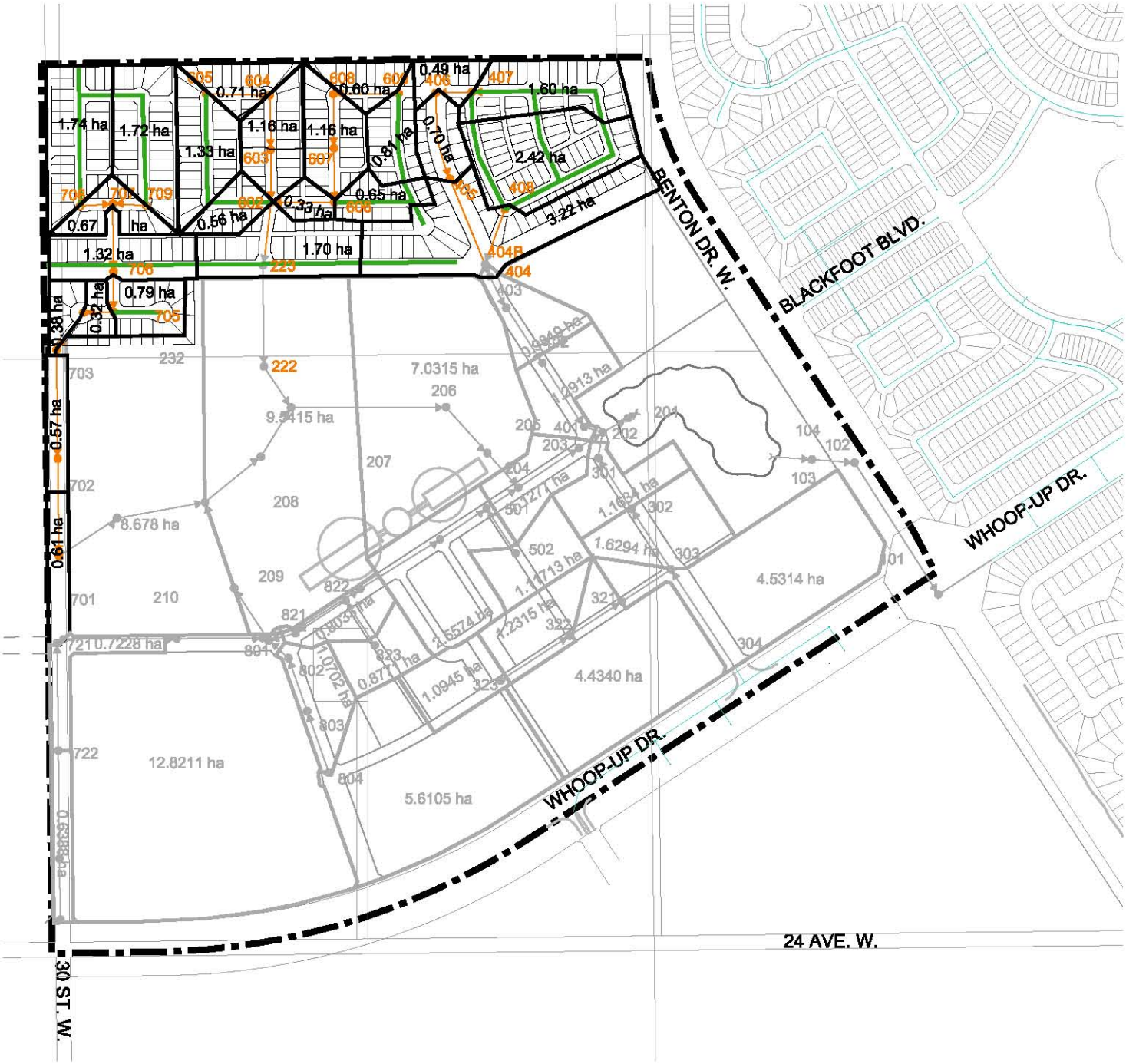
Armin A. Preiksaitis & Associates Ltd.

0 50 100 250 m

N

Benton Crossing Outline Plan



LEGEND

- Outline Plan Boundary
- Existing Storm Sewer
- Proposed Storm Sewer
- Proposed Foundation Drain Collector
- Proposed Pond Release Sewer
- Proposed Storm Manhole & Direction
- 722 — Proposed Manhole Number
- Subcatchment Boundary
- 0.8653 ha — Subcatchment Area

NOTES

1. All proposed storm sewers are 300mm unless otherwise indicated
2. Minor system flows from Benton Dr. and Whoop-up Dr. were not included in sewer size analysis. Some sewers may need to be upsized to accomodate this additional flow.

Appendix J-4
Minor Storm System Subcatchments

Associated Engineering

in association with:
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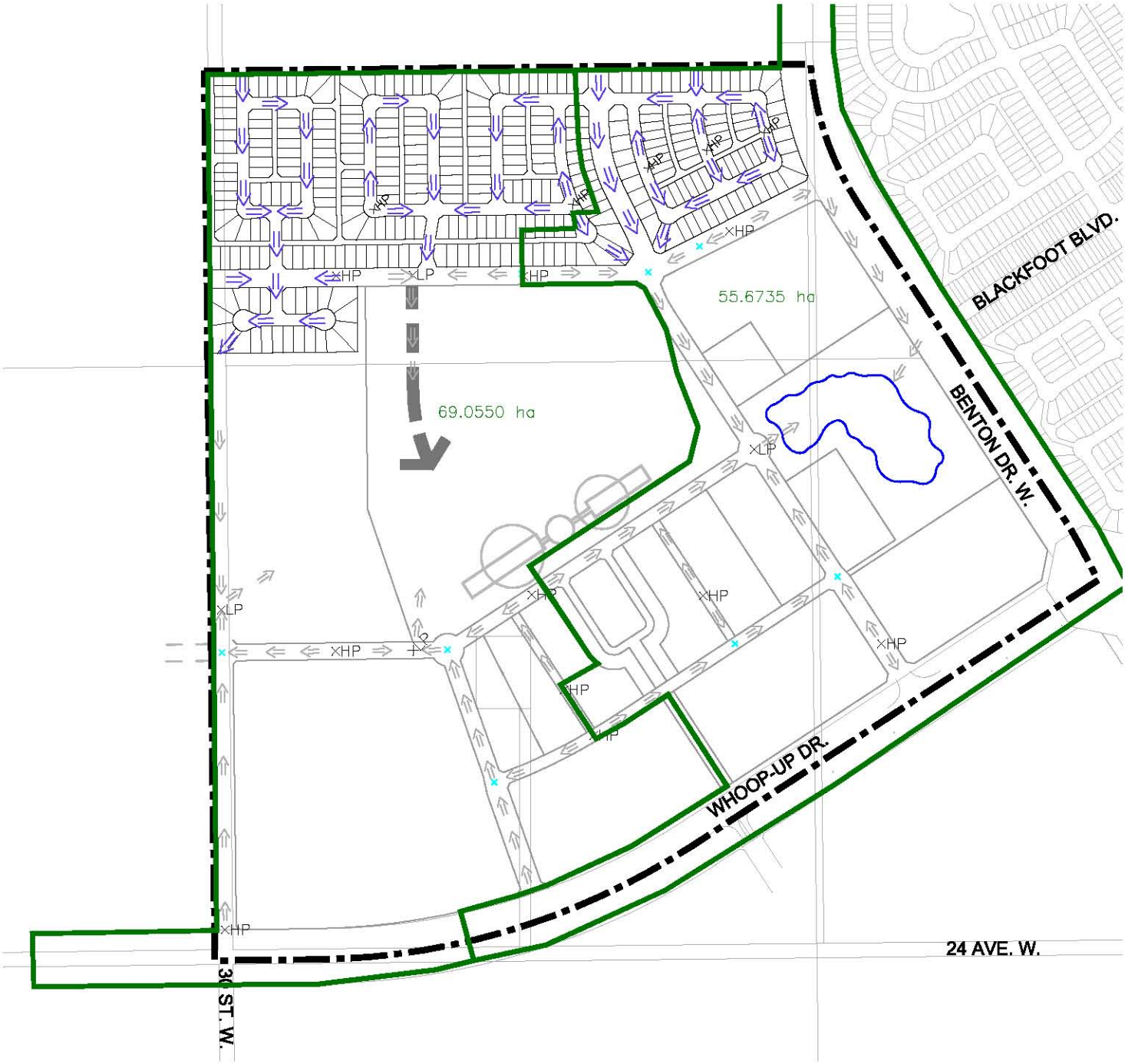
N

Benton Crossing Outline Plan



LEGEND

- Outline Plan Boundary
- Stormwater Catchment Boundary
- Stormwater Management Facility
- Overland Flow Direction
- XHP × XLP Point of Vertical Intersection

NOTES

1. Grading and overland flow directions are conceptual

0 50 100 250 m

N

Appendix J-5
Overland Flow Directions

Associated Engineering

in association with:
Armin A. Preiksaitis & Associates Ltd.

Benton Crossing Outline Plan

LEGEND

	Outline Plan Boundary		Existing Storm Sewer
1	Phase 1		Proposed Storm Sewer Phase 1
2	Phase 2		Proposed Storm Sewer Phase 2
3	Phase 3		Proposed Storm Sewer Phase 3
4	Phase 4		Proposed Storm Sewer Phase 4
5	Phase 5		Proposed Storm Sewer Phase 5
6	Phase 6		Proposed Storm Sewer Phase 6
7	Phase 7		Proposed Storm Sewer Phase 7
8	Phase 8		Proposed Storm Sewer Phase 8
9	Phase 9		Proposed Storm Sewer Phase 9

J-6
Minor Stormwater Staging

Associated Engineering

in association with:
Armin A. Preiksaitis & Associates Ltd.

Benton Crossing Outline Plan

0 50 100 250 m

N

B Appendix B - Model Files

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*#  Date        : Sept 2008
*#  Modeller    : CW
*#  Company     : Associated Engineering Alberta Ltd.,
*#  License #   :  4956681
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*# Determination of active storage volumes at ponds in OPA during the
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*# to (near) zero.
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      StormWater Management HYdrologic Model          999    999  =========

 ********************************************************************************
 ************************** SWMHYMO-99 Ver/4.02 *********************************
 *******  A single event and continuous hydrologic simulation model  ********
 *******     based on the principles of HYMO and its successors      ********
 *******                 OTTHYMO-83 and OTTHYMO-89.                  ********
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 ********************************************************************************
 *******          ++++++ PROGRAM ARRAY DIMENSIONS ++++++              ********
 *******          Maximum value for ID numbers  :     10             ********
 *******          Max. number of rainfall points:  15000             ********
 *******          Max. number of flow points    :  15000             ********
 ********************************************************************************


 *********************   D E T A I L E D   O U T P U T   ********************
 ********************************************************************************
 *       DATE: 2008-09-04      TIME: 08:37:48      RUN COUNTER: 000073        *
 ********************************************************************************
 * Input   filename: Z:\TEMP\opa2008.dat                                        *
 * Output  filename: Z:\TEMP\opa2008.out                                        *
 * Summary filename: Z:\TEMP\opa2008.sum                                        *
 * User comments:                                                               *
 * 1:_____________________________________________________________________      *
 * 2:_____________________________________________________________________      *
 * 3:_____________________________________________________________________      *
 ********************************************************************************

--------------------------------------------------------------------------------
001:0001----------------------------------------------------------------------
*#*****************************************************************************
*#  Project Name: West Lethbridge Outline Plan Area    Project Number:05-3769
*#  Date        : Sept 2008
*#  Modeller    : CW
*#  Company     : Associated Engineering Alberta Ltd.,
*#  License #   :  4956681
*#*****************************************************************************
--------------------
| START            |  Project  dir.: Z:\TEMP\

--------------------  Rainfall dir.: Z:\TEMP\

    TZERO =    .00 hrs on        0
```

METOUT= 2 (output = METRIC)
NRUN = 001
NSTORM= 0

001:0002----------

*#**********

*#

*# Determination of active storage volumes at ponds in OPA during the
*# 1:100 year event. Maximum discharge rate from ponds are set equal
*# to (near) zero.

*#

*#**********

*# 1:100 CHICAGO DESIGN STORM (LETHBRIDGE IDF)

*#

| CHICAGO STORM |
| Ptotal=109.86 mm |

IDF curve parameters: A=2067.450
B= 7.067
C= .840
used in: INTENSITY = A / (t + B)^C

Duration of storm = 24.00 hrs
Storm time step = 5.00 min
Time to peak ratio = .30

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.08	.763	6.08	4.159	12.08	2.205	18.08	1.089
.17	.771	6.17	4.496	12.17	2.172	18.17	1.082
.25	.779	6.25	4.897	12.25	2.140	18.25	1.075
.33	.787	6.33	5.383	12.33	2.109	18.33	1.068
.42	.796	6.42	5.985	12.42	2.079	18.42	1.061
.50	.804	6.50	6.748	12.50	2.050	18.50	1.055
.58	.813	6.58	7.750	12.58	2.021	18.58	1.048
.67	.822	6.67	9.123	12.67	1.994	18.67	1.041
.75	.831	6.75	11.117	12.75	1.967	18.75	1.035
.83	.841	6.83	14.266	12.83	1.941	18.83	1.028
.92	.851	6.92	19.931	12.92	1.916	18.92	1.022
1.00	.861	7.00	32.779	13.00	1.892	19.00	1.016
1.08	.871	7.08	83.515	13.08	1.868	19.08	1.010
1.17	.881	7.17	255.206	13.17	1.845	19.17	1.004
1.25	.892	7.25	114.934	13.25	1.822	19.25	.998
1.33	.903	7.33	63.946	13.33	1.800	19.33	.992
1.42	.914	7.42	43.017	13.42	1.779	19.42	.986
1.50	.926	7.50	31.998	13.50	1.758	19.50	.980
1.58	.938	7.58	25.321	13.58	1.738	19.58	.974
1.67	.950	7.67	20.889	13.67	1.718	19.67	.969
1.75	.963	7.75	17.754	13.75	1.699	19.75	.963
1.83	.976	7.83	15.429	13.83	1.680	19.83	.958
1.92	.990	7.92	13.641	13.92	1.661	19.92	.952
2.00	1.004	8.00	12.226	14.00	1.643	20.00	.947
2.08	1.018	8.08	11.080	14.08	1.626	20.08	.942
2.17	1.033	8.17	10.134	14.17	1.609	20.17	.936
2.25	1.048	8.25	9.340	14.25	1.592	20.25	.931
2.33	1.064	8.33	8.665	14.33	1.576	20.33	.926
2.42	1.080	8.42	8.083	14.42	1.560	20.42	.921
2.50	1.097	8.50	7.577	14.50	1.544	20.50	.916
2.58	1.114	8.58	7.133	14.58	1.529	20.58	.911
2.67	1.132	8.67	6.740	14.67	1.514	20.67	.906
2.75	1.151	8.75	6.390	14.75	1.499	20.75	.901
2.83	1.170	8.83	6.077	14.83	1.485	20.83	.897
2.92	1.191	8.92	5.794	14.92	1.470	20.92	.892
3.00	1.211	9.00	5.538	15.00	1.457	21.00	.887
3.08	1.233	9.08	5.304	15.08	1.443	21.08	.883

3.17	1.256	9.17	5.091	15.17	1.430	21.17	.878
3.25	1.279	9.25	4.895	15.25	1.417	21.25	.874
3.33	1.304	9.33	4.714	15.33	1.404	21.33	.869
3.42	1.329	9.42	4.547	15.42	1.392	21.42	.865
3.50	1.356	9.50	4.392	15.50	1.380	21.50	.861
3.58	1.384	9.58	4.248	15.58	1.368	21.58	.856
3.67	1.413	9.67	4.114	15.67	1.356	21.67	.852
3.75	1.443	9.75	3.989	15.75	1.344	21.75	.848
3.83	1.475	9.83	3.871	15.83	1.333	21.83	.844
3.92	1.509	9.92	3.761	15.92	1.322	21.92	.840
4.00	1.544	10.00	3.657	16.00	1.311	22.00	.835
4.08	1.581	10.08	3.559	16.08	1.300	22.08	.831
4.17	1.620	10.17	3.467	16.17	1.289	22.17	.827
4.25	1.661	10.25	3.380	16.25	1.279	22.25	.823
4.33	1.705	10.33	3.297	16.33	1.269	22.33	.820
4.42	1.751	10.42	3.219	16.42	1.259	22.42	.816
4.50	1.800	10.50	3.144	16.50	1.249	22.50	.812
4.58	1.853	10.58	3.073	16.58	1.239	22.58	.808
4.67	1.908	10.67	3.006	16.67	1.230	22.67	.804
4.75	1.967	10.75	2.941	16.75	1.221	22.75	.801
4.83	2.031	10.83	2.880	16.83	1.211	22.83	.797
4.92	2.099	10.92	2.821	16.92	1.202	22.92	.793
5.00	2.172	11.00	2.765	17.00	1.193	23.00	.790
5.08	2.251	11.08	2.711	17.08	1.185	23.08	.786
5.17	2.337	11.17	2.659	17.17	1.176	23.17	.783
5.25	2.430	11.25	2.610	17.25	1.168	23.25	.779
5.33	2.532	11.33	2.562	17.33	1.159	23.33	.776
5.42	2.643	11.42	2.516	17.42	1.151	23.42	.772
5.50	2.765	11.50	2.472	17.50	1.143	23.50	.769
5.58	2.900	11.58	2.430	17.58	1.135	23.58	.766
5.67	3.051	11.67	2.389	17.67	1.127	23.67	.762
5.75	3.219	11.75	2.350	17.75	1.119	23.75	.759
5.83	3.409	11.83	2.312	17.83	1.112	23.83	.756
5.92	3.625	11.92	2.275	17.92	1.104	23.92	.752
6.00	3.873	12.00	2.240	18.00	1.097	24.00	.749

001:0003----------

*# DRAINAGE CATCHMENT TO WET POND
*#

CALIB STANDHYD	Area (ha)= 55.70
01:001001 DT= 1.00	Total Imp(%)= 57.80 Dir. Conn.(%)= 57.80

		IMPERVIOUS	PERVIOUS (i)	
Surface Area	(ha)=	32.19	23.51	
Dep. Storage	(mm)=	1.60	3.20	
Average Slope	(%)=	2.00	1.00	
Length	(m)=	800.00	20.00	
Mannings n	=	.013	.070	
Max.eff.Inten.	(mm/hr)=	255.21	152.37	
over	(min)	5.00	7.00	
Storage Coeff.	(min)=	4.97 (ii)	7.22 (ii)	
Unit Hyd. Tpeak	(min)=	5.00	7.00	
Unit Hyd. peak	(cms)=	.23	.16	
				TOTALS
PEAK FLOW	(cms)=	15.18	6.52	21.062 (iii)
TIME TO PEAK	(hrs)=	7.22	7.27	7.233
RUNOFF VOLUME	(mm)=	108.24	77.08	95.107
TOTAL RAINFALL	(mm)=	109.86	109.86	109.859
RUNOFF COEFFICIENT	=	.99	.70	.866

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 86.1 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

001:0004

*# ACTIVE STORAGE REQUIRED FOR WET POND
*#

COMPUTE VOLUME ID:01 (001001)		DISCHARGE (cms)	TIME (hrs)
	START CONTROLLING AT	.000	1.850
	INFLOW HYD. PEAKS AT	21.062	7.233
	STOP CONTROLLING AT	.001	24.541

REQUIRED STORAGE VOLUME (ha.m.)= 5.2934
TOTAL HYDROGRAPH VOLUME (ha.m.)= 5.2975
% OF HYDROGRAPH TO STORE = 99.9219

NOTE: Storage was computed to reduce the Inflow
peak to .001 (cms).

001:0005

*# DRAINAGE CATCHMENT TO DRY POND
*#

CALIB STANDHYD | Area (ha)= 69.00
03:000103 DT= 1.00 | Total Imp(%)= 67.50 Dir. Conn.(%)= 67.50

		IMPERVIOUS	PERVIOUS (i)	
Surface Area	(ha)=	46.58	22.42	
Dep. Storage	(mm)=	1.60	3.20	
Average Slope	(%)=	2.00	1.00	
Length	(m)=	900.00	20.00	
Mannings n	=	.013	.070	
Max.eff.Inten.(mm/hr)=		255.21	154.07	
over (min)		5.00	8.00	
Storage Coeff. (min)=		5.33 (ii)	7.58 (ii)	
Unit Hyd. Tpeak (min)=		5.00	8.00	
Unit Hyd. peak (cms)=		.22	.15	
				TOTALS
PEAK FLOW	(cms)=	21.41	6.43	26.904 (iii)
TIME TO PEAK	(hrs)=	7.22	7.28	7.233
RUNOFF VOLUME	(mm)=	108.25	80.83	99.351
TOTAL RAINFALL	(mm)=	109.86	109.86	109.859
RUNOFF COEFFICIENT	=	.99	.74	.904

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 88.2 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

001:0006

*# ACTIVE STORAGE REQUIRED FOR DRY POND
*#

```
| COMPUTE VOLUME    |
| ID:03  (000103)   |                DISCHARGE       TIME
--------------------                  (cms)        (hrs)
           START CONTROLLING AT        .000        1.850
           INFLOW HYD. PEAKS AT      26.904        7.233
           STOP  CONTROLLING AT        .001       24.581

           REQUIRED STORAGE VOLUME (ha.m.)=     6.8511
           TOTAL HYDROGRAPH VOLUME (ha.m.)=     6.8553
           % OF HYDROGRAPH TO STORE       =    99.9394

           NOTE:  Storage was computed to reduce the Inflow
                  peak to      .001  (cms).

-------------------------------------------------------------------------------
001:0007---------------------------------------------------------------------
      FINISH
-------------------------------------------------------------------------------
*******************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2008-09-04     at 08:37:50
===============================================================================
```

C Appendix C - Rational Formula Analysis

Minor Pipe Design - Dry Pond Catchment Area (Revised for Low Density Residential Area Only, North of Caledonia)

Catchment Data								
Manhole	Area (ha)	Runoff Coef	Incr. A*C	Cum. A*C	Incr. tc (min)	Cum. tc (min)	Intensity (mm/hr)	Flow (L/s)
804	5.611	0.8	4.4884	4.4884	10.00	10.00	89.52	1116.2
803	0.000	0.8	0	4.4884	0.75	10.75	86.18	1074.5
802	1.070	0.8	0.85616	5.34456	0.66	11.42	83.47	1239.2
801	0	0	0	5.34456	0.34	11.76	82.15	1219.7
823	0.877	0.8	0.70168	0.70168	10.00	10.00	89.52	174.5
822	0.000	0.8	0	0.70168	1.04	11.04	84.99	165.7
821	0.803	0.8	0.64264	1.34432	1.08	12.12	80.80	301.7
801	0	0	0	1.34432	0.52	12.64	78.94	294.8
801	13.203	0.8	10.56216	17.25104	12.64	12.64	78.94	3782.7
209	0	0	0	17.25104	0.60	13.24	76.91	3685.4
709	1.724	0.4	0.689416	0.689416	10.00	10.00	89.52	171.4
707	0.000	0.4	0	0.689416	0.59	10.59	86.88	166.4
708	1.742	0.4	0.696896	0.696896	10.00	10.00	89.52	173.3
707	0.000	0.4	0	0.696896	0.57	10.57	86.99	168.4
707	0.677	0.4	0.27084	1.657152	10.00	10.00	89.52	412.1
706	1.324	0.4	0.529544	2.186696	0.97	10.97	85.29	518.1
705	0.793	0.4	0.317128	2.503824	0.55	11.52	83.07	577.8

Sewer Data										
Upstream Manhole	Downstream Manhole	Length (m)	Nominal Pipe Size (mm)	Pipe ID (mm)	Material	Slope (m/m)	n	Capacity (L/s)	Velocity (m/s)	Time in Pipe (min)
804	803	91	900	900	Conc	0.005	0.013	1280.1	2.01	0.75
803	802	80	900	900	Conc	0.005	0.013	1280.1	2.01	0.66
802	801	41	900	900	Conc	0.005	0.013	1280.1	2.01	0.34
823	822	79	450	450	Conc	0.005	0.013	201.6	1.27	1.04
822	821	82	450	450	Conc	0.005	0.013	201.6	1.27	1.08
821	801	44	525	525	Conc	0.005	0.013	304.1	1.40	0.52
801	209	95	1350	1350	Conc	0.005	0.013	3774.1	2.64	0.60
709	707	45	450	450	Conc	0.005	0.013	201.6	1.27	0.59
708	707	43	450	450	Conc	0.005	0.013	201.6	1.27	0.57
707	706	89	600	600	Conc	0.005	0.013	434.2	1.54	0.97
706	705	55	675	675	Conc	0.005	0.013	594.4	1.66	0.55

Minor Pipe Design - Dry Pond Catchment Area (Revised for Low Density Residential Area Only, North of Caledonia)

Catchment Data								
Manhole	Area (ha)	Runoff Coef	Incr. A*C	Cum. A*C	Incr. tc (min)	Cum. tc (min)	Intensity (mm/hr)	Flow (L/s)
704	0.315	0.4	0.126192	2.630016	0.46	11.98	81.31	594.0
703	0.382	0.4	0.15284	2.782856	0.64	12.62	79.00	610.7
702	0.570	0.8	0.456	3.238856	1.40	14.02	74.42	669.6
701	0	0	0	3.238856	1.38	15.41	70.46	633.9
722	0.634	0.8	0.50696	0.50696	10.00	10.00	89.52	126.1
721	1.134	0.8	0.9068	1.41376	1.96	11.96	81.39	319.6
701	0	0	0	1.41376	0.72	12.68	78.81	309.5
701	0.644	0.8	0.5152	5.167816	15.41	15.41	70.46	1011.4
210	0.000	0.8	0	5.167816	1.13	16.54	67.54	969.6
209	0	0	0	5.167816	1.04	17.58	65.11	934.7
209	8.963	0.4	3.58516	26.00402	17.58	17.58	65.11	4703.2
208	0.000	0.4	0	26.00402	0.67	18.25	63.63	4596.6
207	9.524	0.4	3.80948	29.8135	0.81	19.06	61.96	5131.1
206	0.000	0	0	29.8135	0.72	19.78	60.55	5014.1
605	1.334	0.4	0.533468	0.533468	10.00	10.00	89.52	132.7
604	0.705	0.4	0.282156	0.815624	1.25	11.25	84.14	190.6
603	1.156	0.4	0.462592	1.278216	0.93	12.18	80.56	286.1
602	0	0	0	1.278216	1.02	13.20	77.03	273.5

Sewer Data											
Upstream Manhole	Downstream Manhole	Length (m)	Nominal Pipe Size (mm)	Pipe ID (mm)	Material	Slope (m/m)	n	Capacity (L/s)	Velocity (m/s)	Time in Pipe (min)
705	704	46	675	675	Conc	0.005	0.013	594.4	1.66	0.46
704	703	64	675	675	Conc	0.005	0.013	594.4	1.66	0.64
703	702	150	750	750	Conc	0.005	0.013	787.2	1.78	1.40
702	701	148	750	750	Conc	0.005	0.013	787.2	1.78	1.38
722	721	149	450	450	Conc	0.005	0.013	201.6	1.27	1.96
721	701	66	600	600	Conc	0.005	0.013	434.2	1.54	0.72
701	210	137	900	900	Conc	0.005	0.013	1280.1	2.01	1.13
210	209	125	900	900	Conc	0.005	0.013	1280.1	2.01	1.04
209	208	114	1500	1500	Conc	0.005	0.013	4998.4	2.83	0.67
208	207	137	1500	1500	Conc	0.005	0.013	4998.4	2.83	0.81
208	206	122	1500	1500	Conc	0.005	0.013	4998.4	2.83	0.72
605	604	95	450	450	Conc	0.005	0.013	201.6	1.27	1.25
604	603	71	450	450	Conc	0.005	0.013	201.6	1.27	0.93
603	602	86	525	525	Conc	0.005	0.013	304.1	1.40	1.02

Minor Pipe Design - Dry Pond Catchment Area (Revised for Low Density Residential Area Only, North of Caledonia)

Catchment Data								
Manhole	Area (ha)	Runoff Coef	Incr. A*C	Cum. A*C	Incr. tc (min)	Cum. tc (min)	Intensity (mm/hr)	Flow (L/s)
609	0.810	0.4	0.324	0.324	10.00	10.00	89.52	80.6
608	0.604	0.4	0.24156	0.56556	1.31	11.31	83.91	131.8
607	0.000	0.4	0	0.56556	0.93	12.24	80.36	126.2
606	1.822	0.4	0.728628	1.294188	1.13	13.37	76.48	274.9
602	0	0	0	1.294188	0.84	14.21	73.85	265.5
602	0.887	0.4	0.354852	2.927256	14.21	14.21	73.85	600.5
223	1.705	0.4	0.681944	3.6092	0.80	15.02	71.53	717.1
222	0.000	0.8	0	3.6092	1.10	16.12	68.60	687.7
221	0.000	0.8	0	3.6092	0.80	15.01	71.56	717.4
206	0	0	0	3.6092	0.66	15.67	69.76	699.3
206	7.032	0.4	2.8126	36.2353	19.78	19.78	60.55	6094.2
205	0	0	0	36.2353	0.75	20.53	59.14	5953.1

Sewer Data										
Upstream Manhole	Downstream Manhole	Length (m)	Nominal Pipe Size (mm)	Pipe ID (mm)	Material	Slope (m/m)	n	Capacity (L/s)	Velocity (m/s)	Time in Pipe (min)
609	608	88	375	375	Conc	0.005	0.013	124.0	1.12	1.31
608	607	71	450	450	Conc	0.005	0.013	201.6	1.27	0.93
607	606	86	450	450	Conc	0.005	0.013	201.6	1.27	1.13
606	602	71	525	525	Conc	0.005	0.013	304.1	1.40	0.84
602	223	86	750	750	Conc	0.005	0.013	787.2	1.78	0.80
223	222	118	750	750	Conc	0.005	0.013	787.2	1.78	1.10
222	221	85	750	750	Conc	0.005	0.013	787.2	1.78	0.80
221	206	71	750	750	Conc	0.005	0.013	787.2	1.78	0.66
206	205	136	1650	1650	Conc	0.005	0.013	6444.9	3.01	0.75

Runoff Coefficent = 0.8 primarily commercial, institutional, HDR
Runoff Coefficent = 0.4 primarily LDR

Slope = 0.005
unless noted.

Minor Pipe Design - Wet Pond Catchment Area (Revised for Low Density Residential Area Only, North of Caledonia)

Catchment Data									Sewer Data											
Manhole	Area (ha)	Runoff Coef	Incr. A*C	Cum. A*C	Incr. tc (min)	Cum. tc (min)	Intensity (mm/hr)	Flow (L/s)	Upstream Manhole	Downstream Manhole	Length (m)	Nominal Pipe Size (mm)	Pipe ID (mm)	Material	Slope (m/m)	n	Capacity (L/s)	Velocity (m/s)	Time in Pipe (min)
408	2.423	0.4	0.969212	0.969212	10.00	10.00	89.52	241.0											
									408	404B	63	525	525	Conc	0.005	0.013	304.1	1.40	0.75
404B	0.000	0.4	0	0.969212	0.75	10.75	86.21	232.1											
407	1.605	0.4	0.641824	0.641824	10.00	10.00	89.52	159.6											
									407	406	34	450	450	Conc	0.005	0.013	201.6	1.27	0.45
406	0.492	0.4	0.196796	0.83862	0.45	10.45	87.51	203.9											
									406	405	132	525	525	Conc	0.005	0.013	304.1	1.40	1.57
405	0.701	0.4	0.280216	1.118836	1.57	12.01	81.19	252.3											
									405	404B	105	525	525	Conc	0.005	0.013	304.1	1.40	1.25
404B	0	0	0	1.118836	1.25	13.26	76.84	238.8											
404B	0.000	0.4	0	2.088048	13.26	13.26	76.84	445.7											
									404B	404	21	750	750	Conc	0.005	0.013	787.2	1.78	0.20
404	3.221	0.4	1.28854	3.376588	0.20	13.46	76.21	714.8											
									404	403	53	750	750	Conc	0.005	0.013	787.2	1.78	0.50
403	0.949	0.4	0.37948	3.756068	0.50	13.95	74.65	778.9											
									403	402	131	750	750	Conc	0.005	0.013	787.2	1.78	1.23
402	0.982	0.8	0.78552	4.541588	1.23	15.18	71.09	896.9											
									402	401	112	750	750	Conc	0.005	0.013	787.2	1.78	1.05
401	1.291	0.8	1.03304	5.574628	1.05	16.22	68.34	1058.2											
									401	202	32	900	900	Conc	0.005	0.013	1280.1	2.01	0.27
202	0	0	0	5.574628	0.27	16.49	67.68	1048.0											
304	0.000	0.8	0	0	10.00	10.00	89.52	1510.0	A											
									304	303	141	1200	1200	Conc	0.005	0.013	2756.8	2.44	0.96
303	0	0	0	0	0.96	10.96	85.30	0.0											
323	1.095	0.8	0.8756	0.8756	10.00	10.00	89.52	217.7											
									323	322	118	525	525	Conc	0.005	0.013	304.1	1.40	1.40
322	1.232	0.8	0.9852	1.8608	1.40	11.40	83.54	431.8											
									322	321	81	600	600	Conc	0.005	0.013	434.2	1.54	0.88
321	4.434	0.8	3.54712	5.40792	0.88	12.28	80.21	1205.0											
									321	303	86	900	900	Conc	0.005	0.013	1280.1	2.01	0.71
303	0	0	0	5.40792	0.71	12.99	77.73	1167.7											
303	4.531	0.8	3.62504	9.03296	12.99	12.99	77.73	3460.4											

Minor Pipe Design - Wet Pond Catchment Area (Revised for Low Density Residential Area Only, North of Caledonia)

Catchment Data									Sewer Data										
Manhole	Area (ha)	Runoff Coef	Incr. A*C	Cum. A*C	Incr. tc (min)	Cum. tc (min)	Intensity (mm/hr)	Flow (L/s)	Upstream Manhole	Downstream Manhole	Length (m)	Nominal Pipe Size (mm)	Pipe ID (mm)	Material	Slope (m/m)	n	Capacity (L/s)	Velocity (m/s)	Time in Pipe (min)
									303	302	103	1350	1350	Conc	0.005	0.013	3774.1	2.64	0.65
302	1.629	0.8	1.30352	10.33648	0.65	13.64	75.61	3681.0											
									302	301	84	1350	1350	Conc	0.005	0.013	3774.1	2.64	0.53
301	1.163	0.8	0.93072	11.2672	0.53	14.17	73.97	3825.2											
									301	202	30	1500	1500	Conc	0.005	0.013	4998.4	2.83	0.18
202	0	0	0	11.2672	0.18	14.35	73.45	3808.7											
502	1.171	0.8	0.93704	0.93704	10.00	10.00	89.52	233.0											
									502	501	79	525	525	Conc	0.005	0.013	304.1	1.40	0.94
501	2.557	0.8	2.04592	2.98296	0.94	10.94	85.41	707.7											
									501	204	88	750	750	Conc	0.005	0.013	787.2	1.78	0.82
204	0.000	0.8	0	2.98296	0.82	11.76	82.14	680.6											
									204	203	62	750	750	Conc	0.005	0.013	787.2	1.78	0.58
203	1.128	0.8	0.90216	3.88512	0.58	12.34	79.99	863.3											
									203	202	42	900	900	Conc	0.005	0.013	1280.1	2.01	0.35
202	0	0	0	3.88512	0.35	12.69	78.77	850.1											
202	0.000	0.8	0	20.72695	16.49	16.49	67.68	5406.5											
									202	201	33	1500	1500	Conc	0.006	0.013	5475.5	3.10	0.18
201	0	0	0	20.72695	0.18	16.67	67.24	5381.6											

Runoff Coefficent = 0.8 primarily commercial, institutional, HDR
Runoff Coefficent = 0.4 primarily LDR

slope = 0.005
unless noted.

Note A: The 1:100 year flow from Whoop-Up Drive is expected to be 1.51 m3/s (Whoop-Up Drive Pre-Design Report, May 2005, Stantec).