COULEE VIEW
AREA STUCTURE PLAN

LOT 1 BLOCK 2 PLAN 0210532
AND
LOT 2 BLOCK 2 PLAN 0210532

IN

S.W. ¼ SEC. 14-9-22-W4
AND
S.E. ¼ SEC. 14-9-22-W4

Prepared for: **Mr. Peter Fiorino**

Prepared by: **MARTIN GEOMATIC CONSULTANTS LTD.**

PROJECT 166729CE
April 2018

TABLE OF CONTENTS

TABLE OF FIGURES

APPENDICES

1. INTRODUCTION

a. PURPOSE OF THE PLAN

i. The purpose of the Coulee View Area Structure Plan (ASP) is to provide a comprehensive planning framework for development of the land within the south half of Sec. 14-9-22-W4. The Plan Area is located in Lethbridge County and is shown on **Figure 1.** Prior to consideration of subdividing or re-subdividing a property, Lethbridge County requires preparation of an Area Structure Plan to address all planning issues related thereto. The purpose of this area structure plan is thus to provide all pertinent information to the County and its advisors that will enable development of the subject property.

b. BACKGROUND TO THE AREA STRUCTURE PLAN

i. The subject property containing approximately 111.54 acres (45.14 ha) more or less is proposed for re-zoning from Lethbridge Urban Fringe (LUF) to Grouped Country Residential (GCR). This will allow the development to proceed with subdivision of the area into smaller parcels with a minimum lot size of 2 acres (0.8 ha).

c. THE APPROVAL PROCESS

i. Lethbridge County requires submission of planning documents that are of sufficient detail and clarity to permit comprehensive review by the various agencies, government departments, and utility companies which provide community planning advice to the County.

ii. The plan is submitted for approval according to provincial statutory requirements. This plan will also support a land use reclassification pursuant to Lethbridge County Land Use Bylaw #1404.

iii. The plan should be submitted by Lethbridge County to the City of Lethbridge and to the Town of Coalhurst for comments and verification that the plan adheres to the relevant Intermunicipal Development plans.

d. PLAN PREPARATION

i. PRELIMINARY CONSULTATION

(a) Prior to commencing the preparation of the area structure plan document, Martin Geomatic Consultants Ltd. (MGCL) had discussions and met with:

- (i) the landowner of the proposed plan area,
- (ii) Lethbridge County staffs,
- (iii) Alberta Environment and Parks staff,
- (iv) Lethbridge North County Potable Water Co-op,
- (v) Alberta Transportation staff,
- (vi) Fortis Alberta,
- (vii) Lethbridge Northern Irrigation District,
- (viii) ATCO Gas,
- (ix) Shaw Cable,
- (x) Telus Communications.

e. LEGISLATIVE FRAMEWORK

i. THE MUNICIPAL GOVERNMENT ACT

(a) The Coulee View Area Structure Plan has been produced in accordance with Section 633 of the Municipal Government Act. It is the intention of this plan to create a framework for the development of a portion of S. ½ Sec. 14-9-22-W4 into Grouped Country Residential classified area.

ii. THE SOUTH SASKATCHEWAN REGIONAL PLAN

(a) The Coulee View ASP aims to follow the Alberta Government South Saskatchewan Regional Plan (SSRP) 2014 – 2024, Amended February 2017.

(b) Strategic Outcomes of the SSRP aligned with the Coulee View ASP include: sustainable development wherein economic development takes into account environmental sustainability and social outcomes, conserving and maintaining the benefits of biodiversity, advancing watershed management, promoting efficient use of land, and strengthening communities.

iii. COUNTY MUNICIPAL DEVELOPMENT PLAN

(a) The Coulee View ASP aims to follow the Lethbridge County Municipal Development Plan (MDP) Bylaw No. 1331.

(b) The MDP outlines specific requirements necessary for the creation of an Area Structure Plan which sets the stage for development within Lethbridge County.

(c) Section 6.3.3 of the MDP sets criteria with respect to the development of Grouped Country Residential subdivisions. The plan area is proposed to be re-designated from Lethbridge Urban Fringe to Grouped Country Residential after having met these criteria.

(d) Section 6.9.2 of the MDP identifies eight distinct Special Planning Areas (SPAs). The Coulee View ASP plan area is located in SPA Area A which supports GCR parcels along the Oldman River Valley.

iv. COUNTY LAND USE BYLAW

(a) The Grouped Country Residential Land Use District (GCR) is intended to provide for a high quality clustered residential development in areas where no conflict to agriculture can be anticipated pursuant to the municipal development plan.

(b) The minimum lot size is 2 acres (0.8 ha) to facilitate on-site sewage disposal systems.

(c) Additional requirements of the Land Use Bylaw will be noted in subsequent sections of the plan where necessary.

v. INTERMUNICIPAL DEVELOPMENT PLAN (CITY & COUNTY)

(a) The Coulee View ASP aims to follow the City of Lethbridge and Lethbridge County Intermunicipal Development Plan (IDP) City Bylaw No. 6015 & County Bylaw No. 1478.

(b) The plan area falls within the boundaries of IDP Policy Area 2, Sub-Area 3, which allows for opportunities of rezoning and subdivision for Grouped Country Residential.

(c) The plan area falls within the boundaries of the IDP Highway Corridor along Highway 25, which identifies a visual appeal and attractiveness of the development.

vi. INTERMUNICIPAL DEVELOPMENT PLAN (COUNTY & TOWN OF COALHURST)

(a) The Coulee View ASP aims to follow the Lethbridge County and Town of Coalhurst Intermunicipal Development Plan (IMDP) County Bylaw No. 1478 & Town Bylaw No. 375-14.

(b) The plan area falls within the boundaries of the IMDP City Interface Area, which recognizes and respects the City & County IDP, and provides that the Town and the County consult and cooperate together on planning strategies with a regional perspective.

f. INTERPRETATION

i. This document shall be referred to as "*The Coulee View Area Structure Plan*".

ii. All terms referred to in this Bylaw shall have the same meaning as in the Municipal Government Act, the Municipal Development Plan or the Land Use Bylaw unless otherwise indicated.

2. THE PLAN AREA

a. LOCATION AND DEFINITION OF PLAN AREA

i. The plan area is located in Lethbridge County within S. ½ Sec. 14-9-22-W4. It is approximately 1.4 km driving distance north of the City of Lethbridge boundary at Highway 3, and 2.7 km driving distance southeast of the Town of Coalhurst boundary. It is bordered on the north by existing farmland; on the east by an existing Government Road Allowance, on the south by Township Road 92, and on the west by an acreage bordering Highway 25 *(refer to **Figure 2**)*. The plan area includes two land parcels:

a) Lot 1 Block 2 Plan 021532, 31.33 acres (12.68 ha);

b) And lot 2 Block 2 Plan 0210532, 80.21 acres (32.46 ha).

b. GENERAL PHYSICAL DESCRIPTION

I. The site includes an upland prairie area and a coulee area. The upland prairie area is relatively flat (slopes are in the order of 1%) and drains easterly to the coulee area. The coulee area has relatively steep banks (approaching 35% gradients) with a channel sloping down (about 60 meters deep) to the Oldman River. The upland prairie area offers excellent views of the coulees and river valley.

3. PLAN GOALS AND OBJECTIVES

a. PLAN GOALS

i. The Coulee View Area Structure Plan will respond to the needs, issues and requirements identified by the owners, Lethbridge County as well as those agencies and organizations having an interest in the planning of this area.

ii. The goals of this Area Structure Plan follow the planning policies outlined through the legislative framework.

iii. When adopted by the County Council, this Area Structure Plan will create the framework for subdividing and developing the subject property.

iv. This document will function as the required plan and as such will outline:

(a) proposed land use,
(b) proposed lot layout,
(c) the road access and circulation,
(d) the location of public utilities,
(e) other related matters.

b. PLAN OBJECTIVES

i. The Coulee View Area Structure Plan will adhere to the following objectives:

(a) create lots with a minimum size of 2 acres (0.8 ha),
(b) determine safe development setback distances from the coulees,
(c) institute a storm water management system for the planned development,
(d) utilize potable water from the Lethbridge North County Potable Water Co-op.,
(e) consider road access and circulation for the development,
(f) investigate the suitability of on-site septic systems for wastewater treatment and disposal,
(g) allow for a community irrigation system,
(h) identify electrical, gas, and communications servicing.

4. SITE ANALYSIS

a. SITE CHARACTERISTICS

i. The total plan area is approximately 111.54 acres (45.14 ha), which is comprised of an 80.21 acres (32.46 ha) parcel to the east, and a 31.33 acres (12.68 ha) parcel to the west. Land ownership Certificate's of Titles are included in the attached **Appendix 1**.

- ii. Access to the plan area is from Alberta Highway 25 and Lethbridge County Township Road 92.
- iii. There is an existing 40 mm waterline owned by Lethbridge North County Potable Water Co-op, which runs adjacent to the site to the west of the plan area along Highway 25, which will serve as a drinking water source for the plan area.
- iv. There is an existing dugout at the southwest corner of the site, with irrigation water supplied by Lethbridge Northern Irrigation District (L.N.I.D.),
- v. There is an existing LNID drain line at the north boundary of the plan area, which drains irrigation water through a buried pipeline to the ground surface and flows into the coulee,
- vi. There is an existing 42 mm gas line owned by ATCO Gas, which runs across the site to service the existing dwellings,
- vii. Overhead power follows the Twp. Rd. 92 Road Allowance with a transmission main that crosses the plan area from east to west.
- viii. One existing residential dwelling is located in the plan area which is currently using septic field disposal of wastewater.

b. SOILS

- i. According to the Alberta Soils Information System, the site soils are characterized as a "Lethbridge (LET) Series" soil - "…Orthic Dark Brown Chernozem on medium textured ([loam], [silt-loam]) sediments deposited by wind and water", and "…Orthic Dark Brown Chernozem on medium textured ([loam], [silt-loam], [clay-loam]) materials over medium ([loam], [clay-loam]) or fine [clay] textured till."
- ii. The "Geotechnical Evaluation, Rural Country Residential Subdivision Development, Lethbridge County, Alberta" report prepared by Tetra Tech Canada Inc., December 2017, and January 2018 (refer to the attached **Appendix 2**) indicates:

    (a) Nine (9) boreholes were completed to a depth of 6.6 m, with depth to groundwater varying from 2.6 m to dry. Soil stratigraphy was found to have topsoil underlain by clay fill, native clay, and clay till deposits.
    (b) A slope stability assessment has determined development setback lines ranging from 17 m to 25 m from the top of bank, which is consistent with other residential developments in this region of the Oldman River Valley.
    (c) Recommendations on site development, pavement structures, foundations and stormwater dry pond development are included.

c. TOPOGRAPHY
  i. The site is split in to two distinct areas which are characterized by the natural terrain. The two areas are the coulee area, and the upland area as described below. The boundary between these two areas is defined by the top of bank.
    (a) Coulee area: this high relief landform area includes the undevelopable portion of the site, which forms the western bank of the Oldman river valley. This area is characterized with steep banks (~35% gradient) extending down to a drainage channel that slopes down toward the riparian zone of the Oldman River. The high point at the western edge of this coulee area is at elevation 912.0 m and the low point is at elevation 840.0 m at the eastern limit of the plan boundary.
    (b) Upland area: this high ground area above the top of bank line is relatively flat with the ground sloping at 1 % to 2 % towards the coulee banks. The high point of the upland area is at elevation 920.0 m at the western limit of the plan boundary. The low point is at 900.0 m at the eastern top of bank.

d. WATER AND HYDROLOGY
  i. There are no natural bodies of water within the plan area,
  ii. A natural channel has been formed by erosion over time, which extends from the upland area down to the Oldman River. The channel extends approximately 2 km in length across the site at an average gradient of 8%. The channel is normally dry, and during storm events the runoff water is conveyed along the channel from west to east, and into the Oldman River valley.

iii. A man made dugout exists directly north of Township Road 92 and approximately 200 m east of Highway 25 which is filled by a pipeline owned by the Lethbridge Northern Irrigation District (L.N.I.D.).

e. HABITAT AND VEGETATION

i. Coulee area: the coulee area is a natural habitat that is generally undisturbed by human activity. The Oldman river valley and coulees is a productive habitat corridor for wildlife and native plants. Deer, fox, coyotes, porcupine, rabbit, snakes and many bird species including hawks, owls and bats are commonly seen here. The flora found in the coulee area includes native grasses and shrubs such as northern wheatgrass, western snowberry, saskatoon, creeping juniper, skunkbush, and silver sagebrush. Willow and chokecherry are also found in the lower areas around the channel.

ii. Upland area: The upland area consists mainly of cultivated mixed grasses that produce a hay crop.

f. ENVIRONMENTAL, HISTORICAL AND ARCHAEOLOGICAL SIGNIFICANCE

i. The “Environmentally Significant Areas in the Oldman River Region” report prepared for Lethbridge County indicates that the “Oldman River Lethbridge East” area falls within and adjacent to the plan area, which may include: Diverse valley habitats, large normal bedrock fault, pleistocene geological sections, extensive and productive riparian habitats, rare plant, nesting of rare and threatened birds of prey, great blue heron colony, american white pelican feeding area, and key deer habitat. These environmentally significant coulee areas are to remain mainly undisturbed and will be protected with the creation of an environmental easement on these lands *(refer to* ***Figure 4****)*.

ii. The “Phase 1 Environmental Site Assessment, Plan 0210532, Block 2, Lots 1 & 2, Lethbridge County, Alberta” report prepared by Tetra Tech Canada Inc., December 2017 (refer to the attached **Appendix 3**) indicates:

(a) The site and surrounding area has historically been used for agriculture,

(b) livestock corals may have been used between 1973 and 2005,

(c) a building was constructed on Lot 1 in 2002,

(d) fill material has been observed in three locations and identified as potential sources of environmental impairment,

(e) further action is recommended if adverse sub-soil conditions are encountered during future site development.

iii. The Arrow Archeology Ltd. Historical Resources Statement of Justification (refer to the attached **Appendix 4**) was completed as a provision of the *Historical Resources Act* (HRA) approval. This evaluation found that there is little potential for intact historical resources within the project footprint. Upon Alberta Culture and Tourism's review, it was determined that:

(a) A Historical Resource Impact Assessment (HRIA) is required for the target area (2.3ha) of native prairie above the coulee slopes,

(b) Cultivated or disturbed areas and sloping coulee terrain do not require assessment.

The Developer wishes to secure approval of this ASP prior to completing the HRIA. The HRIA would be done prior to rezoning.

g. EXISTING LAND USE

i. The upland area is mainly used for agriculture, with approximately 23 Ha (57 Ac) of irrigated cropland *(refer to **Figure 3A**)*;

ii. There is a house situated on the eastern portion of the upland area in Lot 1 Block 2 overlooking the river valley. This house is intended to remain in place and is incorporated in the development layout *(refer to **Figure 3B**)*;

iii. Township Road 92 passes along the south side of the site which provides access to the plan area.

iv. An electrical transmission Right-of-way passes through the eastern portion of the plan area which accommodates the high-voltage overhead transmission lines. The transmission lines extend to the west along the Twp-Rd. 92 and to the east across the River Valley.

5. CONSTRAINTS & OPPORTUNITIES

a. CONSTRAINT EVALUATION

i. SOIL CAPABILITY FOR RESIDENTIAL DEVELOPMENT

A geotechnical investigation has been completed to provide the necessary information on the ground and/or sub-surface characteristics that are necessary for determining the general suitability of the proposed development.

ii. TOPOGRAPHY

The gentle slope of the site is well suited to naturally shed overland water from the upland area to the coulee area. Safe setback lines have been determined through the slope stability analysis, with an established distance from the top of bank to the developable area.

iii. TRAFFIC IMPACT & ACCESS CONSIDERATIONS

(a) The plan area is located along Township Road 92, adjacent to Highway 25 and approximately 1.4 km north of Lethbridge City limits.

(b) The “Town of Coalhurst South East Access Collector Road Traffic Impact Assessment, January 25, 2017” report prepared by MPE Engineering Ltd., includes intersection improvements at the intersection of Hwy. 25 and Twp-Rd. 92. These improvements include road widening with the addition of turning lanes and acceleration / deceleration lanes along Hwy. 25.

(c) Discussions with AT have indicated that a Traffic Impact Analysis (TIA) is likely not necessary for the proposed Coulee View development due to its relatively small scale of 15 GCR lots, and the planned intersection improvements at Hwy. 25 & Twp.-Rd.92.

iv. AGRICULTURAL CONSIDERATIONS

(a) The proposed development of the plan area is not likely to constrain any existing agricultural land use surrounding the plan area.

(b) There are two Confined Feeding Operations (CFOs) identified in the vicinity of the plan area, as noted in the County MDP. There is a dairy farm (150 animals) and a beef farm (200 animals) along Twp-Rd. 92 just west of Hwy. 25. The County MDP indicates that CFO’s will be discouraged in this area which is a distinct development node.

v. NATURAL RESOURCE DEVELOPMENT

(a) There is no natural resource development within the vicinity of the plan area which can either restrict or be impacted by the proposed subdivision development.

vi. RIVER VALLEY

(a) The plan area is constrained by the Oldman river valley with steep banks and key wildlife habitat along the coulees.

b. DEVELOPMENT OPPORTUNITIES

i. LOCATION

(a) The proposed development is located within the Lethbridge Urban Fringe area of Lethbridge County, within close proximity to the City of Lethbridge and the Town of Coalhurst where a wide variety of educational, medical, commercial, recreational and community services exist. The paved Provincial Highway 25 provides direct access to the development area.

ii. HOUSING CHOICE

(a) The proposed development provides for a type of residential land use that would allow families to build and live in a community offering rural lifestyle.

iii. LAND USE RE-CLASSIFICATION

(a) A County Land Use Bylaw Amendment will be required to re-designate portions of the plan area. The portion of the area to be developed will be re-designated to Grouped Country Residential (GCR), while the balance of the land will remain as Lethbridge Urban Fringe (LUF). Refer to ***Figure 4*.** Most of the LUF land will be protected with an Environmental Easement (*refer to* ***Figure 6A*** *and* ***Figure 6B*****).**

iv. EASE OF DEVELOPMENT

(a) All of the basic utilities (except for sanitary sewer) are located at or near the site boundary and therefore the servicing and development of the site will be generally simple and efficient.

v. RIVER VALLEY

(a) The river valley offers excellent views from the proposed building sites in the plan area with sightlines extending along the coulees and down to the Oldman River. This area offers a unique development potential with residential lots backing on to the coulees.

6. PROPOSED LAND USE & DESIGN

a. PROPOSED LAND USE

i. A total of 15 lots with a minimum size of 2 acres (0.8 ha) will be created on the proposed development which is proposed to be re-zoned as a Grouped Country Residential, with the balance of land remaining as Lethbridge Urban Fringe as shown on **Figure 4**,

b. DENSITY AND POPULATION

i. The housing density within the proposed development comprises 15 lots or 0.14 units per acre (0.33 units per ha.) of net area (*refer to **Figure 6A** and **Figure 6B***),

ii. Based on an average occupancy of 3 persons per household, the population within the plan area is estimated to be approximately 45 persons.

c. RESERVE REQUIREMENTS

i. MUNICIPAL RESERVE

(a) There is no land within the proposed area structure plan dedicated for municipal reserve. Municipal Reserve will be dedicated as cash-in-lieu to Lethbridge County.

ii. ENVIRONMENTAL

iii. Most of the coulee area will be protected by an environmental easement (*refer to **Figure 6A** and **Figure 6B***).

d. TRANSPORTATION

i. SITE ACCESS AND CIRCULATION

(a) Access into the proposed development area will be on Township Road 92, via Highway 25. A local road is proposed to extend north from Twp-Rd. 92 to a cul-de-sac turnaround, to create access for 9 residential lots. There are 8 residential lots with direct access to the Twp-Rd. 92. There are 2 corner lots with access to both the cul-de-sac road and the Twp-Rd. 92. The proposed cul-de-sac road and upgrade to the existing Twp-Rd. 92 will be designed and constructed to the Lethbridge County Standards (*refer to **Figure 8***).

e. SERVICING

i. POTABLE WATER SUPPLY AND DISTRIBUTION

(a) Domestic Water and Fire Protection Requirement for ASP Area:

- (i) The domestic water requirements for the subdivision will be supplied by the Lethbridge North County Potable Water Coop via extensions from an existing 40mm potable water pipe running parallel along the east side of Hwy. 25. Each lot will be supplied with a trickle system to fill individual cisterns (*refer to* ***Figures 7A & 7B*****)**. The Water Coop has confirmed that there is sufficient capacity available to service the proposed subdivision (refer to the attached **Appendix 5**);
- (ii) Cisterns will be installed in accordance with requirements of the Chinook Health Region and Safety Codes Council of Alberta;
- (iii) A home owners association will be formed to own and maintain the potable water system within the development. The irrigation and potable water will be installed in an easement through the lots in favor of the home owners association.

ii. SEWAGE DISPOSAL

(1) Each lot will have its own on-site wastewater treatment and dispersal system, to be designed and installed by qualified contractors,

(2) As per Alberta Regulations AR229/97 and AR196/2015, the *Alberta Private Sewage Systems Standard of Practice 2015* (the “SOP”) describes the requirements for the design of on-site wastewater treatment and disposal systems.

(3) The “Septic Disposal Field Feasibility Assessment, Proposed Rural Country Residential Subdivision, Plan 0210532, Block 2, Lots 1 & 2, Near Lethbridge, Alberta” report prepared by Tetra Tech Canada Inc., December 2017 (refer to the attached **Appendix 6**) indicates:

- (i) Fourteen (14) test pits were excavated to a depth of 3 m to observe soil profiles and collect samples which found clay, clay loam, sand, silt loam, sandy loam, and sandy clay loam,
- (ii) The majority of soil textures are suitable for septic effluent,

(iii) Restrictive soil layers encountered may require further assessment.

(4) No on-site wastewater management system components shall be installed in areas designated for conveyance or detention of runoff or behind the development setback lines.

iii. STORM WATER MANAGEMENT

Stormwater within the development will be managed such that runoff will be stored on-site and directed to the existing discharge location which is down the coulee channel to the east (*refer to* ***Figure 5***). Post-development runoff will be controlled and released at the pre-development rates, per the Alberta Environment and Parks requirements and the Lethbridge County Engineering Guidelines and Minimum Service Standards. Existing site topography will be utilized to minimize site grading. A brief summary of the existing and proposed drainage systems follows, and a more detailed description of the site drainage is included in the Stormwater Management Plan, which is appended to this document in **Appendix 7**;

(a) EXISTING CONDITION

(i) Runoff from the site presently flows eastward from the cropland in the upland prairie area and enters the coulee draws which drains down to the Oldman river valley. Runoff leaving the property is generally concentrated in the bottom of the coulee draw at the northeast corner of the plan area. A natural channel flows north and east across the adjacent private properties and runs on to the flood plain area of lands located within S.W. ¼ SEC. 13 9-22-W4M, where the flat valley floor extends north and east about 500 m from the coulee toe to the Oldman river.

(ii) The offsite runoff area includes about 15.8 ha (39 acre) of land that presently runs on to and drains across the plan area. This includes 5.5 ha (13.6 acre) from the west and 10.3 ha (25.5 acre) from the north. The runoff from these areas will be planned for and accommodated in the Coulee View Estates stormwater system.

(b) DRAINAGE CONCEPT

- (i) The stormwater management concept is detailed in the attached Stormwater Management Plan,
- (ii) Most of the runoff from the site will drain to a dry pond to detain water on site and then be released at the calculated pre-development levels through a controlled outlet to the existing natural channel, which flows down to the Oldman River,
- (iii) All of the designated drainage conveyance routes and storage facilities will be protected by caveat, easement or right-of-way as required.

(c) SITE GRADING

- (i) The subdivision will be graded to be consistent with the overall Stormwater Management Plan as shown on ***Figure 5***. Individual lots will be graded such that all surface runoff will be directed to perimeter swales designed to carry the stormwater runoff into the stormwater detention facilities and towards the designated outfall. The required size and cross section of these conveyance facilities will be determined during Detailed Design stage.

f. UTILITIES

i. ELECTRICITY

(a) Epcor is the electricity provider for Lethbridge County and the distributor is Fortis Alberta. All necessary applications for the detailed design and installation of electric utilities will be submitted to Fortis for their approval.

ii. NATURAL GAS

(a) Natural gas is available through ATCO Gas. An existing domestic gas line is located within the plan area.

iii. TELECOMMUNICATIONS/CABLE SERVICE

(a) Telus Communications provides telephone and cable service for the area. Cellular phone service is also available.

iv. SOLID WASTE MANAGEMENT

(a) Individual/Private solid waste will be disposed of at local transfer station for the development unless a municipal fee-for-service is available.

v. IRRIGATION

(a) A community irrigation system will provide non-potable water to each lot to be used for watering lawns and gardens. The non-potable water will be supplied by LNID through an existing pipeline feeding the pond located at the entrance of the development. The water will be pumped from the pond through a communal pipeline system with lateral connections supplying each lot. A homeowners association will be formed to own and operate the irrigation system within the development. This ownership will include the pond on lot 16. The irrigation and potable water will be installed in an easement through the lots in favor of the homeowners association. (*Refer to* ***Figures 7A & 7B*****)**.

(b) There is an existing LNID drain line at the north boundary of the plan area. This drain line will be extended across the development to the Environmental Reserve, and be protected by Utility Right of Way.

g. PROTECTIVE SERVICES

i. FIRE PROTECTION

(a) The Town of Coalhurst will be the responding fire station. The Coalhurst fire hall is approximately 5 km from the plan area.

ii. POLICE PROTECTION

(a) Policing in Lethbridge County is provided by the R.C.M.P. which has detachments located in the City of Lethbridge and in Picture Butte. The Lethbridge detachment is approximately 7 km from the plan area and the Picture Butte detachment is approximately 23 km from the plan area.

7. DEVELOPMENT CONTROL

a. Purchasers must apply for development approval according to the process in effect for the appropriate Land Use District in the Lethbridge County Land Use Bylaw # 1404,

b. No cattle will be allowed on the new development,

c. Houses and wastewater treatment and dispersal shall be located outside runoff conveyances and detention areas.

8. DEVELOPMENT AGREEMENT

a. The Developer will enter into a Development Agreement with Lethbridge County regarding the following matters:

   i. Easements for runoff conveyance and detention as per the Stormwater Management Plan,

   ii. Other services or matters considered necessary by Lethbridge County.

9. ARCHITECTURAL CONTROLS

a. Architectural controls that are intended to provide a set of rules to ensure a reasonably high quality development will be utilized in the Coulee View development area and to ensure an appropriate level of housing design compatibility. Architectural control will be administered by the developer or his designate. Typically the controls that will be in effect within Coulee View include the following:

   i. Minimum dwelling unit area and site coverage (building footprint),
   ii. Diversity in home design,
   iii. Incorporation of energy efficiency features,
   iv. Roof pitch & materials,
   v. Exterior finishing materials,
   vi. Fencing materials,
   vii. Minimum landscaping requirements in which xeriscaping will be considered,
   viii. Hobby farm animals such as horses,
   ix. Storage building and vehicle storage.

b. The developer may undertake construction of certain stretches of fencing or installation of certain aspects of landscaping to establish the character of the development.

10. ADJACENT LANDOWNER CONSULTATION

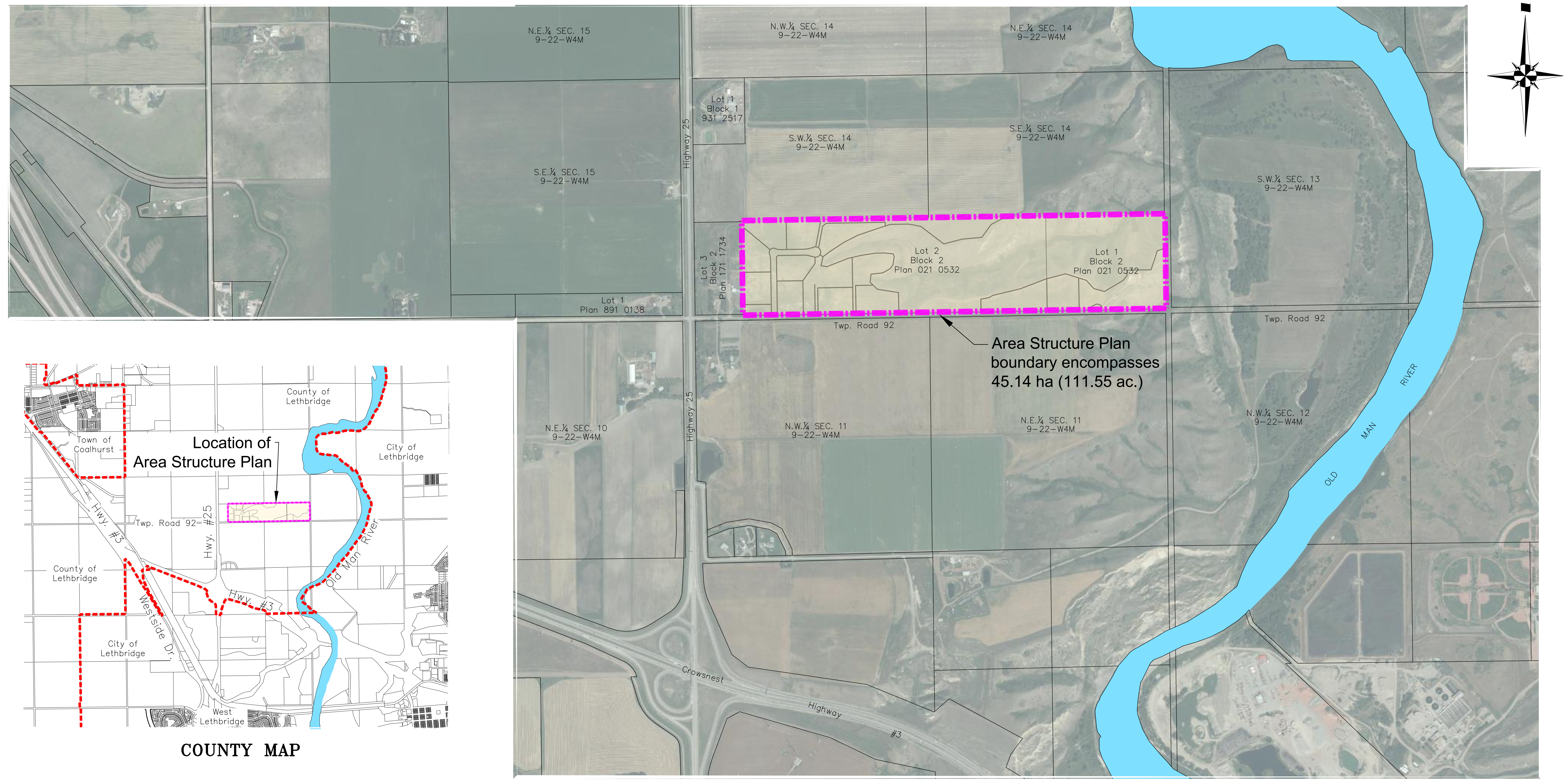
a. At the request of Lethbridge County, the developer and their agents have consulted with the adjacent landowners with respect to the proposed Coulee View ASP. Prior to finalizing the area structure plan document, Martin Geomatic Consultants Ltd. (MGCL) had discussions and met with (refer to the attached **Appendix 8**):

  (i) Peter Zmurchyk, adjacent landowner to the south, Title 121 009 533 & Title 111 262 785 +1,
  (ii) Garry, Larry & Pauline Boychuck, adjacent landowners to the east, Title 121 020 496,
  (iii) Joe Fekete, adjacent landowner to the north, Title 051 308 576,
  (iv) Allan Chell, landowner to the north, Title 141 253 592.

11. IMPLEMENTATION

a. This Area Structure Plan will become a Bylaw of Lethbridge County.
b. All subsequent subdivision applications must adhere to provisions of this A.S.P. Bylaw and the Land Use Bylaw.
c. Subdivision of land can only occur through established provincial (Municipal Government Act and Subdivision Regulation) in conjunction with the Oldman River Regional Services Commission; and municipal processes that will ensure appropriate municipal and environmental reserves are bestowed and that appropriate fees, levies and service agreements are provided.
d. Development applications, within the boundaries of the plan area, must comply with the requirements of the respective land use districts for which they are proposed.
e. Building permits must be reviewed through a safety codes process approved by Lethbridge County.
f. The developer of Coulee View subdivision will establish a level of architectural standards and development limitations in order to achieve the desired results within the proposed subdivision. These standards and limitations are beyond the normal statutory requirements of Lethbridge County and will thus be administered by either the Developers or agents acting on their behalf and within their legal authority.
g. Lethbridge County may utilize other bylaws and policies that will regulate aspects of activity within the boundaries of the Area Structure Plan.
h. Farming on adjacent lands is considered a compatible land use activity in the Lethbridge County and future purchasers will be advised of the types of agricultural activities that take place in the vicinity of Coulee View subdivision.

FIGURES



Area Structure Plan boundary encompasses 45.14 ha (111.55 ac.)

LEGEND

▬ ▪ ▬ DEVELOPMENT BOUNDARY

- - - - CITY / TOWN BOUNDARY

COULEE VIEW AREA STRUCTURE PLAN

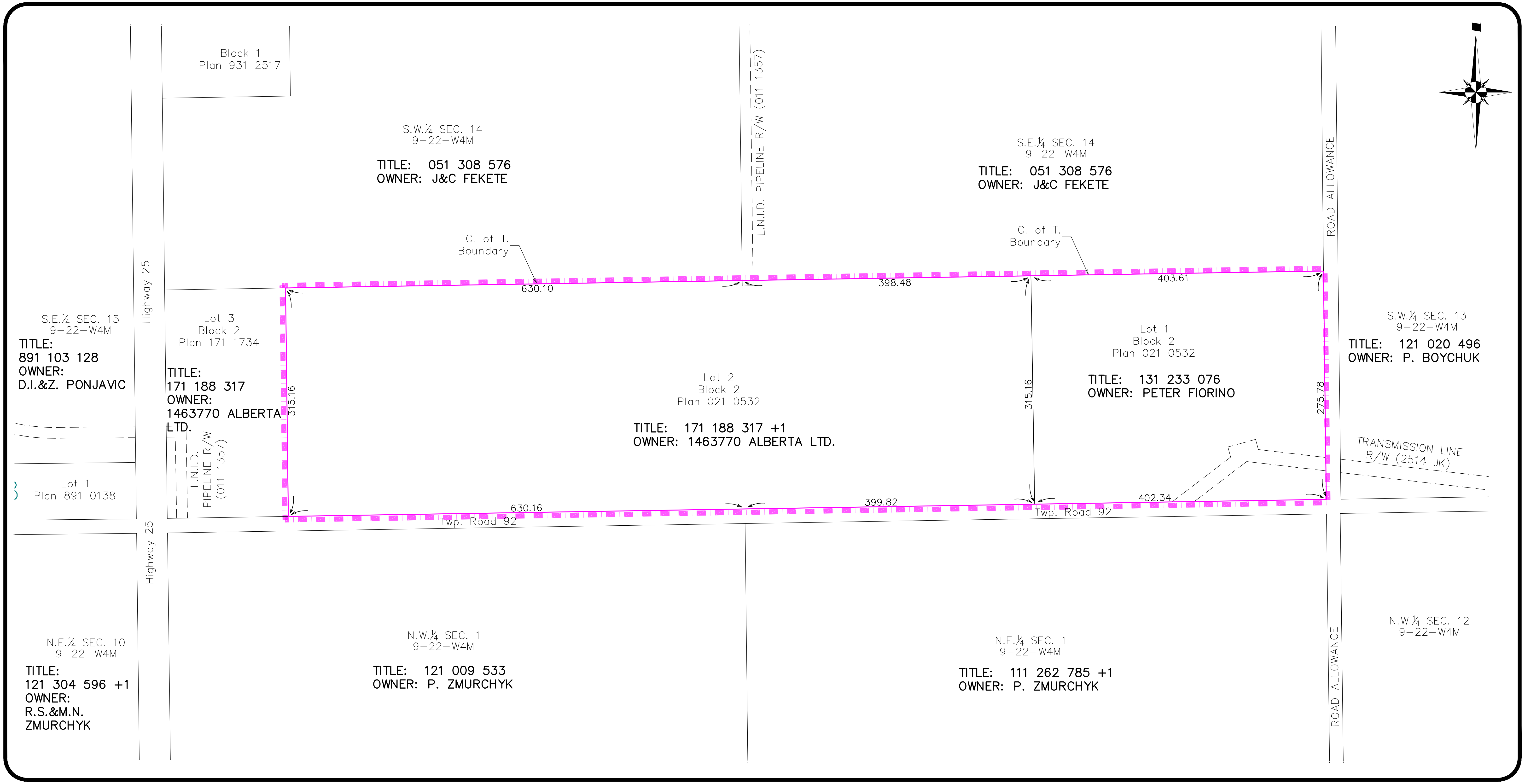
GENERAL LOCATION PLAN

FIGURE 1

MARTIN GEOMATIC CONSULTANTS LTD

SCALE: NOT TO SCALE
DRAWN: RJM
DATE: March 5, 2018
JOB #: 166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce-asp – feb28-2018.dwg



LEGEND

▬ ▬ ▬ DEVELOPMENT BOUNDARY

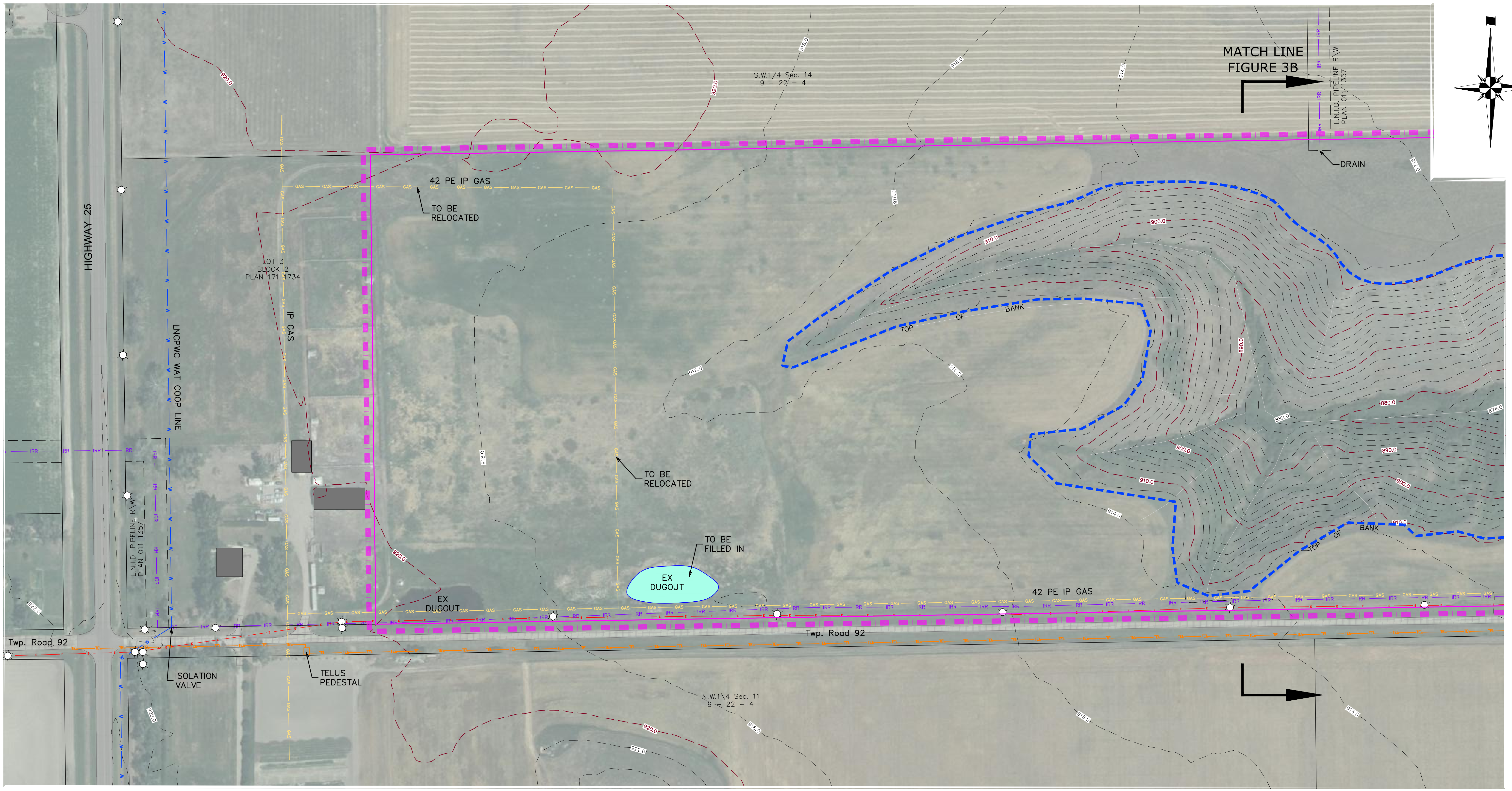
COULEE VIEW AREA STRUCTURE PLAN

LAND OWNERSHIP
FIGURE 2

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE:	1:5000
DRAWN:	RJM
DATE:	March 5, 2018
JOB #:	166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce-asp – feb28-2018.dwg



LEGEND

▬ ▬ ▬	DEVELOPMENT BOUNDARY
– – –	MAJOR CONTOURS (10m INT)
– – –	MINOR CONTOURS (2m INT)
– – –	TOP OF BANK
▨	EXISTING GRAVEL ROAD
▩	EXISTING PAVED ROAD
— E — E —	OVERHEAD ELECTRICAL LINE
— TEL — TEL —	BURIED TELUS CABLE
— GAS —	BURIED GAS LINE
— W — W — W —	WATER COOP LINE
— IRR — IRR — IRR —	IRRIGATION LINE
☼	EXISTING POWER POLE

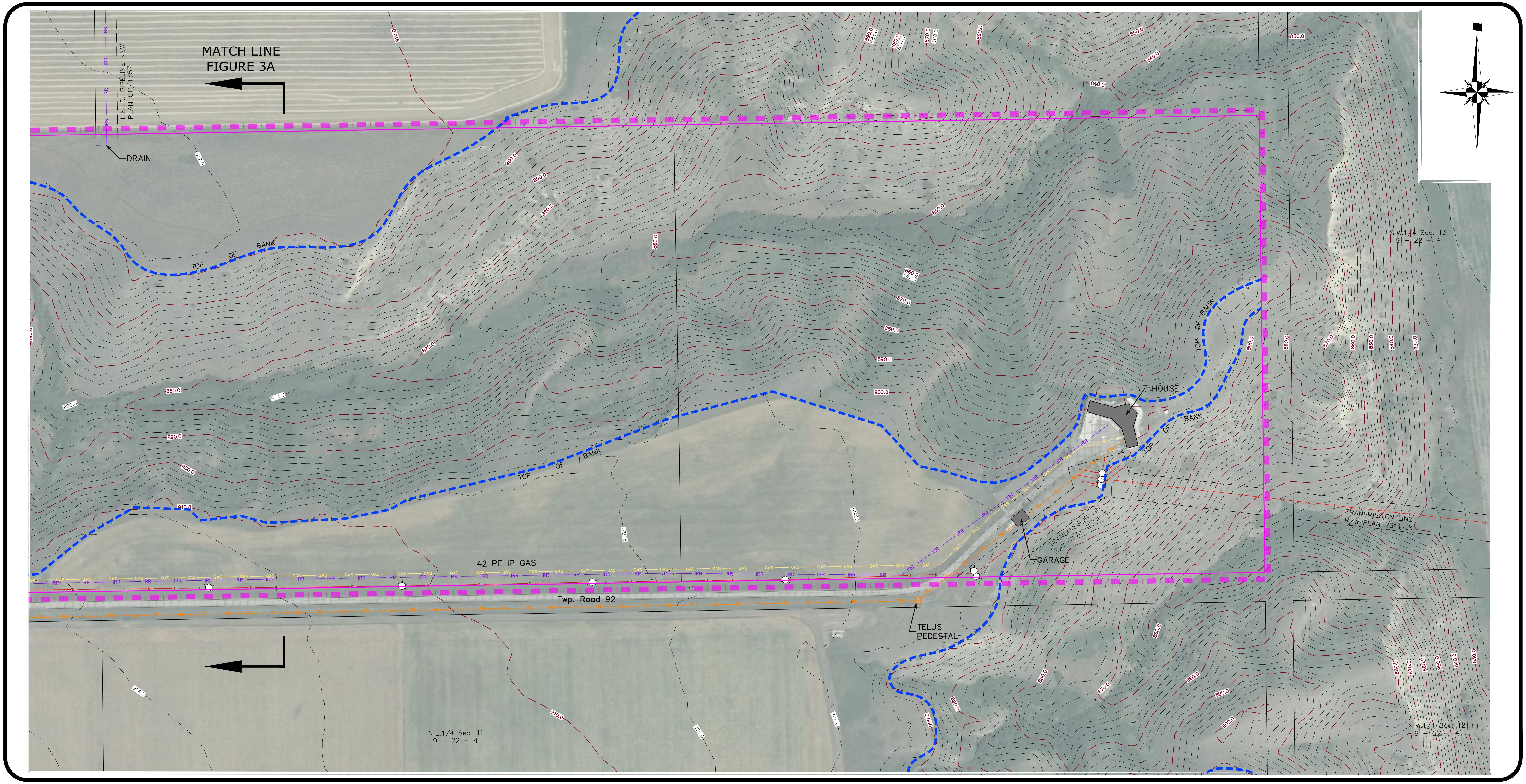
COULEE VIEW
AREA STRUCTURE PLAN

EXISTING SITE (WEST)
FIGURE 3A

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE: 1:2500
DRAWN: RJM
DATE: March 5, 2018
JOB #: 166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce-asp – feb28-2018.dwg



LEGEND

▬ ▬ ▬	DEVELOPMENT BOUNDARY
— — —	MAJOR CONTOURS (10m INT)
— — —	MINOR CONTOURS (2m INT)
— — —	TOP OF BANK
▨	EXISTING GRAVEL ROAD
▬	EXISTING PAVED ROAD
—E—E—	OVERHEAD ELECTRICAL LINE
—TEL—TEL—	BURIED TELUS CABLE
—GAS—	BURIED GAS LINE
—W—W—W—	WATER COOP LINE
—IRR—IRR—IRR—	IRRIGATION LINE
☼	EXISTING POWER POLE

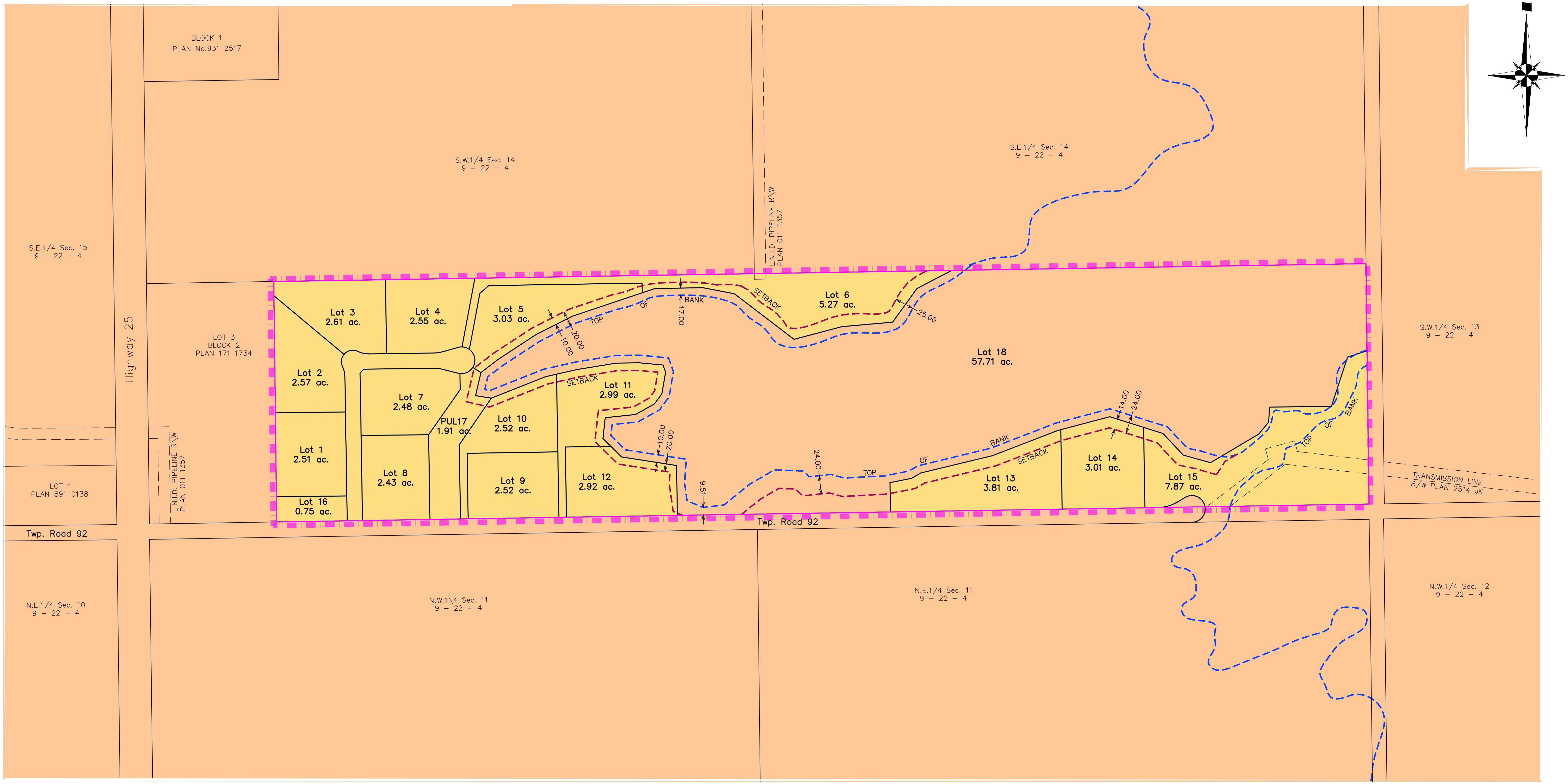
COULEE VIEW
AREA STRUCTURE PLAN

EXISTING SITE (EAST)
FIGURE 3B

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE:	1:2500
DRAWN:	RJM
DATE:	March 5, 2018
JOB #:	166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce-asp – feb28-2018.dwg



LEGEND

▪ ▪ ▪ ▪ ▪ ▪ AREA STRUCTURE PLAN BOUNDARY

– – – – – – TOP OF BANK

– – – – – – SETBACK - TOP OF BANK

🟨	53.83 ac. (21.78 ha.)	GROUPED COUNTRY RESIDENTIAL - GCR
🟧		LETHBRIDGE URBAN FRINGE - LUF

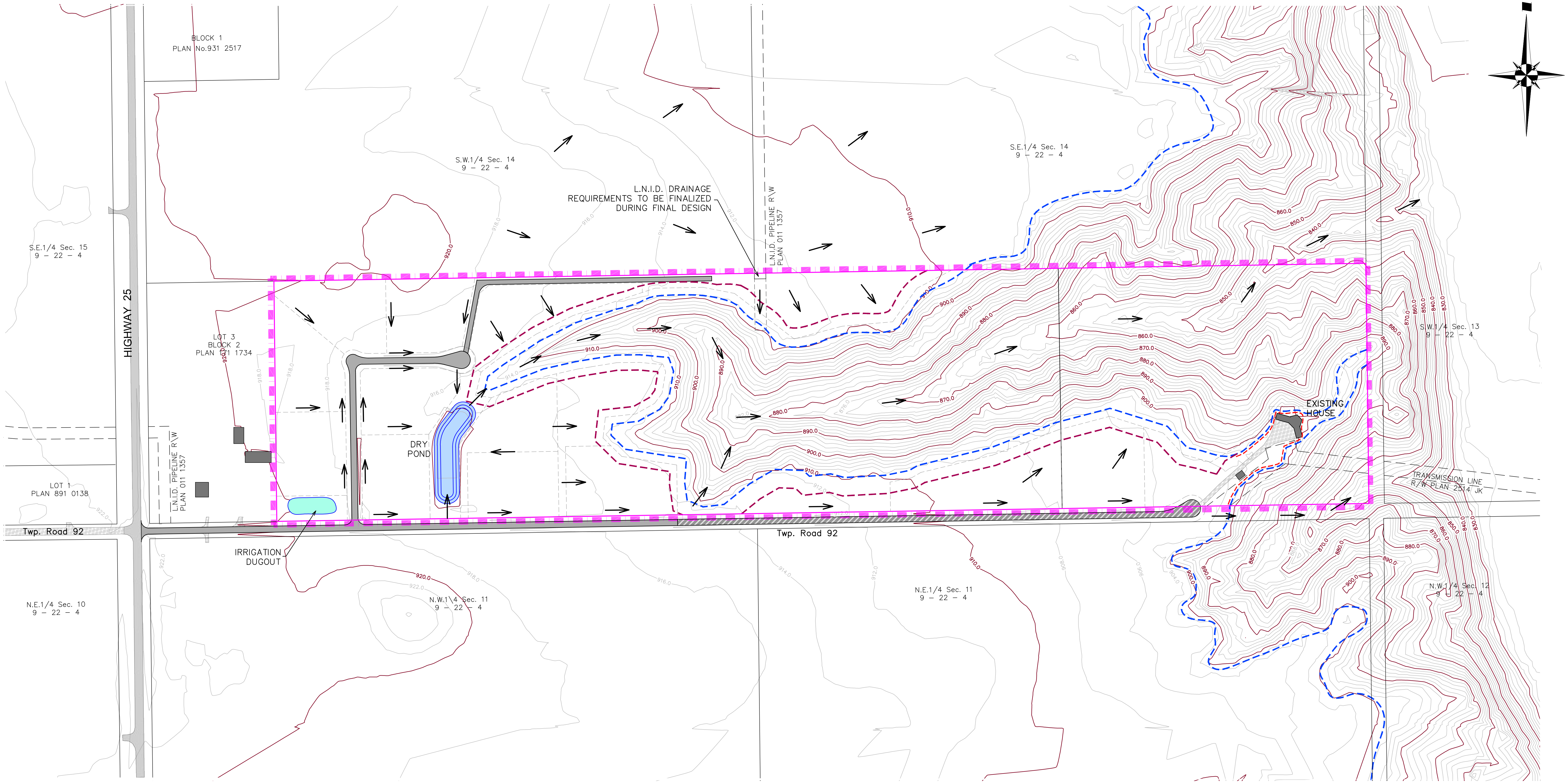
COULEE VIEW AREA STRUCTURE PLAN

LAND USE CONCEPT
FIGURE 4

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE: 1:5000
DRAWN: RJM
DATE: January 26, 2018
JOB #: 166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce-asp — feb28-2018.dwg



LEGEND

▬ ▬ ▬	DEVELOPMENT BOUNDARY
～	MAJOR CONTOURS (10m INT)
～	MINOR CONTOURS (2m INT)
- - -	TOP OF BANK
↗	PROPOSED DRAINAGE
░	EXISTING GRAVEL ROAD
▭	EXISTING PAVED ROAD
▬	PROPOSED ASPHALT ROAD
▨	PROPOSED GRAVEL ROAD

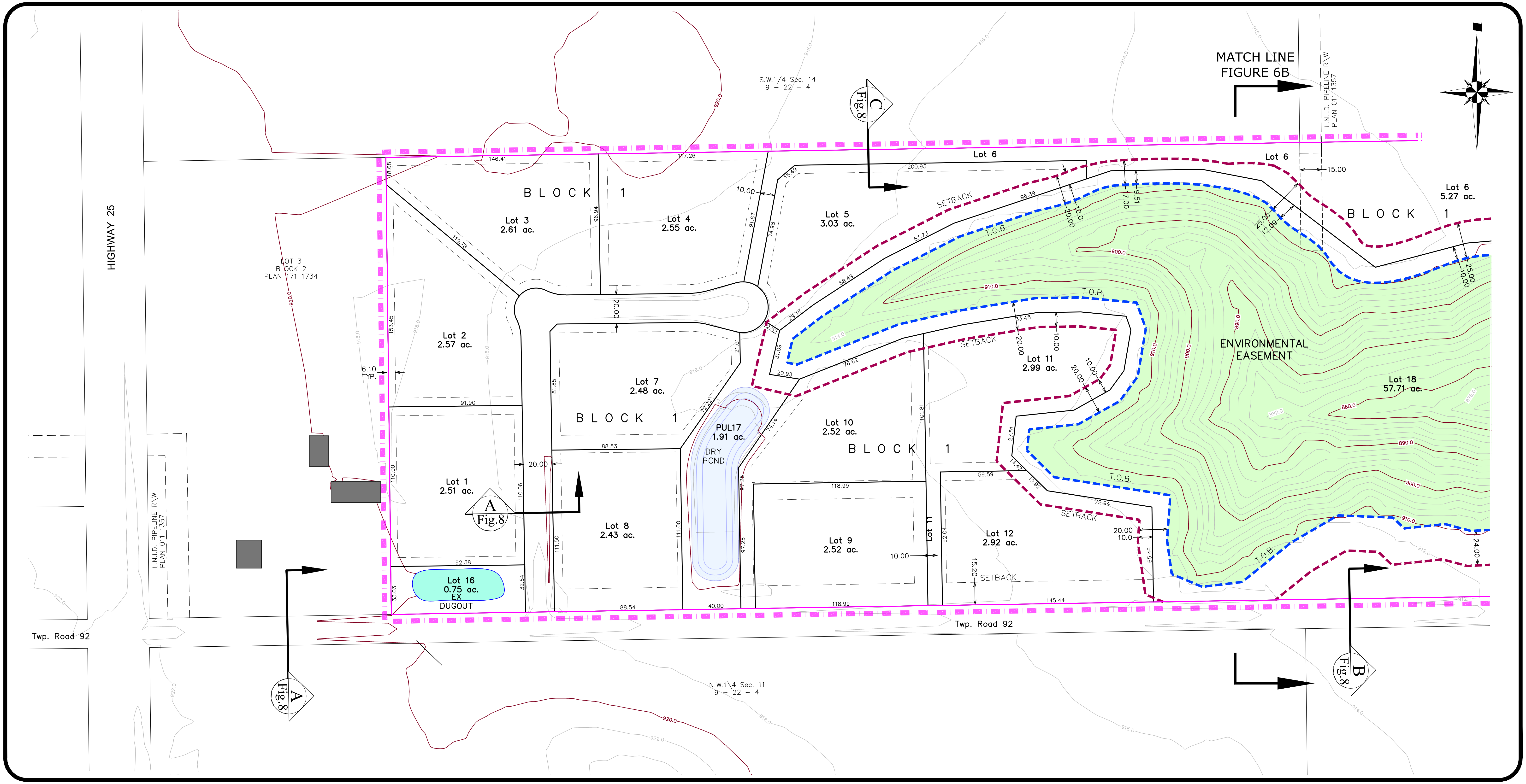
COULEE VIEW
AREA STRUCTURE PLAN

STORM WATER MANAGEMENT
FIGURE 5

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE:	1:5000
DRAWN:	RJM
DATE:	March 5, 2018
JOB #:	166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce-asp – feb28-2018.dwg



LEGEND

▬ ▬ ▬	DEVELOPMENT BOUNDARY
⁓	MAJOR CONTOURS (10m INT)
⁓	MINOR CONTOURS (2m INT)
- - -	TOP OF BANK
- - -	SETBACK FROM COULEE
– – –	SETBACK LINES AS PER COUNTY BYLAW

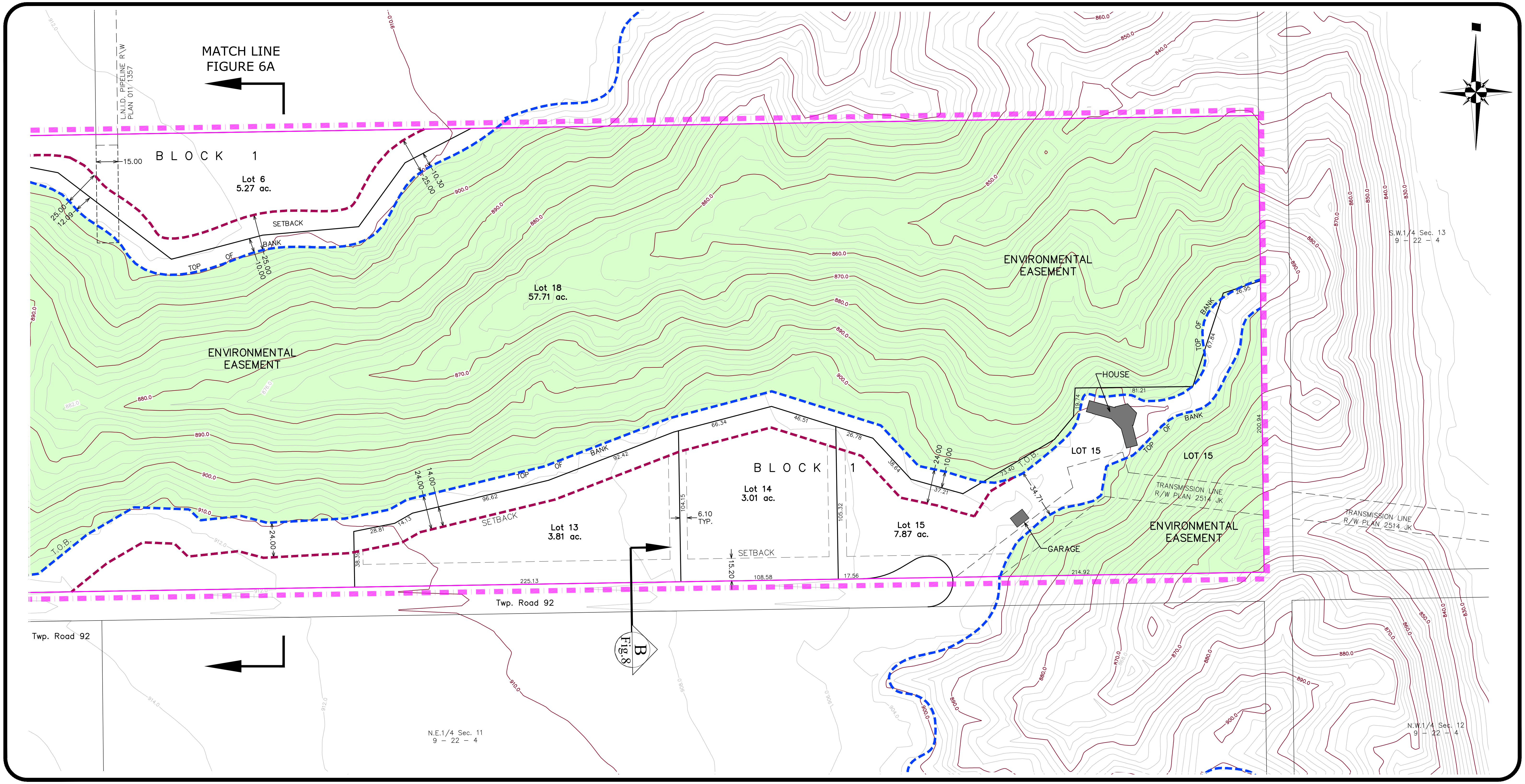
COULEE VIEW
AREA STRUCTURE PLAN

LOT LAYOUT (WEST)
FIGURE 6A

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE: 1:2500
DRAWN: RJM
DATE: March 5, 2018
JOB #: 166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce-asp - feb28-2018.dwg



LEGEND

DEVELOPMENT BOUNDARY

MAJOR CONTOURS (10m INT)

MINOR CONTOURS (2m INT)

TOP OF BANK

SETBACK FROM COULEE

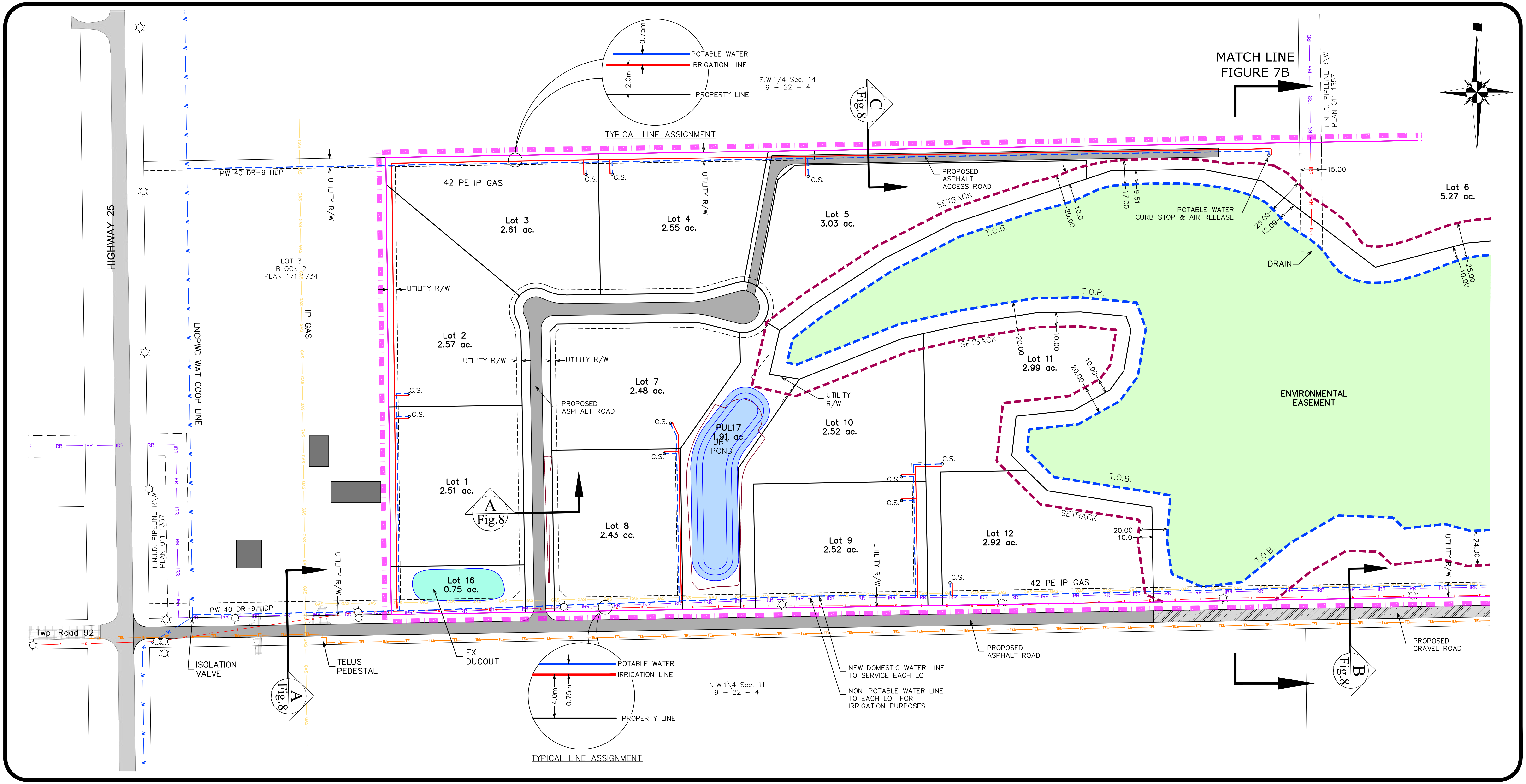
SETBACK LINES AS PER COUNTY BYLAW

COULEE VIEW AREA STRUCTURE PLAN

LOT LAYOUT (EAST)
FIGURE 6B

MARTIN GEOMATIC CONSULTANTS LTD

SCALE:	1:2500
DRAWN:	RJM
DATE:	March 5, 2018
JOB #:	166729CE



LEGEND

▬ ▬ ▬	DEVELOPMENT BOUNDARY
- - -	TOP OF BANK
░	EXISTING GRAVEL ROAD
▭	EXISTING PAVED ROAD
■	PROPOSED ASPHALT ROAD
▨	PROPOSED GRAVEL ROAD
- - - -	POTABLE WATER LINE (40 DR-9 HD8)
───	IRRIGATION LINE
— E — E —	OVERHEAD ELECTRICAL LINE
— TEL — TEL —	BURIED TELUS CABLE
— GAS — GAS —	BURIED GAS LINE
— W — W —	WATER COOP LINE
— IRR — IRR —	LNID IRRIGATION LINE
☼	EXISTING POWER POLE

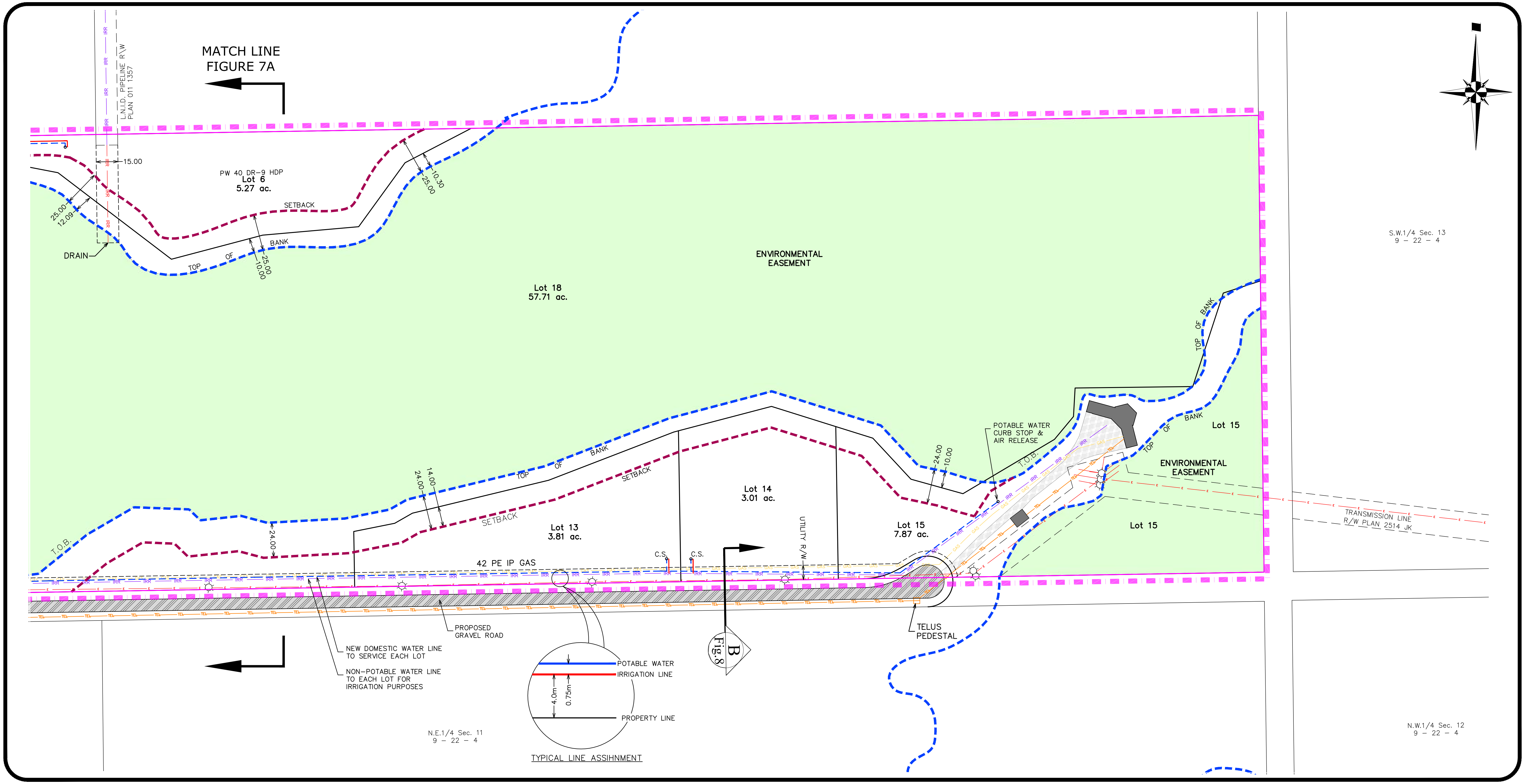
COULEE VIEW
AREA STRUCTURE PLAN

LOT SERVICING (WEST)
FIGURE 7A

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE: 1:2500
DRAWN: RJM
DATE: March 5, 2018
JOB #: 166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce-asp – feb28-2018.dwg



LEGEND

DEVELOPMENT BOUNDARY
TOP OF BANK
EXISTING GRAVEL ROAD
EXISTING PAVED ROAD
PROPOSED ASPHALT ROAD
PROPOSED GRAVEL ROAD
POTABLE WATER LINE (40 DR-9 HD8)
IRRIGATION LINE
OVERHEAD ELECTRICAL LINE
BUNRIED TELUS CABLE
BURIED GAS LINE
WATER COOP LINE
LNID IRRIGATION LINE
☼ EXISTING POWER POLE

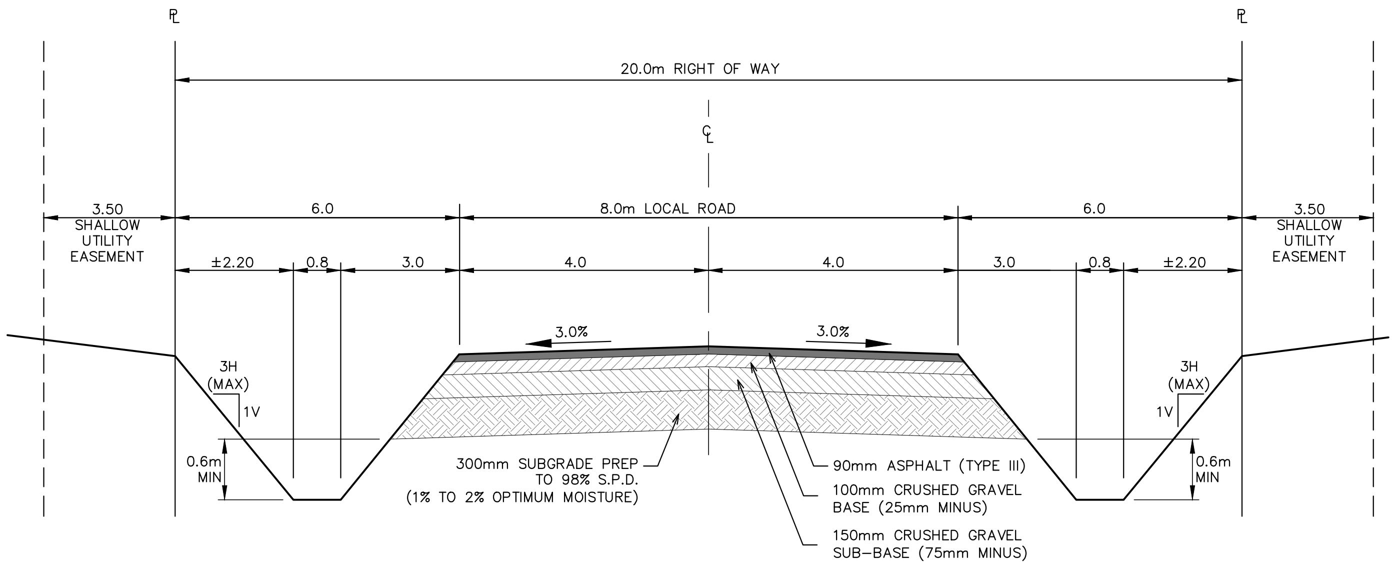
COULEE VIEW
AREA STRUCTURE PLAN

LOT SERVICING (EAST)
FIGURE 7B

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE: 1:2500
DRAWN: RJM
DATE: March 5, 2018
JOB #: 166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce-asp – feb28-2018.dwg



NOTES:

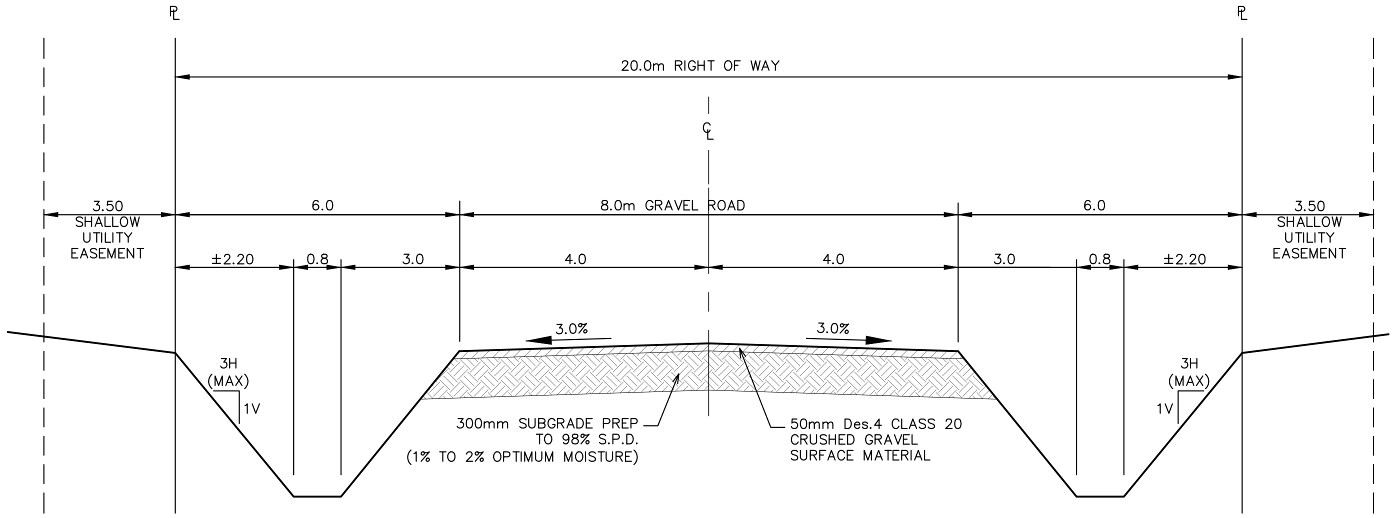
- MINIMUM DEPTH FROM BOTTOM OF DITCH TO BOTTOM OF FIRST GRANULAR LAYER TO BE MINIMUM 0.60m
- AN ACCESS TO ONE LOT SHALL HAVE A FINISHED TRAVELING SURFACE OF 6.0m, WHILE JOINT ACCESS APPROACHES REQUIRE A FINISHED TRAVELING SURFACE OF 7.0m
- DUE TO SERVICING CONSTRAINTS, THE MAXIMUM CULVERT LENGTH IS 20.0m

DRIVEWAYS / ROAD APPROACHES

- 75mm ASPHALT (TYPE III)
- ±150mm OF 20mm MINUS CRUSHED GRAVEL BASE
- 300mm SUBGRADE PREP TO 98% S.P.D. (0% TO 2% OPTIMUM MOISTURE)

A TYPICAL PAVED ROADWAY SECTION

SCALE : N.T.S.

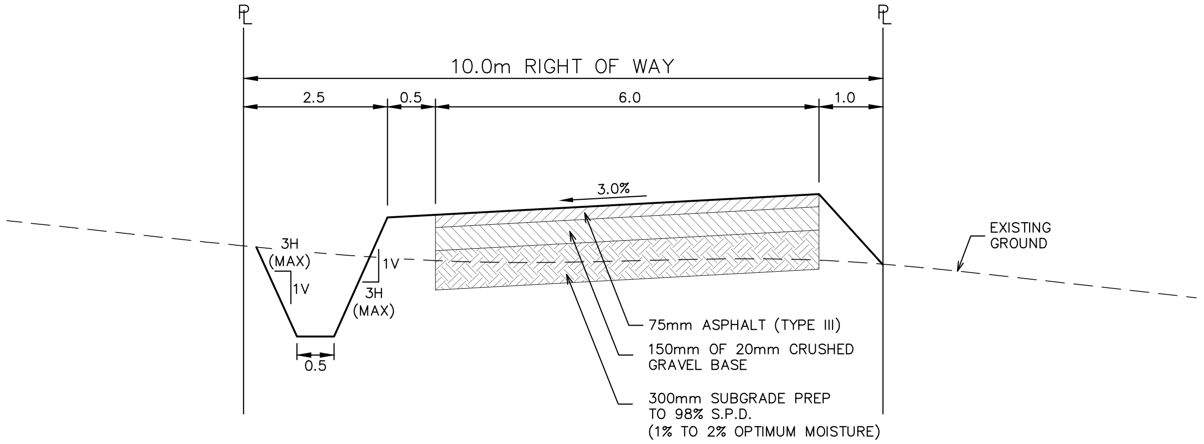


NOTES:

- MINIMUM DEPTH FROM BOTTOM OF DITCH TO BOTTOM OF FIRST GRANULAR LAYER TO BE MINIMUM 0.60m
- AN ACCESS TO ONE LOT SHALL HAVE A FINISHED TRAVELING SURFACE OF 6.0m, WHILE JOINT ACCESS APPROACHES REQUIRE A FINISHED TRAVELING SURFACE OF 7.0m
- DUE TO SERVICING CONSTRAINTS, THE MAXIMUM CULVERT LENGTH IS 20.0m

B TYPICAL GRAVEL ROADWAY SECTION

SCALE : N.T.S.



C LOT 6 TYPICAL DRIVEWAY SECTION

SCALE : N.T.S.

COULEE VIEW
AREA STRUCTURE PLAN

DETAILS
FIGURE 8

MARTIN GEOMATIC CONSULTANTS LTD

SCALE: AS SHOWN
DRAWN: RJM
DATE: March 5, 2018
JOB #: 166729CE

APPENDIX

APPENDIX 1 ~ PROPERTY OWNERSHIP TITLES

TABLE OF REQUIRED AREAS:	AREA (ha)
Within Lot 1, Block 2, –S.E. 1\4 Sec.14–9–22–4	12.68
Within Lot 2, Block 2, –S.E. 1\4 Sec.14–9–22–4 –S.W. 1\4 Sec.14–9–22–4	12.60 25.12
TOTAL	50.40 ha

REGISTRAR
SOUTH ALBERTA LAND REGISTRATION DISTRICT

PLAN No. 0210532

ENTERED AND REGISTERED
ON February 20, 2002
INSTRUMENT No. 021058050
Keith Stang
A.D. REGISTRAR

DESCRIPTIVE PLAN
SHOWING
SUBDIVISION
OF A PORTION OF
S.E. and S.W 1/4 Sec. 14, Twp. 9, Rge. 22 W.4 M.
COUNTY of LETHBRIDGE

LEGEND

DISTANCES ARE IN METRES AND DECIMALS THEREOF.
PORTION TO BE REGISTERED IS OUTLINED THUS ....
AND CONTAINS **50.40 ha**
A FIELD INSPECTION WAS CARRIED OUT ON September 13th, 2001
AND BOUNDARIES HAVE NOT BEEN ESTABLISHED ON THE GROUND.
PARALLEL LINES ARE SHOWN THUS —//— OR —/—

Sec.	SECTION	S.	SOUTH
ha	HECTARE	Twp.	TOWNSHIP
M.	MERIDIAN	W.	WEST
N.	NORTH	E.	EAST
Rge	RANGE	C. of T.	Certificate of title

GRAPHIC SCALE
(IN METRES)
100 0 50 100 200 300 400 500
1 : 5000

REGISTERED OWNER:
GEORGE BROOKS
MARGARET ELIZABETH BROOKS

SUBDIVISION AUTHORITY
OLDMAN RIVER INTERMUNICIPAL SERVICE AGENCY
FILE No : 2001–0–147

S U R V E Y O R

NAME: BRUCE A. BARNETT, A.L.S. Reg.No. 615

P 181
MARTIN GEOMATIC CONSULTANTS LTD.

MARTIN GEOMATIC CONSULTANTS Ltd.
LETHBRIDGE, ALBERTA

ACAD FILE: D:\LEGAL\SUBD\M4190.dwg	CLIENT: **PETE FIORINO**	FILE No
PT. FILE: C:\PROJ\M4190S	DRAWN BY: Ursula Bendkowski, C.E.T.	M4190

Plotted January 29th, 2002

GOVERNMENT OF THE PROVINCE OF ALBERTA

LAND TITLE CERTIFICATE

S

LINC	SHORT LEGAL	TITLE NUMBER
0029 217 908	0210532;2;1	131 233 076

LEGAL DESCRIPTION

DESCRIPTIVE PLAN 0210532
BLOCK 2
LOT 1
EXCEPTING THEREOUT ALL MINES AND MINERALS
AREA: 12.68 HECTARES (31.33 ACRES) MORE OR LESS

ATS REFERENCE: 4;22;9;14;S
ESTATE: FEE SIMPLE

MUNICIPALITY: LETHBRIDGE COUNTY

REFERENCE NUMBER: 021 058 088

REGISTERED OWNER(S)

REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
131 233 076	13/09/2013	TRANSFER OF LAND	$1,320,000	SEE INSTRUMENT

OWNERS

PETER FIORINO
OF 1106-3 AVE N
LETHBRIDGE
ALBERTA T1H 0H6

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
8691EX .		RESTRICTIVE COVENANT
5619DI .	06/05/1926	RESTRICTIVE COVENANT
1084EJ .	31/07/1931	CAVEAT RE : EASEMENT CAVEATOR - LETHBRIDGE NORTHERN IRRIGATION DISTRICT.

(CONTINUED)

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
7337JP .	25/11/1966	CAVEAT CAVEATOR - CANADIAN WESTERN NATURAL GAS COMPANY LIMITED.
741 091 031	27/09/1974	IRRIGATION ORDER/NOTICE THIS PROPERTY IS INCLUDED IN THE LETHBRIDGE NORTHERN IRRIGATION DISTRICT
841 181 508	05/11/1984	UTILITY RIGHT OF WAY GRANTEE - FORTISALBERTA INC. 320 - 17 AVENUE S.W. CALGARY ALBERTA T2S2Y1 "PORTION DESCRIBED" (DATA UPDATED BY: TRANSFER OF UTILITY RIGHT OF WAY 001287703) (DATA UPDATED BY: CHANGE OF NAME 051014950)
861 050 204	25/03/1986	CAVEAT RE : AMENDING AGREEMENT CAVEATOR - ALTALINK MANAGEMENT LTD. 2611 - 3 AVE SE CALGARY ALBERTA T2A7W7 (DATA UPDATED BY: TRANSFER OF CAVEAT 021189410) (DATA UPDATED BY: CHANGE OF ADDRESS 081422776)
861 050 205	25/03/1986	CAVEAT RE : AMENDING AGREEMENT CAVEATOR - ALTALINK MANAGEMENT LTD. 2611 - 3 AVE SE CALGARY ALBERTA T2A7W7 (DATA UPDATED BY: TRANSFER OF CAVEAT 021189410) (DATA UPDATED BY: CHANGE OF ADDRESS 081422776)
011 333 554	08/11/2001	UTILITY RIGHT OF WAY GRANTEE - ATCO GAS AND PIPELINES LTD.
021 058 051	20/02/2002	CAVEAT RE : DEFERRED RESERVE CAVEATOR - COUNTY OF LETHBRIDGE. C/O OLDMAN RIVER INTERMUNICIPAL SERVICE AGENCY #B, 905 - 4 AVENUE SOUTH LETHBRIDGE ALBERTA T1J0P4 AGENT - OLDMAN RIVER INTERMUNICIPAL SERVICE AGENCY.

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
7072IZ .	27/08/1964	UTILITY RIGHT OF WAY GRANTEE - ALTALINK MANAGEMENT LTD. 2611 - 3 AVE SE CALGARY ALBERTA T2A7W7 AS TO PORTION OR PLAN:2514JK "ENDORSED BY 051034527 ON 20050126" (DATA UPDATED BY: CHANGE OF ADDRESS 091108519)
131 233 077	13/09/2013	MORTGAGE MORTGAGEE - ROYAL BANK OF CANADA. 10 YORK MILLS ROAD 3RD FLOOR TORONTO ONTARIO M2P0A2 ORIGINAL PRINCIPAL AMOUNT: $1,350,000

TOTAL INSTRUMENTS: 012

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 17 DAY OF OCTOBER, 2017 AT 08:08 A.M.

ORDER NUMBER: 33895716

CUSTOMER FILE NUMBER: 166729

END OF CERTIFICATE

GOVERNMENT OF THE PROVINCE OF ALBERTA

LAND TITLE CERTIFICATE

S

LINC	SHORT LEGAL	TITLE NUMBER
0037 664 075	0210532;2;2	171 188 317 +1

LEGAL DESCRIPTION

DESCRIPTIVE PLAN 0210532
BLOCK 2
LOT 2
EXCEPTING THEREOUT:

A) PLAN	NUMBER	HECTARES	(ACRES)	MORE OR LESS
SUBDIVISION	1711734	5.26	13.00	

EXCEPTING THEREOUT ALL MINES AND MINERALS

ATS REFERENCE: 4;22;9;14;S
ESTATE: FEE SIMPLE

MUNICIPALITY: LETHBRIDGE COUNTY

REFERENCE NUMBER: 091 280 016

REGISTERED OWNER(S)

REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
171 188 317	24/08/2017	SUBDIVISION PLAN		

OWNERS

1463770 ALBERTA LTD.
OF 1106-3 AVENUE NORTH
LETHBRIDGE
ALBERTA T1H 0H6

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
8691EX .		RESTRICTIVE COVENANT
5619DI .	06/05/1926	RESTRICTIVE COVENANT
1084EJ .	31/07/1931	CAVEAT RE : EASEMENT

(CONTINUED)

```
                         CAVEATOR - LETHBRIDGE NORTHERN IRRIGATION DISTRICT.

7073IZ  .     27/08/1964 UTILITY RIGHT OF WAY
                         GRANTEE - ALTALINK MANAGEMENT LTD.
                         2611 - 3 AVE SE
                         CALGARY
                         ALBERTA T2A7W7
                         "PORTION DESCRIBED"
                              (DATA UPDATED BY: TRANSFER OF UTILITY RIGHT
                              OF WAY 021217402)
                              (DATA UPDATED BY: CHANGE OF ADDRESS 091108519)

741 091 031   27/09/1974 IRRIGATION ORDER/NOTICE
                         THIS PROPERTY IS INCLUDED IN THE LETHBRIDGE
                         NORTHERN IRRIGATION DISTRICT

801 167 573   16/10/1980 UTILITY RIGHT OF WAY
                         GRANTEE - CANADIAN WESTERN NATURAL GAS COMPANY
                         LIMITED.

861 050 204   25/03/1986 CAVEAT
                         RE : AMENDING AGREEMENT
                         CAVEATOR - ALTALINK MANAGEMENT LTD.
                         2611 - 3 AVE SE
                         CALGARY
                         ALBERTA T2A7W7
                              (DATA UPDATED BY: TRANSFER OF CAVEAT
                              021189410)
                              (DATA UPDATED BY: CHANGE OF ADDRESS 081422776)

861 050 205   25/03/1986 CAVEAT
                         RE : AMENDING AGREEMENT
                         CAVEATOR - ALTALINK MANAGEMENT LTD.
                         2611 - 3 AVE SE
                         CALGARY
                         ALBERTA T2A7W7
                              (DATA UPDATED BY: TRANSFER OF CAVEAT
                              021189410)
                              (DATA UPDATED BY: CHANGE OF ADDRESS 081422776)

011 333 554   08/11/2001 UTILITY RIGHT OF WAY
                         GRANTEE - ATCO GAS AND PIPELINES LTD.

021 026 046   22/01/2002 UTILITY RIGHT OF WAY
                         GRANTEE - LETHBRIDGE NORTHERN IRRIGATION DISTRICT.
                         AS TO PORTION OR PLAN:0111357
                         TAKES PRIORITY OF CAVEAT 001165849
                         REGISTERED ON JUNE 20, 2000

101 216 514   21/07/2010 UTILITY RIGHT OF WAY
```

(CONTINUED)

```
REGISTRATION
  NUMBER    DATE (D/M/Y)       PARTICULARS
-------------------------------------------------------------------------------

                              GRANTEE - LETHBRIDGE NORTH COUNTY POTABLE WATER
                              CO-OP LTD.

121 057 227   08/03/2012 MORTGAGE
                         MORTGAGEE - CANADIAN WESTERN BANK.
                         744-4 AVE. SOUTH
                         LETHBRIDGE
                         ALBERTA T1J0N8
                         ORIGINAL PRINCIPAL AMOUNT: $388,000

121 057 228   08/03/2012 CAVEAT
                         RE : ASSIGNMENT OF RENTS AND LEASES
                         CAVEATOR - CANADIAN WESTERN BANK.
                         C/O NORTH & COMPANY LLP
                         600, 220-4 ST SOUTH
                         LETHBRIDGE
                         ALBERTA T1J4J7
                         AGENT - DOUGLAS R LINT

171 092 770   04/05/2017 UTILITY RIGHT OF WAY
                         GRANTEE - ALTALINK MANAGEMENT LTD.

171 188 316   24/08/2017 CAVEAT
                         RE : ROADWAY
                         CAVEATOR - HER MAJESTY THE QUEEN IN RIGHT OF
                         ALBERTA
                         AS REPRESENTED BY MINSTER OF TRANSPORTATION
                         C/O ALBERTA TRANSPORTATION
                         2ND FLOOR, TWIN ATRIA           BUILDING
                         4999 - 98 AVENUE NW
                         EDMONTON
                         ALBERTA T6B2X3
```

TOTAL INSTRUMENTS: 015

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 17 DAY OF OCTOBER, 2017 AT 08:08 A.M.

ORDER NUMBER: 33895716

CUSTOMER FILE NUMBER: 166729

END OF CERTIFICATE

(CONTINUED)

APPENDIX

APPENDIX 2 ~ GEOTECHNICAL EVALUATION

TETRA TECH

Geotechnical Evaluation
Rural Country Residential Subdivision Development
Lethbridge County, Alberta

PRESENTED TO

Fiorino Homes Ltd.

DECEMBER 2017
ISSUED FOR USE
FILE: ENG.LGEO03581-01

Tetra Tech Canada Inc.
442 - 10 Street N.
Lethbridge, AB T1H 2C7 CANADA
Tel 403.329.9009 Fax 403.328.8817

This page intentionally left blank.

TABLE OF CONTENTS

LIST OF TABLES IN TEXT

APPENDIX SECTIONS

FIGURES

APPENDICES

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Fiorino Homes Ltd., and their agents. Tetra Tech Canada Inc. (Tetra Tech) 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 Fiorino Homes Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on Use of this Document attached in Appendix A or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

This report presents the results of a geotechnical evaluation conducted by Tetra Tech Canada Inc. (Tetra Tech) for the proposed Rural Country Residential Subdivision Development to be located in the Lethbridge County, Alberta (Figure 1). The legal description of the site address is LSD South ½ Sec 14-9-22 W4M.

The scope of work for the geotechnical evaluation was outlined in a proposal (Tetra Tech File No. PENG.LGEO03410-01) issued to Mr. Matthew Redgrave, of Martin Geomatic Consultants Ltd. (MGCL), on March 15, 2017. The objective of this evaluation was to determine the general subsurface stratigraphy and groundwater conditions in the area of the proposed development and to provide general recommendations for the geotechnical aspects of design and construction for the project.

It is understood that a septic disposal field feasibility assessment, as well as a Phase I environmental site assessment will also be conducted for the proposed development and issued in separate reports.

Authorization to proceed with the evaluation was provided by Mr. Pete Fiorino, of Fiorino Homes Ltd., by a signed Services Agreement on October 4, 2017.

2.0 PROJECT DESCRIPTION AND SCOPE OF WORK

It is understood that the proposed residential subdivision will include 16 residential lots with underground utilities, a stormwater dry pond, and paved roadways. The total planned area is approximately 41 acres. It is understood that the proposed underground waterline will be approximately 3.0 m below the roadway surface elevation.

Shallow foundations with a floor slabs-on-grade system are typically considered for residential subdivisions in southern Alberta. Alternatively, a deep pile foundation system, such as bored cast-in-place piles or screw piles, is also considered feasible; however, may not be as economically viable when compared to a shallow foundation system. The choice of foundation system should be based on subsurface conditions encountered for each of the proposed residential dwellings.

The scope of work for this evaluation comprised the drilling of nine (9) boreholes, a laboratory program to assist in classification of the subsurface soils, and this report providing the following design and construction recommendations:

- General site grading.
- Slope stability assessment to determine appropriate development setbacks from the crest of the slopes.
- Construction of below-grade utilities.
- Design parameters for shallow foundations and below-grade structures.
- Design and installation of floor slabs-on-grade.
- Recommendations regarding suitability of on-site materials for the construction of compacted clay liners for a stormwater containment pond.
- Recommendations for pond construction, including design thickness for a compacted clay liner
- Classification of site for seismic design.
- Volumetric changes of soil due to changes in moisture content and/or frost.
- Construction of subgrades, backfill materials, and compaction.
- Roadway subgrade preparation.
- Concrete type for structured elements in contact with soil.

3.0 GEOTECHNICAL FIELD AND LABORATORY WORK

The fieldwork for this evaluation was carried out on October 31, 2017. A truck-mounted drill rig was contracted from Chilako Drilling Services Ltd. of Coaldale, Alberta. The rig was equipped with 150 mm diameter solid stem continuous flight augers. Tetra Tech's field representative was Mr. Stuart Smith. Buried utility locating was carried out through Alberta One-Call.

Nine (9) boreholes (17BH001 through 17BH009) were drilled across the site to depths of 6.6 m below ground surface. The borehole locations are depicted on Figure 1. The borehole elevations were interpreted from the information provided by MGCL, with coordinates obtained by Tetra Tech using a handheld GPS. Borehole coordinates and elevations are shown on the borehole logs provided in Appendix B.

In all boreholes, disturbed grab samples were obtained at depth intervals of approximately 600 mm. Standard Penetration Tests (SPT) were completed at intervals of 1.5 m. 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 polyvinyl chloride (PVC) standpipes were installed in each of the boreholes in order to monitor the groundwater levels. Auger cuttings were used to backfill around the standpipes and the boreholes were sealed at the ground surface with bentonite chips.

Soil 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. The results of the laboratory tests are presented on the borehole logs in Appendix B.

4.0 SITE CONDITIONS

4.1 Surface Features

The proposed site is in the northeast corner of the intersection of HWY 25 and Township Road 92, approximately 6.0 km northwest of Lethbridge, Alberta, within the Lethbridge County. The site is on prairie level, abutting the west valley wall of the Oldman River Valley. A tributary valley (coulee) is orientated in an east-west direction cutting through the eastern two thirds of the development property. The project site on prairie level is relatively flat, generally sloping eastward towards the Oldman River Valley.

As part of the evaluation, Tetra Tech reviewed historical aerial photographs of the site and surrounding area. The following observations were noted:

- Lot 2 (refer to Figure 1) has a stormwater or dugout pond on the south end of the lot (seen as far back as 1950).
- Lot 11 appears to have a low lying area (slough) on the south extremity of the lot (1961 and 1989 photographs).
- East of Lot 13, to the valley wall edge, it appears fill was placed for construction of Township Road 92.

4.2 Soil Stratigraphy

The general subsurface stratigraphy of the project site generally comprised a surficial layer of topsoil, underlain by clay fill, in turn underlain by native clay and clay till deposits. The following subsections provide a summary of the stratigraphic units encountered at the specific borehole locations across the site. A more detailed description is provided on the borehole logs presented in Appendix B.

4.2.1 Top Soil

Topsoil was encountered at the borehole locations, with thicknesses of between 100 mm and 200 mm. Due to previous agricultural practices and depositional processes (i.e., wind), the topsoil layer is expected to vary in thickness. The method of stripping should be taken into account when determining stripping volumes.

4.2.2 Clay Fill

A layer of clay fill was encountered at the majority of the borehole locations under the topsoil layer, extending to depths of between 0.4 m and 2.0 m below grade level. The clay fill was generally described as silty, some sand, damp to moist, stiff, medium plastic, and brown with trace organics and root hairs. Moisture content tests taken on clay fill samples ranged between 8% and 21%.

4.2.3 Clay

Native clay was encountered under the topsoil or clay fill layers at the boreholes (with the exception of 17BH006), extending to depths of between 0.9 m to 3.1 m below grade. The clay was generally described as silty, trace to some sand, damp to moist, firm to stiff, medium plastic to high plastic, and brown with greyish brown mottling. Occasional silt and sand lenses, with high plastic clay inclusions, were encountered within the clay. Moisture content tests taken on clay samples ranged between 7% and 31%. Atterberg Limits testing (one test) indicated a Liquid Limit of 61% and a Plastic Limit of 17%; indicative of high plasticity.

SPT “N” values within this layer ranged from 8 to 14 blows per 300 mm penetration, indicative of a firm to stiff consistency.

4.2.4 Clay Till

Clay till was encountered beneath the clay fill and clay layers, extending to the borehole termination depths. The clay till was generally described as silty, some sand, trace gravel, moist to very moist, medium plastic, firm to stiff, and brown with grey mottling and coal and oxide specks. Occasional silt and sand pockets, and high plastic clay inclusions were encountered within the clay till. Moisture content tests taken on clay till samples ranged between 11% and 29%. Atterberg Limits testing (three tests) indicated Liquid Limits ranging between 35% and 48%, and Plastic Limits ranging between 11% and 16%; indicative of medium plasticity.

SPT “N” values within this layer ranged from 5 to 11 blows per 300 mm penetration, indicative of a firm to stiff consistency.

4.3 Groundwater Conditions

During the field drilling, no sloughing was encountered in the boreholes. Groundwater seepage was encountered only in 17BH004 at a depth of 3.1 m. The groundwater levels were measured on November 10, 2017. Table A summarizes the groundwater monitoring data.

Table A: Groundwater Monitoring Data – November 10, 2017

Borehole Number	Depth of Standpipe (m)	Borehole Elevation (m)	Depth to Groundwater (m)	Groundwater Elevation (m)
17BH001	6.6	919.0	2.60	916.40
17BH002	6.6	918.8	3.50	915.30
17BH003	6.6	916.7	3.06	913.64
17BH004	6.6	917.0	DRY	-
17BH005	6.6	916.7	DRY	-
17BH006	6.6	915.5	5.83	909.67
17BH007	6.6	912.0	DRY	-
17BH008	6.6	910.0	6.12	903.88
17BH009	6.6	907.0	4.85	902.15

5.0 RECOMMENDATIONS

The recommendations that follow provide varying options intended to aid in the development of project concepts and specifications. The recommendations are based on the understanding and condition that Tetra Tech will be retained to review the relevant aspects of the final design (drawings and specifications) and to conduct such field reviews as are necessary to ensure compliance with the geotechnical aspects of the 2014 Alberta Building Code, the Lethbridge County Engineering Guidelines & Minimum Servicing Standards, the 2016 Lethbridge Design Standards, this report, and the final plans and specifications. Tetra Tech accepts no liability for any use of this report in the event that Tetra Tech is not retained to provide these review services.

Specific recommendations that apply to this project are provided for site development, pavement structures, foundation alternatives and floor slab systems for residential dwellings, stormwater management facilities, and development setback lines with respect to slope stability issues.

5.1 Site Development

5.1.1 Topsoil Depth

The initial topsoil stripping depth should be considered as being of particular importance with regard to site subgrade grading design elevations. Based on the findings of the field drilling program, the surficial topsoil (A Horizon) layer thickness generally varies between 100 mm and 200 mm; however, may be somewhat variable in thickness due to historical cultivation practices of the land surface and/or depositional processes (i.e., wind). Consideration can be given however, to incorporating the underlying B Horizon layer (organic content <5%) 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.

5.1.2 Lot Grading

It is understood that surface runoff will be handled by surface ditches that typically parallel the roadways. It is unknown whether specific lot grading will be undertaken for the proposed rural country residential development. In some instances, grading may be limited to the roadways being constructed for the subdivision. In the event that lot grading is being carried out, the following recommendations should be adopted.

The lot grading should be designed and carried out to the current Lethbridge County Engineering Guidelines & Minimum Servicing Standards, or equivalent. Following organic topsoil stripping, all lots should be graded for drainage at a minimum gradient of 2.0%. The existing site soils, comprising medium plastic clay fill, clay, and clay till are suitable for use as landscape fill materials or for use as general engineered fill materials for lot grading, provided they are acceptably moisture conditioned. High plastic clay should be expected at some locations and be separately stockpiled and not be used for generally engineered fill. The moisture content of the site soils generally appear to be variable with respect to the anticipated optimum moisture content (OMC). Moisture conditioning will likely be required at the site for proper compaction. Although soil moisture variability should be expected, the earthwork contractor should assess the requirements and should consider such factors as weather and construction procedures.

General engineered cohesive fill materials for lot grading should be moisture conditioned to within a range of 0% to +2% of the OMC prior to compaction, and compacted to a minimum of 98% of Standard Proctor Density (SPD). Granular materials, if used, placed as “general engineered fill” should be compacted within a range of OMC to +2% above OMC.

5.1.3 Subgrade Preparation

Subgrade preparation to Lethbridge County Engineering Guidelines & Minimum Servicing Standards is required in all residential subdivision development areas, including lot grading, as well as all paved areas. Vegetation, topsoil, and other identified deleterious or unsuitable materials should be excavated from under proposed fill areas during grading operations and removed off site. Any excess grading materials should not be disposed of on the coulee slopes.

The native clay and clay till soils should be acceptable for site grading purposes in most areas, depending on other development constraints. The moisture content of the clay materials appears to be variable across the site and moisture conditioning 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. Specific subgrade preparation recommendations for slabs-on-grade and paved areas are discussed in subsequent sections of this report.

5.1.4 Backfill Materials

The medium plastic soils, including clay fill, native clay, and clay till, are considered acceptable for site grading purposes in most areas. Any sand or silt, if locally encountered, are only considered suitable for landscaping purposes or backfill below frost protection depths due to high frost susceptibility. The near-surface clay soils appears to be variable in moisture content across the site; and therefore, moisture conditioning will be required for proper backfill placement. The earthwork contractor should make his/her own estimate of the requirements for moisture conditioning to the recommended standards, and should consider such factors as weather and construction procedures.

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

5.1.5 Construction Excavations

Excavations should be carried out in accordance with Alberta Occupational Health and Safety Regulations. For excavations required for underground utilities, for example the water lines, the excavation depth is understood to be less than 3.0 m from final grade. The following recommendations notwithstanding, the responsibility of all excavation cutslopes resides with the Contractor; who should take into consideration site-specific conditions concerning soil stratigraphy and groundwater. All excavations should be reviewed by the Contractor prior to personnel working within the base of the excavation.

Based on the findings of the drilling program, firm to stiff clay soils, in damp to very moist conditions, are generally anticipated to be encountered within 3.0 m below grade during excavation. Short-term excavations (open for less than one month) within firm to stiff clay soils which are to be deeper than 1.5 m should have the sides shored and braced or the slopes should be cut back no steeper than 1.0 horizontal to 1.0 vertical (1.0H:1.0V). In areas where soft to firm clay soils are encountered, a cutslope of 1.5H:1.0V or flatter should be considered.

Spill piles or temporary surcharge loads should not be allowed within a distance equal to the depth of the excavation from an unsupported excavation face, while 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 workers and must be guarded against.

General recommendations regarding construction excavations are contained in Appendix C.

5.1.6 Trench Backfill and Compaction

The existing site soils comprising medium plastic clay fill, clay, and clay till are considered adequate for use as ‘general engineered fill’ within the trenches above the bedding zone. Requirements for ‘general engineered fill’ are defined in Appendix C. High plastic clay should be stockpiled separately and used for landscaping purposes.

The moisture content of the existing clay soils are estimated to be variable with respect to their OMC. As such, moisture conditioning should be anticipated for this project. The earthwork contractor should; however, make his own estimate of the requirements and should consider such factors as weather and construction procedures.

The level of compaction of the backfill must be suitable to limit post-construction trench settlement both for the road embankment as well as to maintain the design surface drainage (stormwater control) profile of the rights-of-way. A minimum compaction level of 95% of SPD is recommended for backfill within the pipe zone of the trench (to 300 mm above the top of pipe). For the remainder of the trench backfill, a minimum compaction standard of 98% of SPD should be utilized in all areas. The compacted thickness of each lift of backfill shall not exceed 250 mm. Moisture conditioning to OMC and 2% over OMC of the soils should be specified for general trench backfill. During placement of the backfill materials it is recommended that ‘notching’ of the excavation sidewalls (1.0H:1.0V) occur with every 1 m of height to develop a bond between the native soils and backfill materials, resulting in less potential for long-term settlement or consolidation.

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 the uniformity, the lift thickness and compaction criteria should be strictly enforced. General recommendations regarding backfill materials and compaction are contained in Appendix C.

For frost protection, pipes buried with less than 2.0 m of soil cover (above top of pipe) should be protected with insulation to avoid frost 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 and backfill materials and compaction are contained in Appendix C.

5.2 Pavement Structures

5.2.1 Subgrade Preparation

Within all roadway areas, following stripping of topsoil, the exposed subgrade should be proof-rolled to assess the subgrade characteristics. Following the proof-roll, a minimum subgrade preparation depth of 300 mm is recommended in all areas in order to improve subgrade uniformity. Where softer soils are encountered, subgrade preparation of 600 mm or more may be necessary. Subgrade preparation includes scarification, moisture conditioning to between OMC and +2% of OMC, and uniform compaction to a minimum of 98% of SPD.

Backfill to raise the subgrade level should be general engineered fill materials, as defined in Appendix C, moisture conditioned and compacted as noted previously. The subgrade should be prepared and graded to allow drainage into drainage ditches or catchbasins, if available. 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.

5.2.2 Gravel Pavement

The following minimum gravel pavement structure, using the above subgrade preparation procedures, is recommended. Both gravel materials should be compacted to 100% of SPD.

- 100 mm of crushed gravel or base gravel (25 mm minus) over
- 200 mm of pit run gravel or sub-base gravel over prepared clay subgrade

It is imperative that positive surface drainage of gravel pavement be established to prevent ponding of water. Recommended minimum grades of 2% should be used in gravel surfaced areas. Surrounding landscaping should be such that runoff water is prevented from ponding beside gravelled areas.

5.2.3 Pavement Structures

The pavement structures presented below are not based on detailed design, and do not take into consideration site-specific traffic loading conditions, as such data was not available at the time of report preparation. The pavement structures are provided as a general guideline, are not intended to have a specific design life, and are based on the assumption that good subgrade support can be achieved. In the absence of good traffic loading data, Tetra Tech recommends the use of the following “Local” pavement structure taken from the City of Lethbridge 2016 Design Standards for use in lightly loaded areas:

- Type III Asphalt Surfacing = 90 mm
- Granular Base Course = 250 mm
- Subgrade Preparation = 300 mm

For heavy duty access ways, the following “Major and Minor Collector” pavement structure taken from the City of Lethbridge 2016 Design Standards is recommended:

- Type I Asphalt Surfacing = 60 mm
- Type II Asphalt Base Course = 60 mm
- Granular Base Course = 100 mm
- Granular Sub-base = 150 mm
- Subgrade Preparation = 300 mm

For heavy duty loading aprons and refuse collection pads, the use of a Portland Cement concrete pavement is recommended, with a minimum thickness of 180 mm overlying 200 mm of crushed granular base course.

The recommended pavement layer thicknesses generally refer to average values and recognize typical construction variability. As-constructed layer thicknesses should satisfy the thickness tolerances identified in the City of Lethbridge 2016 Design Standards (or equivalent) for granular materials and asphalt concrete.

5.3 Foundations

5.3.1 General

Based on the soil conditions encountered at the borehole locations, shallow foundations are considered suitable for the proposed residential development. Deep pile foundations are considered technically feasible; however, may not be preferred due to the relatively high cost compared to a shallow foundation system. Deep pile foundations, such as cast-in-place concrete piles or helical piles (as an alternative), should only be considered for residential lots where foundation subgrade soils are not suitable for shallow foundations. Recommendations for the design of deep foundation systems are not included in this report; rather, left to the responsible professional designing the residential dwelling.

All shallow foundation design recommendations presented in this report are based on the assumption that an adequate level of monitoring by Tetra Tech 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 the following:

- 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.

Suitably qualified persons, independent of the Contractor, should carry out all such monitoring. 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.

5.3.2 Limit States Design

The design parameters provided in the following sections may be used to calculate the ultimate foundation capacity in each case. For the Limit States Design (LSD) methodology, in order to calculate the factored load capacity, the appropriate Soil Resistance Factors must be applied to each loading condition as follows:

Factored Capacity = Ultimate Capacity x Soil Resistance Factors

In general, the soil resistance factors in Table B should be incorporated into the foundation design. These factors are considered to be in accordance with the Canadian Foundation Engineering Manual (CFEM) (2006) as well as the Alberta Building Code (2014).

Table B: Soil Resistance Factors – Shallow Foundations

Item	Soil Resistance Factor
Bearing Resistance	0.5
Passive Resistance	0.5
Horizontal Passive Resistance	0.5

Under LSD methodology, foundations should be designed on the basis of factored Ultimate Limit States (ULS) parameters. In order to determine the applicable working capacity, Serviceability Limit States (SLS) must also be considered.

5.3.3 Shallow Foundations

Shallow footings should be constructed a minimum of 1.4 m below the final design ground surface (frost protection requirement for footings under heated structures). For unheated structures, the footings should be constructed a minimum of 2.1 m below grade.

Where footings bear on native soils, the ultimate static bearing pressure may be taken as 200 kPa, subject to other recommendations in this report. The ultimate static bearing pressure is based on a correlation between SPT “N” values. Factoring should be considered as noted in the previous section. Footing dimensions should be in accordance with the minimum requirements of the Alberta Building Code, 2014.

A weeping tile system is recommended for all residential foundations in order to aid in maintaining a consistent moisture profile. The weeping tile should consist of a perforated pipe surrounded by free draining granular material, wrapped in filter cloth. The pipe should have a consistent slope leading to a sump. It should be noted that sump operation could be significant if the basement level is placed below the groundwater table.

Bearing certification by a geotechnical engineer is recommended to ensure that the shallow foundations are placed on competent native soils. If weak soils are encountered at footing level, recommendations may be provided to remove the weak materials and bring the subcut back to design elevation with low strength lean mix concrete. Alternatively, it may be possible to lower the footing elevation to more competent native soils.

It is recommended that a grade-all bucket be used for final excavation to the foundation subgrade elevation to minimize disturbance of the founding soils. A 50 mm concrete mudslab should be placed immediately following excavation and inspection to protect the bearing surface from disturbance and inclement weather.

Further recommendations regarding shallow foundations are given in Appendix C.

5.3.4 Foundation Perimeter Drainage Requirements

It is recommended that a weeping tile and sump system be constructed around the outside perimeter of the buildings (at the base of the footings, if selected) to maintain a relatively consistent moisture profile of the subgrade soils. The weeping tile system should comprise a perforated weeping tile, in turn surrounded with a minimum of 150 mm thick blanket of washed rock (maximum size 20 mm), with the granular layer wrapped in non-woven geotextile. The weeping tile should have a minimum 0.5% slope leading to a sump.

5.3.5 Below-Grade Walls

All below-grade 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 expression:

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

Where:

P_o = Lateral earth pressure “at-rest” condition (no wall movement occurs at a given depth).

K_o = Coefficient of earth pressure “at-rest” condition (use 0.5 for cohesive backfill and 0.45 for sand and gravel backfill).

γ = Bulk unit weight of backfill soil (use 19 or 21 kN/m^3 for cohesive or granular backfill, respectively).

H = Depth below final grade (m).

Q = Surcharge pressure at ground level (kPa).

It is assumed that drainage will be provided for all below-grade walls through the installation of a weeping tile system, as described above, and hydrostatic pressures will not be a factor in design. The weeping tile should have a minimum 0.5% slope leading to a sump. The preferred method would be to have provision to tie the sump into the property's on-site drainage system.

Backfill around concrete walls should not commence before the concrete has reached a minimum two thirds of its design strength and first floor framing is 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% of SPD is recommended. To avoid differential wall pressures, the backfill should be brought up evenly around the walls. A minimum 600 mm thick clay cap should be placed at the ground surface to reduce the infiltration of surface water.

5.3.6 Floor Slab System

5.3.6.1 Floor Slabs-on-Grade

Construction of floor slabs-on-grade for this project (outside of basements) must consider the surficial clay and/or clay fill noted within the development area. Construction may be considered feasible, provided the following precautions and construction recommendations are followed.

In native soils areas, following removal of topsoil, the subgrade should be scarified to a minimum depth of 300 mm, and moisture conditioned to a range of optimum to 2% over OMC. In areas of general engineered fill placed during site grading, a minimum depth of 150 mm subgrade preparation is recommended; if weathering is evident, 300 mm subgrade preparation is required. The minimum compaction should be 98% of SPD. The prepared subgrade should be proof-rolled and any soft or loose pockets detected should be reconditioned, as recommended above, or over-excavated and replaced with general engineered fill.

A levelling course of clean well-graded crushed gravel, at least 150 mm in compacted thickness, is recommended directly beneath the slabs-on-grade, unless a thicker course is required for structural purposes. The subgrade beneath slabs-on-grade should be protected at all times from moisture or exposure which may cause softening or disturbance of the subgrade soils. This applies during and after the construction period (and before and after placement of the required general engineered fill). Should the exposed surface become saturated or disturbed, it should be reworked to achieve the above standards.

If the subgrade is properly prepared, as noted above, floor slab movements should be limited to less than approximately 25 mm. Slabs-on-grade should be separated from bearing members to allow some differential movement. If this differential movement is unacceptable, the owner should consider a structurally supported floor.

Recommended procedures for compaction and backfill materials, and further recommendations for floor slabs-on-grade construction are included in Appendix C.

5.3.7 Building Site Grading

Drainage of surface water away from buildings should be maintained during construction. The finished grade of the proposed building site should be designed so that surface water is drained away from buildings by the shortest route. All drains should discharge well clear of the buildings. If there is a roof drain for a building, caution should be taken where downspouts discharge due to the high probability of ice forming in the winter. Downspouts may be discharged onto landscaped areas, provided the water is carried, by means of a concrete splash pad or extendable section so the point of discharge of the water is at least 2 m from the building. Landscaped surfaces adjacent to the walls of the buildings should be graded to slope away from the buildings at a gradient of at least 5% within 2 m of the buildings' perimeter. General landscaped areas should have grades of no less than 2% to minimize ponding.

5.3.8 Seismic Design

The site classification recommended for seismic site response is Classification D, as noted in Table 4.1.8.4.a of the National Building Code (2010).

5.3.9 Cement Type

Based on soluble sulphate concentration test results from selected samples taken during the field program and Tetra Tech's experience on local soils, the properties of concrete for foundations in contact with soil shall meet the requirements of the Canadian Standards Association (CSA) A23.1-14, Class S-2 exposure including water/cementing materials (w/cm) ratio of 0.45, air entrainment of 4% to 7% (for 14 mm to 20 mm nominal maximum aggregate size), and a minimum specified 56-day compressive strength of 32 MPa.

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 HSb cements.

5.3.10 Frost Protection

For protection against frost action, all perimeter footings must be placed a minimum of 1.4 m below final grade for heated structures, or 2.1 m for unheated structures.

Cast-in-place concrete piles, if considered and exposed to frost action, should have a minimum length of 6 m and should have full-length steel reinforcement. A void form is recommended for all grade beams and pile caps, to accommodate movements due to frost or soil swelling. For helical piles in unheated areas, all helices must be founded below a depth of 6 m from pile cut-off.

Pipes buried with less than 2.1 m of soil cover should be protected with insulation to avoid frost effects that might cause damage to, or breakage of, the pipes.

5.4 Stormwater Dry Pond Development

5.4.1 General

The geotechnical aspects of design and construction of the stormwater management facility, should be in accordance with the pertinent sections of the "Stormwater Management Guidelines for the Province of Alberta", dated March 2013 and prepared by the Municipal Program Development Branch of Alberta Environmental Protection. Detailed recommendations for the design and construction of this facility are provided in this section. In addition, consideration should be given to local municipal jurisdictional requirements for these types of facilities.

A stormwater dry pond is understood to be proposed for this development and is to be constructed within the upper reach of the coulee, generally between Lot 6 and Lot 9 (Figure 1). Specific details of the dry pond, with respect to footprint and depth have not yet been finalized. It is recommended that Tetra Tech be provided the opportunity to review the final configuration, as well as the design and construction aspects of the facility prior to construction, to ensure that the following recommendations are adhered to.

As discussed in the previous sections, the subsurface stratigraphy for the proposed pond site consists primarily of lacustrine clay (or colluvium) 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 liners and are likely to be encountered 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. However, the literature does present a range of permeability (k) for this till sheet between 10E-05 cm/sec and 10E-06 cm/sec. When compared to the field permeability of a reworked clay liner (based on previous permeability testing conducted by Tetra Tech on clay till materials in the general Lethbridge area (k=10E-07 cm/sec), the difference in potential water loss may be in the order of one to two magnitudes (10 to 100 times less for a remoulded clay liner).

It should be recognized that, over time, following construction of the pond (3 to 5 years), siltation of the pond floor, swelling of the medium plastic clays, and the development of a groundwater mound will greatly affect these estimated annual water losses. Quantifying this loss to a greater extent than that predicted here would require groundwater modelling which was not included in the current project scope.

The ultimate decision and risk (in terms of economics) for the performance of any pond containment system is that of the Developer; however, from a geotechnical perspective, 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 (or clay till blended with lacustrine clay) for construction of a remoulded clay liner for the pond 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 remoulded clay liners should be limited to areas above the high water level (HWL).

It is recommended that below the normal water level, the sideslopes should be no steeper than 4H:1V to 5H:1V, with a minimum slope in the bottom of the pond of 1% (2% is preferred). The maximum exterior sideslopes should be no greater than 3H:1V. For this configuration, and understanding of the relative size of the pond, as well as the fact that the embankment between the normal water level and HWL is constructed with an engineered clay liner (as recommended in this report), the potential for erosion from wave action is considered small.. Should erosion not be tolerable for the inside of the constructed embankments due to potential wave action, consideration should be given to erosion protection of the berms. In this instance, slope protection consisting of rip-rap designed for potential wave erosion is recommended. The use of a filter fabric median between the native soils and rip-rap may be required in areas of soft, silty, sandy clays. Where the area below the rip-rap is reworked, a filter fabric is not envisioned to be required. 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.

5.4.2 Pond Construction

5.4.2.1 General Base Preparation

Following stripping of any organic material from the base and sidewalls (slopes) of the pond, the containment basin areas should be over-excavated 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, moisture conditioned to between –1% and +2% of OMC, and recompacted to a minimum of 98% 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.

The basin sidewalls in the cut areas (up to HWL) should also be over-excavated 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 wasted or 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

5.4.2.2 Remoulded Clay Liner

The following recommendations for the design and construction of remoulded clay liners are based on compliance with Alberta Environment's publication, “Stormwater Management Guidelines for the Province of Alberta”, dated March 2013.

Based on the site soil conditions and the assumed permeability value of clay till materials used on similar soils for other projects with stormwater dry ponds, it is recommended that the thickness of remoulded clay liner be 1.0 m along the base of the dry 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 HWL and in other areas termed as ‘dry pond’, which will normally not be below the water level. These liner thicknesses account for the potential desiccation of the upper 0.2 m of the liner during the initial periods when the pond is empty. They also account for potential disturbance (primarily of the sidewalls) during storm events or during periods of shore maintenance. To clarify further, the 0.3 m initial subgrade preparation depth may be included as part of the total liner thickness, provided base preparation is completed in accordance with the recommendations of this report.

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 over-excavated and replaced with compacted cohesive clay fill materials.

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 the HWL or outside the liner zone for berms.

Soil moisture contents for the clay till are generally variable with respect to the OMC for the composite clay till material. Moisture conditioning will be required during liner construction for the pond. 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 (to 0.3 m depth), the excavated clay soils (liner borrow material) should be moisture conditioned to between –1% of the optimum and +2% over the OMC, as determined by the SPT. Each lift should then be compacted to a minimum of 98% 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. All general engineered fill placement in excavation cuts (or abutted to natural slopes following topsoil removal) must be 'notched' into the native slope materials a minimum of 0.5 m to ensure a bond with the native materials to reduce seepage. The engineered soil berm at the east end of the proposed dry pond must be designed to meet all regulatory requirements, taking into account the depth and configuration of the berm in this area. Depending on the final design of the stormwater dry pond, and the operational practices to drain the pond shortly after a storm event, the east berm may be consider a 'dam' and fall under different regulatory requirements.

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, remoisture conditioned, and recompacted. Prior to pond 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

6.0 SLOPE STABILITY ASSESSMENT AND DEVELOPMENT GUIDELINES

6.1 Site Description

As described in Section 4.1, the proposed residential development footprint contains a coulee, orientated east-west, from the west wall of the Oldman River Valley. Within the proposed subdivision footprint, the ground elevation (geodetic datum) at prairie level varies from approximately Elevation 906 m along the south perimeter at the crest of the slope to Elevation 910 m along the north perimeter. The coulee floor within the footprint of the development area varies from approximate Elevation 845 m at the east perimeter to prairie level at the west extremity at the crest of the slopes. Figures 2, 3, and 4 depict the general topography of the coulee.

The north facing slopes of the coulee are approximately 2.2H:1V, whereas the south facing slopes are generally at 2.7H:1V.

Survey for the site was conducted by MGCL of Lethbridge, Alberta.

The site and surrounding area is generally surfaced with native prairie grasses, with some small shrubs in sparse areas on the north facing slopes. The proposed development area at prairie level generally slopes westward and toward the coulee crest.

6.2 Site Reconnaissance

Tetra Tech personnel conducted a detailed site reconnaissance for the site. The reconnaissance included reviewing the existing condition of the slopes and a visual assessment of the slopes and areas at both the crest and toe of the slopes. The following pertinent points were noted:

- No significant areas indicated evidence of recent slope movements. Historical slope instabilities were noted along the north facing slopes at the east end of the coulee.
- Minor erosion was visible along the bottom of the coulee, presumably from more significant precipitation events.
- Groundwater seepage was not noted exiting from the slopes in the area. Given the vegetation cover and lack of shrubs, trees, or other heavy vegetation, it is opined there is no significant groundwater or phreatic surface within the height of the slopes at the development site.

6.3 Mining Activity

Research was conducted to review the possible existence of mine workings within the boundary of the proposed development area using a publication (#88 – 45) by the Energy Resource Conservation Board (Coal Mine Atlas, Operating and Abandoned Coal Mines in Alberta 1988). Based on this publication, there does not appear to have been any mining activity in the general area of the proposed development site.

6.4 Geology

Tetra Tech reviewed published reports regarding the geological history of the area. This information was considered in the stability analyses, as well as information from the borehole drilling program (maximum depth of boreholes was 6.6 m) conducted for this evaluation. A brief summary, in descending order, of the general stratigraphy assumed at the site is presented below:

- Upper Lacustrine Clays and Silts: A surficial fine-grained deposit overlying the Buffalo Lake Till, with a thickness of up to 4 m. Characterized by fine-grained silt and clay.
- Upper Till: Also known as the Buffalo Lake Till; it is characterized by a lack of cohesion which often leads to slumping of this deposit. A single period of consolidation has resulted in the development of vertical stress cracks, well oxidized, with some limited bedding.
- Lenzie Silts: A glaciolacustrine deposit usually comprised of varved clay in the upper zone, with interbedded silts and sands. The assumed contact elevation of the Lenzie Silts is Elevation 895.0 m, taken from a geotechnical study conducted in the Lethbridge area (includes the subject site) in 2002 and authored by AMEC Earth & Environmental Limited (AMEC) (City of Lethbridge Phase II Development Setback Assessment Oldman River Valley Slopes).
- Lower Till: A glacial deposit (Labuma Till), characterized by its dense, hard, clayey consistency, and dark grey or grey brown colour. This layer is hard as a result of consolidation pressure from overlying ice, deposited during Laurentide glaciation. Also contains trace gravel and occasional cobbles.
- Saskatchewan Sands & Gravels: Pre-glacial deposit overlying the bedrock (Bearpaw Formation). The contact elevation of the Saskatchewan Sands & Gravels is generally around Elevation 845 m and the deposit typically around 5 m in thickness.
- Bearpaw Formation: Bedrock generally consisting of a marine shale with interbedded layers of siltstone and sandstone. For the purposes of the slope stability analyses for the subject development, the Saskatchewan Sands & Gravels deposit and bedrock did not impact the stability analyses.

6.5 Slope Stability Analysis

6.5.1 General

Tetra Tech conducted a slope stability analysis using modelling software, Slope/W by GeoStudio (2012). Slope geometry was based on elevation contours which were provided by MGCL. Based on the elevation contour data, four (4) representative slope cross-sections (A-A’, B-B’, C-C’, and D-D’) were generated and reviewed (Figure 2).

The minimum safe development setback distance was determined based on a minimum Factor of Safety (FOS) against slope instability of 1.5. This FOS is considered to be the current engineering standard for this type of development.

6.5.2 Soil Strength Parameters

Assumed soil strength parameters used in the analysis were based on Tetra Tech’s local experience. Groundwater parameters were selected by Tetra Tech to represent post-development conditions assuming an increase in soil moisture caused by the development (lawn irrigation etc.) and reduced evapotranspiration due to development cover (streets, sidewalks, residential dwellings, etc.).

The soil strength and groundwater parameters selected for the analyses, modelling the worst case conditions (post-development), were as follows:

Material: Clay

Unit Weight:	18 kN/m³
Cohesive Intercept c':	0 kPa
Friction Angle:	26°
Pore Water Pressure Parameter r_u:	0.2

Material: Clay Till

Unit Weight:	19 kN/m³
Cohesive Intercept c':	0 kPa
Friction Angle:	26°
Pore Water Pressure Parameter r_u:	0.2

6.5.3 Stability Model

The present stability of the slopes adjacent to the proposed development area has been reviewed based on the site reconnaissance, analyses using Limit Equilibrium Modelling (Slope/W by GeoStudio), and past experience with other slope stability assessments of the Oldman River Valley and coulee slopes. Visual observations of the slopes in the project area indicate that there are no recent surficial instabilities in the upper elevations of the adjacent slope profile, as noted in Section 6.2.

There are several failure mechanisms that may govern along the coulee slopes. Shallow to moderate depth circular failures within the upper clay and clay till deposits may develop at the site; however, would be considered to be relatively shallow within the upper 1 m to 1.5 m of the slope surface and occur within the slope below the crest.

Circular or block failures along the Lenzie Silts contact elevation are also considered possible. This failure mechanism is the most prevalent in the general Lethbridge area with respect to slope instabilities within coulee slopes. Based on past experience (including a review of the AMEC report) this failure mechanism is typically a block failure, with its crest initiating within the slope and regressing back toward prairie level at an inclination of approximately 4H:1V from the elevation of the Lenzie Silts deposit where it exits the slope.

In general terms, a slope's stability is a function of driving forces and resisting forces. The driving forces include self-weight of the soil and any surcharge loads on the upper portion of the slope. The resisting forces are primarily the soil strength which can be mobilized from soil's internal friction and cohesion. Slope geometry (maximum inclination) and moisture content also dictate both driving and resisting forces.

The presence of groundwater has a negative effect, as it simultaneously increases the weight of the soil, applies additional loading (hydrostatic), and decreases the soil's cohesion. If certain soil layers become saturated, this can have a lubricating effect which may decrease stability further.

The results of the software-based slope stability analyses, using predevelopment soil moisture conditions, indicated a FOS against shallow depth failures of between 1.1 and 1.3, and moderate depth failures of greater than 1.3 for failure surfaces taken from the Top-of-Bank[1]. This confirms Tetra Tech's visual assessment as presented in the preceding sections.

---

[1] Top-of-Bank: The line where the general trend of the slope changes from greater than 15% to less than 15%, as determined by field survey.

6.5.4 Impact of Development

Site development generally results in an increase in soil moisture due to irrigation, reduced evapotranspiration due to increased soil cover and reduced vegetation, septic field systems, and other buried utilities, etc. The anticipated increase in soil moisture has been incorporated into the stability model.

The results of the stability analysis (under post-development conditions) indicated a FOS against shallow depth failures at the Top-of-Bank (both a relatively shallow circular failure and a block failure along the contact elevation of the Lenzie Silts deposit) of between 0.9 and 1.2, indicating that these type of failures may occur with an increase in moisture content of the subsurface soils. The computed FOS against moderate to deep failure was greater than 1.5 at the development setback line.

6.6 Development Setback Requirements

Based on the results of the slope stability analyses, as well as local experience and the information discussed herein, Tetra Tech has determined that the minimum development setback distance will be as shown on Figure 5. The development setback distances have been determined by establishing a point within the subject site which results in a minimum FOS of 1.5 against slope instability impacting the development.

During the geotechnical evaluation, Tetra Tech and MGCL established the proposed development setback limits, as well as the Top-of-Bank, in the site. The coordinates of both lines have been established (as presented on Figure 5) by MGCL and approved by Tetra Tech.

6.7 Development Guidelines

Precautionary measures, which should be included in the geotechnical aspects of the design of the proposed development, are outlined as follows:

- Siting of septic fields should be behind the development setback line.
- Any fill excavated from basements should be disposed of well away from the slope, and well behind the development setback line.
- Positive grading should be provided to ensure drainage off of the upper part of the property (i.e., at Top-of-Bank) is directed as sheet flow over the crest of the slopes (i.e., avoiding concentrating the flow which causes erosion).
- All utilities and plumbing should be carefully installed and regularly inspected to ensure they are in good working order.
- Normal, prudent design and construction procedures should be followed during development of the residences, including consideration of stormwater management. Stormwater retention facilities should be kept well away from the development setback line, unless the recommendations contained in this report are strictly followed.
- The zone between the development setback line and Top-of-Bank should be treated as a restricted development zone. This involves the following:
    - Maintain vegetation cover.
    - No irrigation or discharge of water for any reason.
    - Earthworks is not allowed without review by a geotechnical engineer.
    - No dumping of grass cuttings, branches, or other materials of any kind.

Notwithstanding the recommendations discussed above, some surficial sloughing and slope movement may occur. The purpose of the development setback is not to prevent slope failure, but rather, to protect the development from being affected by the failure when it occurs.

7.0 DESIGN AND CONSTRUCTION GUIDELINES

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

- Shallow Foundations
- Construction Excavations
- Backfill Materials and Compaction
- Floor Slabs-on-Grade

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.

8.0 CLOSURE

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

Respectfully submitted,
Tetra Tech Canada Inc.

JIEJUN ZHAO

Dec. 14. 2017

Prepared by:
Pier-Luigi Lucca M.Sc., E.I.T.
Geotechnical Engineer-in-Training
Prairie Engineering
Direct Line: 587.220.3801
pier.lucca@tetratech.com

Reviewed by:
Jiejun Zhao, P.Eng.
Senior Geotechnical Engineer
Prairie Engineering
Direct Line: 403.359.6513
jiejun.zhao@tetratech.com

MARC J. SABOURIN

DEC 14, 2017

Marc J. Sabourin, P.Eng.
Vice President – Western Canada
Engineering Practice
Direct Line: 403.359.6518
marc.sabourin@tetratech.com

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
Signature
Date DECEMBER 14, 2017
PERMIT NUMBER: P13774
The Association of Professional Engineers and Geoscientists of Alberta

/tlp

FIGURES

LEGEND

▬ ▪ ▬ SITE BOUNDARY

◐ BOREHOLE LOCATION

0 250m

Scale: 1:5,000 @ 11"x17"

NOTES
GOOGLE EARTH IMAGERY DATED 2015

CLIENT

Fiorino Homes Ltd.

TETRA TECH

RURAL COUNTRY RESIDENTIAL SUBDIVISION

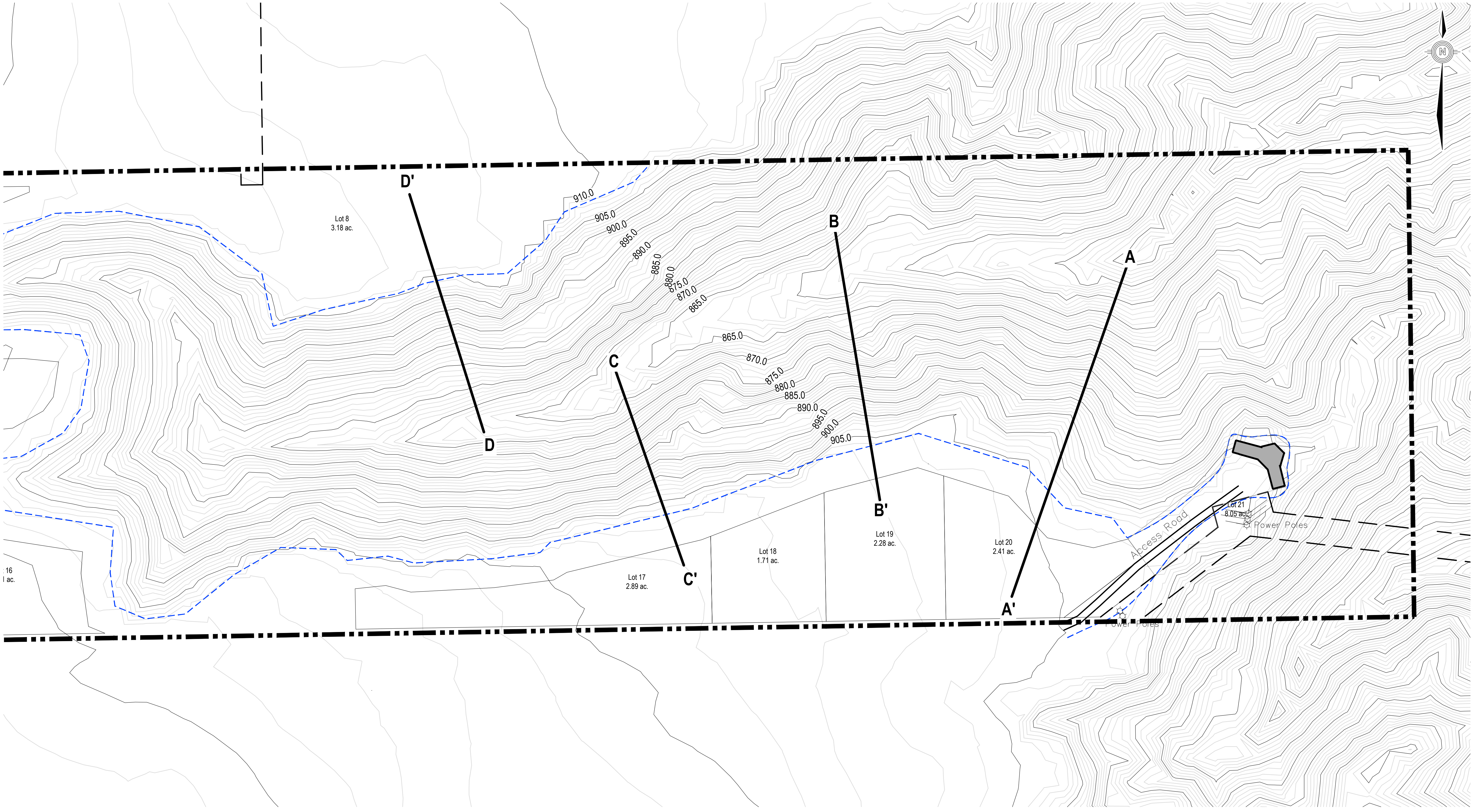
BOREHOLE LOCATION PLAN

PROJECT NO.	DWN	CKD	REV
LGEO03581-01.001	LCH	MJS	0

OFFICE	DATE
TT LETH	December 2017

Figure 1

C:\Lethbridge\Drafting\ENG.LGEO\LGEO03581\LGEO03581-01-001 Figure 1 Slope Stability.dwg [FIGURE 1] December 11, 2017 - 4:19:24 pm (BY: HUGHES, LEANNE)



LEGEND

- SITE BOUNDARY
- TOF OF BANK

0 100m

Scale: 1:2,500 @ 11"x17"

CLIENT

Fiorino Homes Ltd.

TETRA TECH

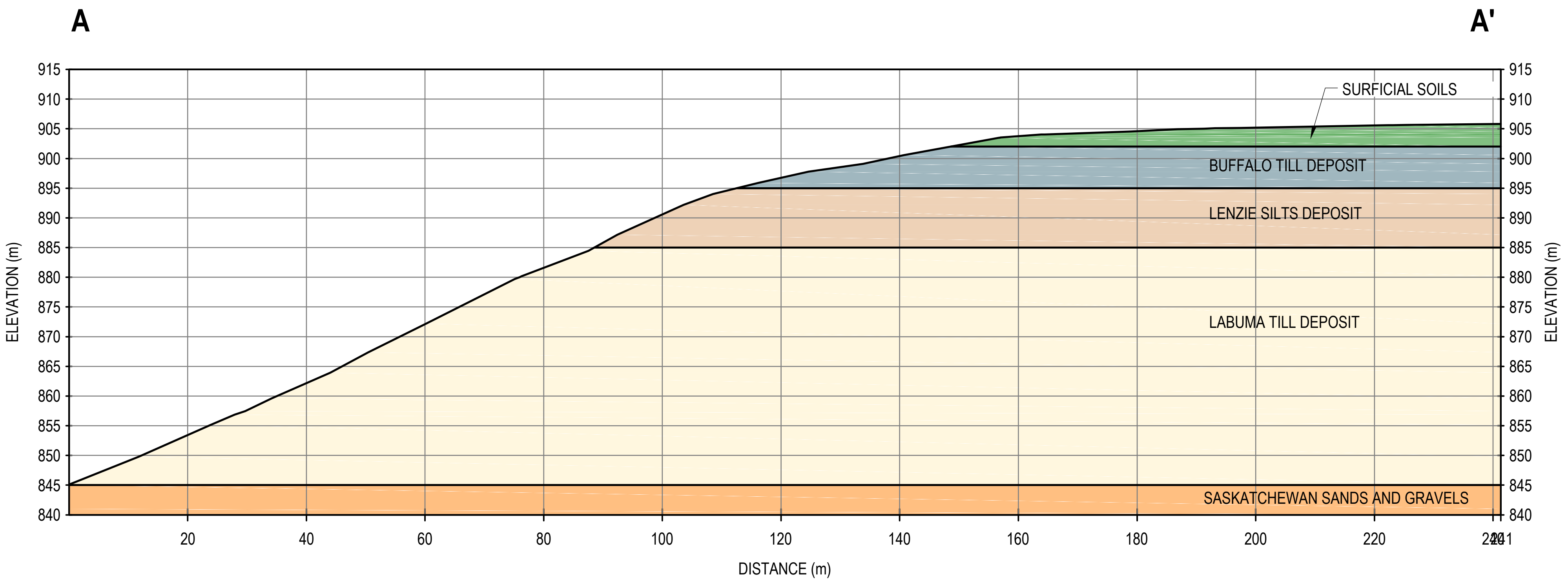
RURAL COUNTRY RESIDENTIAL SUBDIVISION

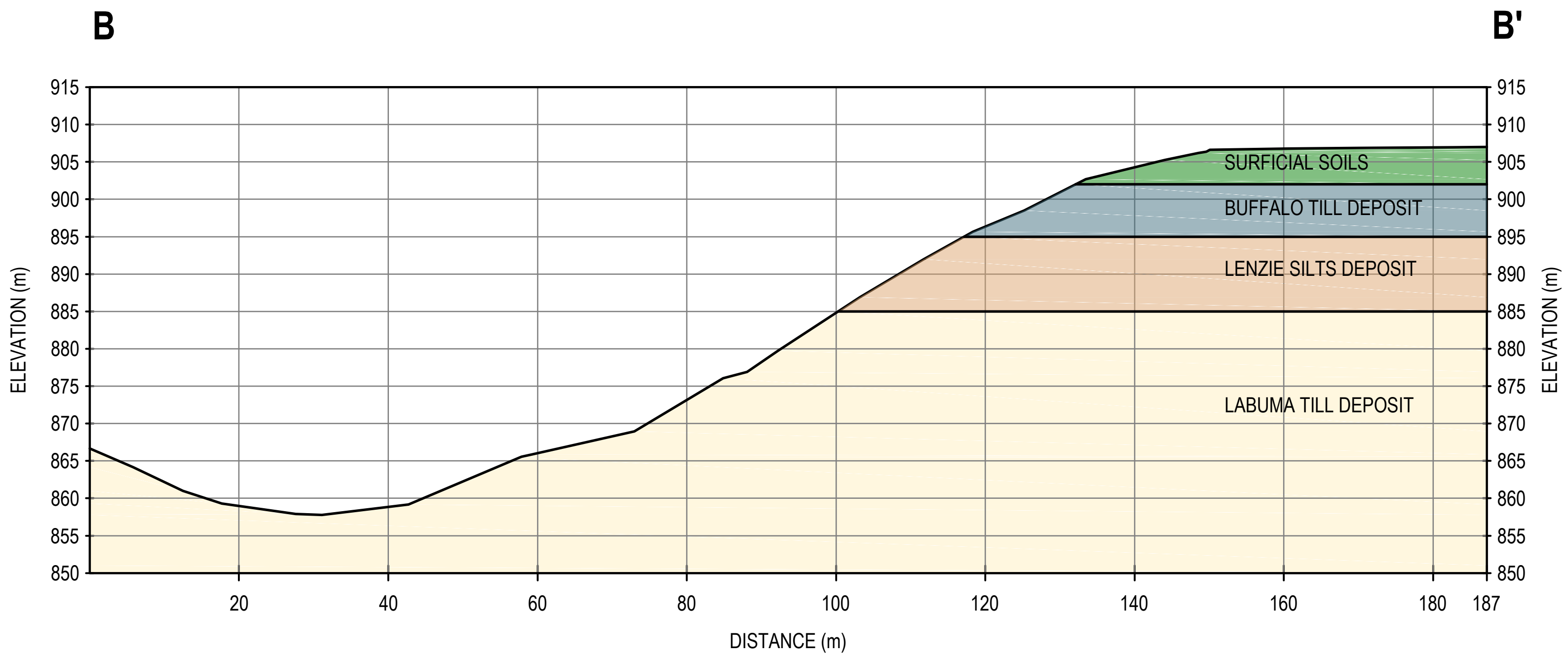
TOPOGRAPHIC PLAN AND SECTION LOCATIONS

PROJECT NO.	DWN	CKD	REV
LGEO03581-01.001	LCH	MJS	0

OFFICE	DATE
TT LETH	December 2017

Figure 2





0 50m

Scale: 1:1,000 @ 11"x17"

CLIENT

Fiorino Homes Ltd.

TETRA TECH

RURAL COUNTRY RESIDENTIAL SUBDIVISION

SECTION A-A' AND B-B'

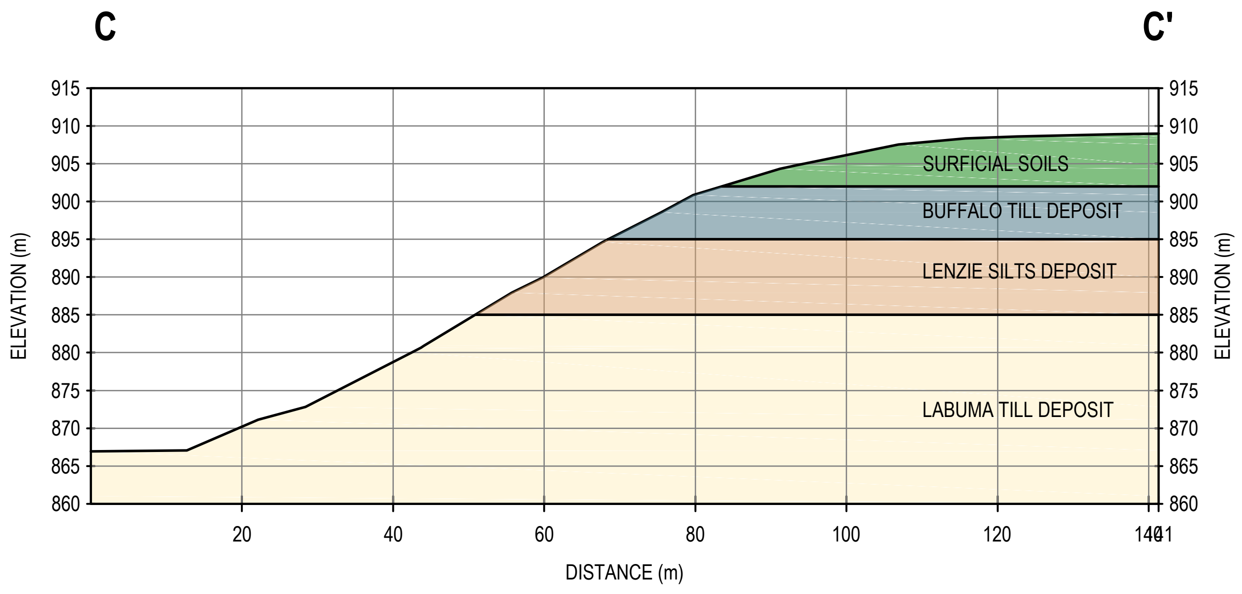
PROJECT NO.	DWN	CKD	REV
LGEO03581-01.001	LCH	MJS	0

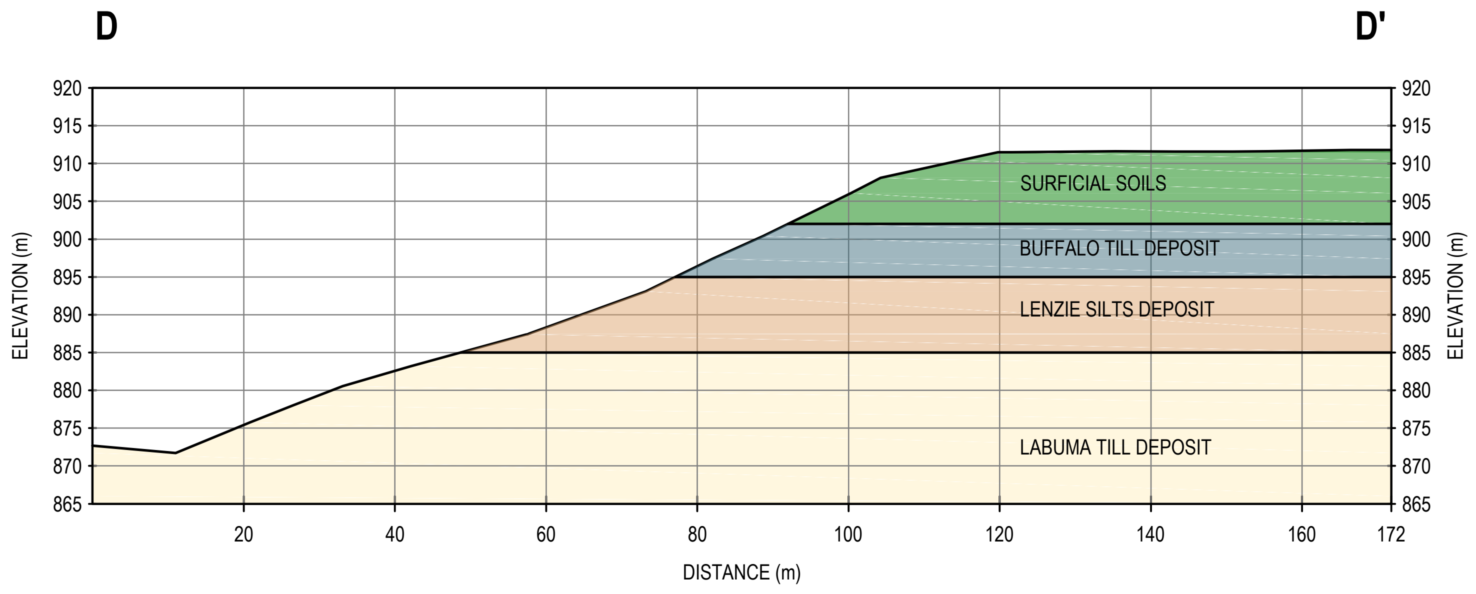
OFFICE	DATE
TT LETH	December 2017

Figure 3

C:\Lethbridge\Drafting\ENG.LGEO\LGEO03581\LGEO03581-01-001 Figures 2-4 Slope Stability.dwg [FIGURE 3] December 11, 2017 - 9:53:07 pm (BY: HUGHES, LEANNE)

C:\Lethbridge\Drafting\ENG.LGEO\LGEO\LGEO03581\LGEO03581-01-001 Figures 2-4 Slope Stability.dwg [FIGURE 4] December 11, 2017 - 9:53:34 pm (BY: HUGHES, LEANNE)





0 50m

Scale: 1:1,000 @ 11"x17"

CLIENT

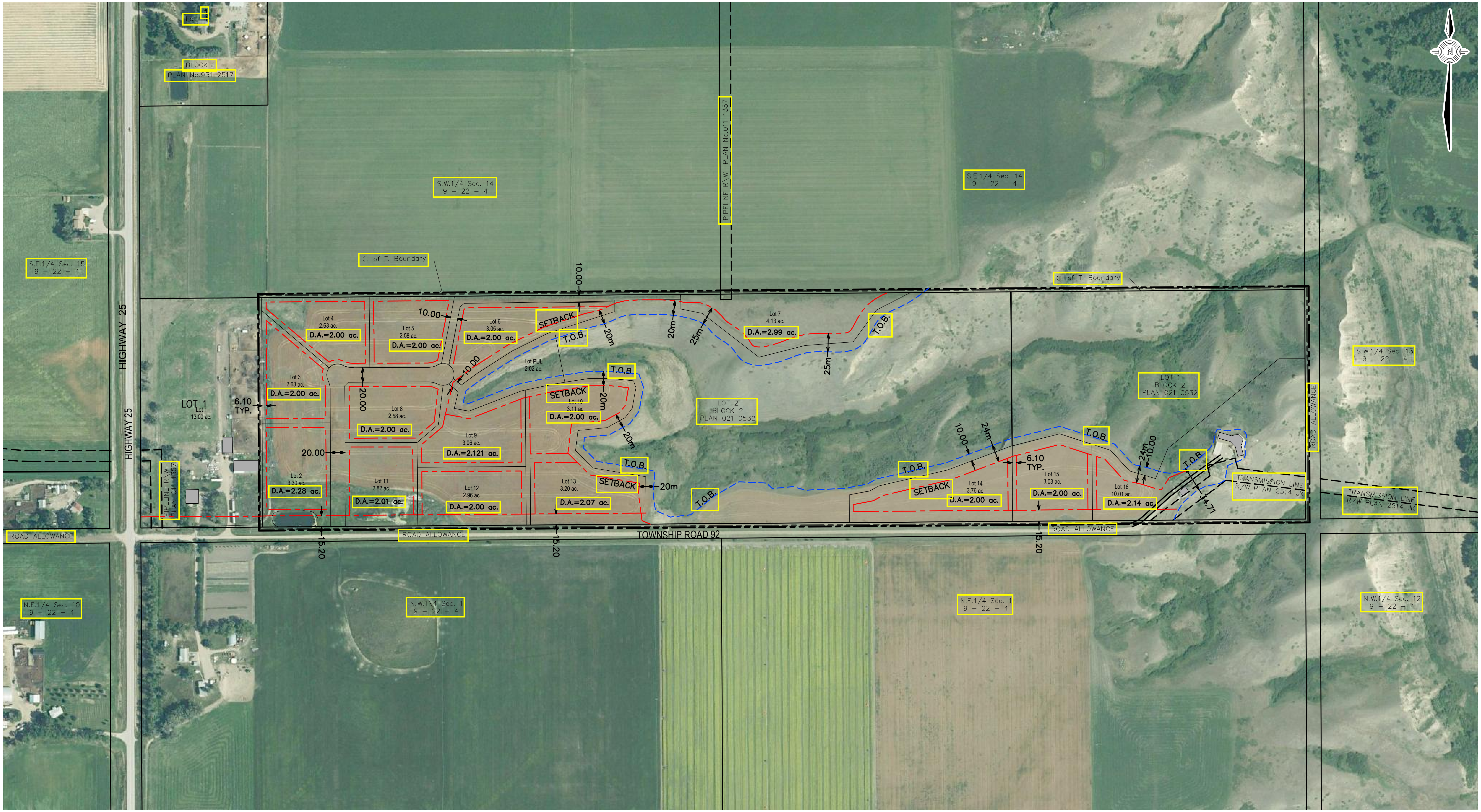
Fiorino Homes Ltd.

TETRA TECH

RURAL COUNTRY RESIDENTIAL SUBDIVISION

SECTION C-C' AND D-D'

PROJECT NO.	DWN	CKD	REV	
LGEO03581-01.001	LCH	MJS	0	**Figure 4**
OFFICE	DATE			
TT LETH	December 2017			



C:\Lethbridge\Drafting\ENG.LGEO\LGEO03581\LGEO03581-01-001 Figure 5 Slope Stability.dwg [FIGURE 5] December 11, 2017 - 4:36:24 pm (BY: HUGHES, LEANNE)

LEGEND

- ▬ ▪ ▬ SITE BOUNDARY
- – – – TOF OF BANK
- — · — SETBACK LINE

0 250m

Scale: 1:5,000 @ 11"x17"

NOTES

GOOGLE EARTH IMAGERY DATED 2015

CLIENT

Fiorino Homes Ltd.

TETRA TECH

RURAL COUNTRY RESIDENTIAL SUBDIVISION

DEVELOPMENT SETBACK LIMITS

PROJECT NO.	DWN	CKD	REV
LGEO03581-01.001	LCH	MJS	0

OFFICE	DATE
TT LETH	December 2017

Figure 5

APPENDIX A

LIMITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the “Professional Document”).

The Professional Document is intended for the sole use of TETRA TECH’s Client (the “Client”) as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the “Contract” herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an “Authorized Party”), consideration for such authorization is the Authorized Party’s acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the “Limitations on Liability”). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party’s express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH’s professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH’s “Instruments of Professional Service”), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH’s Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH’s Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, 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. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH 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 further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document 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 conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH 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.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH 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.

1.8 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. TETRA TECH 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.

1.9 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.

1.10 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. TETRA TECH 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.

1.11 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.

1.12 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.

1.13 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.

1.14 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.

1.15 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.

1.16 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.

1.17 SAMPLES

TETRA TECH 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.

APPENDIX B

BOREHOLE LOGS

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

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

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

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

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

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

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

GENERAL DESCRIPTIVE TERMS

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

TETRA TECH

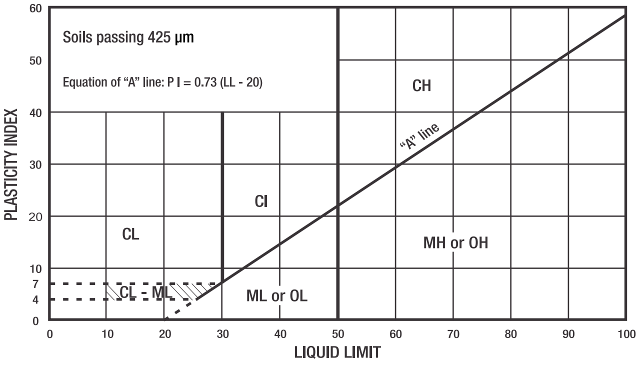
MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS More than 50% retained on 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on 4.75 mm sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines Less than 5% Pass 75 mµsieve GW, GP, SW, SP More than 12% Pass 75 mµsieve GM, GC, SM, SC 5% to 12% Pass 75 µm sieve Borderline Classification requiring use of dual symbols	$C_U = D_{60} / D_{10}$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 4 Between 1 and 3
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above "A" line or plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes 4.75 mm sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines		$C_U = D_{60}/D_{10}$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 6 Between 1 and 3
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above "A" line or plasticity index greater than 7	

MAJOR DIVISION				GROUP SYMBOL	TYPICAL DESCRIPTION
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	SILTS	Liquid limit	<50	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity
			>50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
	CLAYS Above "A" line on plasticity chart negligible organic content	Liquid limit	<30	CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays
			30-50	CI	Inorganic clays of medium plasticity, silty clays
			>50	CH	Inorganic clays of high plasticity, fat clays
	ORGANIC SILTS AND CLAYS	Liquid limit	<50	OL	Organic silts and organic silty clays of low plasticity
			>50	OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS				PT	Peat and other highly organic soils

For classification of fine-grained soils and fine fraction of coarse-grained soils.

PLASTICITY CHART



*Based on the material passing the 75 mm sieve
Reference: ASTM Designation D2487, for identification procedure see D2488. USC as modified by PFRA

SOIL COMPONENTS

FRACTION	SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS	
	PASSING	RETAINED	PERCENTAGE	DESCRIPTOR
GRAVEL				
coarse	75 mm	19 mm	>35 %	"and"
fine	19 mm	4.75 mm	21 to 35 %	"y-adjective"
SAND				
coarse	4.75 mm	2.00 mm	10 to 20 %	"some"
medium	2.00 mm	425 µm	>0 to 10 %	"trace"
fine	425 µm	75 µm		
SILT (non plastic) or CLAY (plastic)	75 µm		as above but by behavior	

OVERSIZE MATERIAL

Rounded or subrounded	
COBBLES	75 mm to 300 mm
BOULDERS	> 300 mm
Not rounded	
ROCK FRAGMENTS	>75 mm
ROCKS	> 0.76 cubic metre in volume

Tt_Modified Unified Soil Classification.cdr

TETRA TECH

BOREHOLE KEYSHEET

Water Level Measurement

▼ Measured in standpipe, piezometer or well

▽ Inferred

Sample Types

▤ A-Casing
◫ Core
▒ Disturbed, Bag, Grab
▮ HQ Core
◹ Jar
⧅ Jar and Bag
⧓ NQ Core
◢ No Recovery
☒ Split Spoon/SPT
▥ Tube

Backfill Materials

■ Asphalt
▒ Bentonite
⁘ Cement/ Grout
▧ Drill Cuttings
⁘ Grout
⁙ Gravel
░ Sand
▥ Slough
⁂ Topsoil Backfill

Lithology - Graphical Legend[1]

■ Asphalt
▧ Bedrock
○ Cobbles/Boulders
▨ Clay
■ Coal
⁘ Concrete
▩ Fill
○ Gravel
▦ Limestone
◇ Mudstone
≋ Organics
⁂ Peat
░ Sand
☒ Sandstone
☰ Shale
▥ Silt
☒ Siltstone
▩ Till
⁂ Topsoil

[1] The graphical legend is an approximation and for visual representation only. Soil strata may comprise a combination of the basic symbols shown above. Particle sizes are not drawn to scale

TETRA TECH

FIORINO HOMES LTD.

Borehole No: **17BH001**

Project: RURAL COUNTRY RESIDENTIAL SUBDIVISION	Project No: ENG.LGEO03581-01
Location: SOUTH 1/2 SEC 14-9-22 W4M	Ground Elev: 919 m
LETHBRIDGE, AB I N:5510123 , E:363900	PROJECT ENGINEER: JIEJUN ZHAO

Method: Solid stem auger

Soil Description

TOPSOIL - clay, sandy, silty, moist, dark brown, roots, organics

CLAY (FILL) - silty, some sand, damp, stiff, medium plastic, brown
... trace gravel, damp to moist
... moist, coal and oxide specks

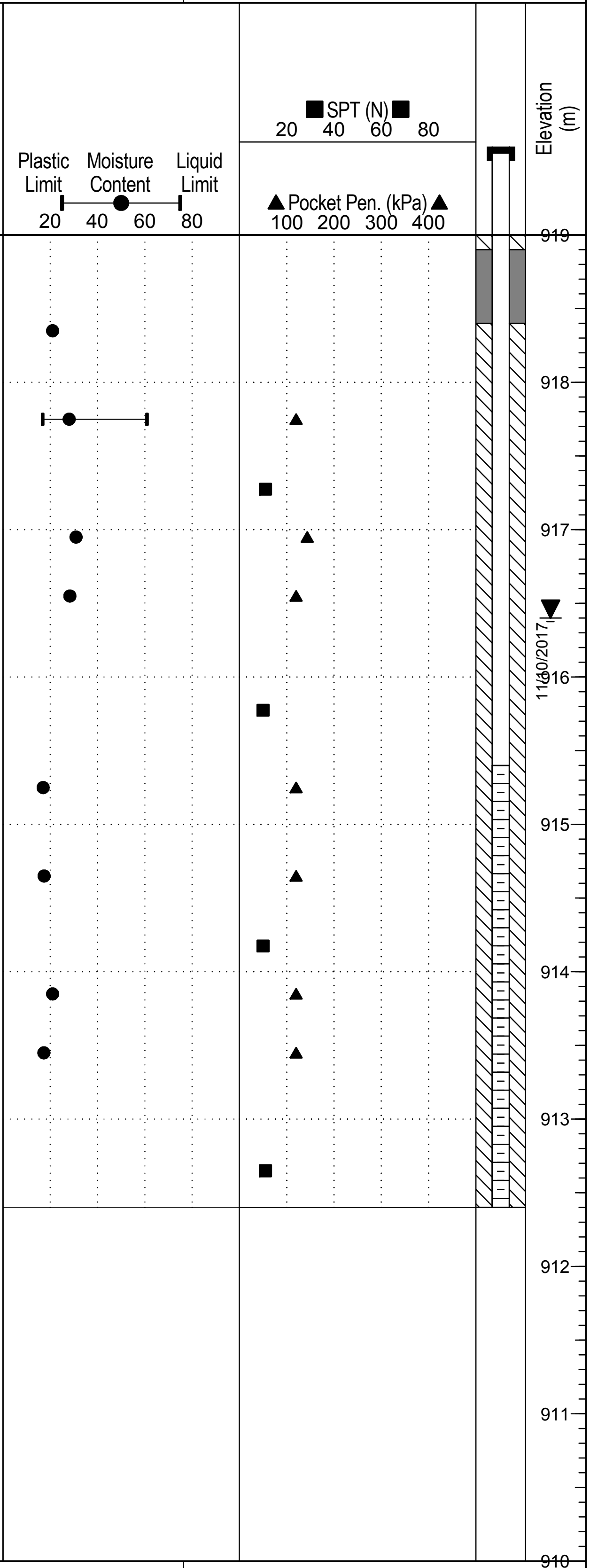
CLAY - silty, trace sand, moist, stiff, high plastic, brown with greyish brown mottling
... coal specks
... soluble sulfate content = 0.3% @ 2.0 m
... oxide specks
... sand lenses

CLAY (TILL) - silty, some sand, trace gravel, moist, stiff, medium plastic, brown with greyish brown mottling, coal and oxide specks, sand lenses
... 75 mm very moist, firm pocket
... high plastic clay lenses to 15 mm

End of Borehole @ 6.6 m

No Seepage or Sloughing Upon Completion
Slotted 25 mm PVC Standpipe Installed to 6.6 m
Indicated Water Level Measured on November 10, 2017

Sample Number	SPT (N)	Moisture Content (%)
B1		21
B2		28
D1	11	
B3		30.9
B4		28.3
D2	10	
B5		17
B6		17.4
D3	10	
B7		21
B8		17.3
D4	11	



Depth (m): 0 1 2 3 4 5 6 7 8 9

11/10/2017

Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 6.6 m
Drilling Rig Type: 150mm SOLID STEM AUGER	Start Date: October 31, 2017
Logged By: SS	Completion Date: October 31, 2017
Reviewed By: MS	Page 1 of 1

TETRA TECH

FIORINO HOMES LTD.

Borehole No: **17BH002**

Project: RURAL COUNTRY RESIDENTIAL SUBDIVISION	Project No: ENG.LGEO03581-01
Location: SOUTH 1/2 SEC 14-9-22 W4M	Ground Elev: 918.8 m
LETHBRIDGE, AB I N:5510293 , E:363947	PROJECT ENGINEER: JIEJUN ZHAO

Depth (m) 0 – 9

Method: Solid stem auger

Soil Description

TOPSOIL - clay, sandy, silty, moist, dark brown, roots, organics

CLAY (FILL) - silty, some sand, damp, stiff, medium plastic, brown, root hairs

... moist, trace organics, tHIN silt lenses, trace organic inclusions, trace oxide specks

CLAY - silty, some sand, moist, stiff, medium plastic, brown, silt lenses, trace precipitates

... 200 mm high plastic clay pocket

CLAY (TILL) - silty, some sand, trace gravel, moist, stiff, medium plastic, brown, coal and oxide specks, silt and sand lenses

... high plastic clay inclusions

... very moist, firm

▼ 11/10/2017

... firm to stiff, very moist

... moist, stiff

... 200 mm some sand to sandy pocket, firm, silt and sand lenses to 15 mm

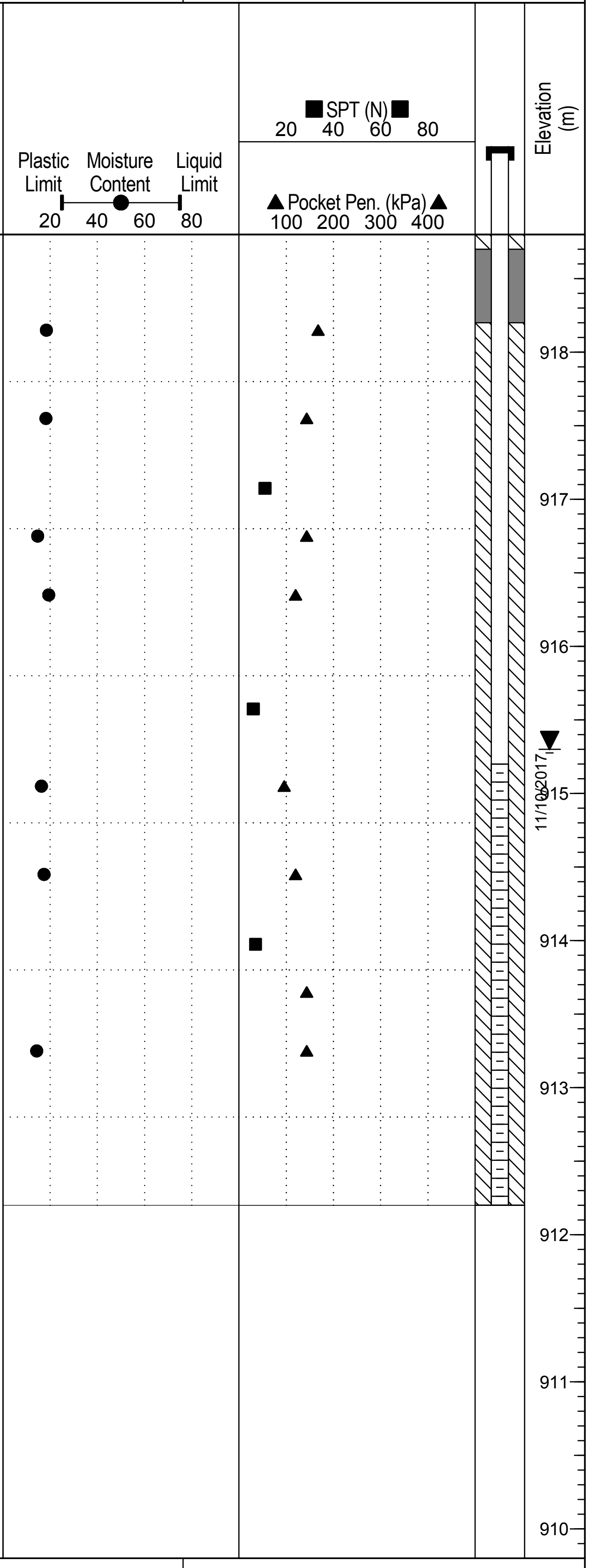
... firm

... stiff, brown, oxide staining

End of Borehole @ 6.6 m

No Seepage or Sloughing Upon Completion
Slotted 25 mm PVC Standpipe Installed to 6.6 m
Indicated Water Level Measured on November 10, 2017

Sample Number	SPT (N)	Moisture Content (%)
B1		18.4
B2		18.2
D1	11	
B3		14.7
B4		19.4
D2	6	
B5		16.3
B6		17.4
D3	7	
B7		
B8		14.3



Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 6.6 m
Drilling Rig Type: 150mm SOLID STEM AUGER	Start Date: October 31, 2017
Logged By: SS	Completion Date: October 31, 2017
Reviewed By: MS	Page 1 of 1

TETRA TECH

FIORINO HOMES LTD.

Borehole No: **17BH003**

Project: RURAL COUNTRY RESIDENTIAL SUBDIVISION	Project No: ENG.LGEO03581-01
Location: SOUTH 1/2 SEC 14-9-22 W4M	Ground Elev: 916.7 m
LETHBRIDGE, AB I N:5510196 , E:364014	PROJECT ENGINEER: JIEJUN ZHAO

Method: Solid stem auger

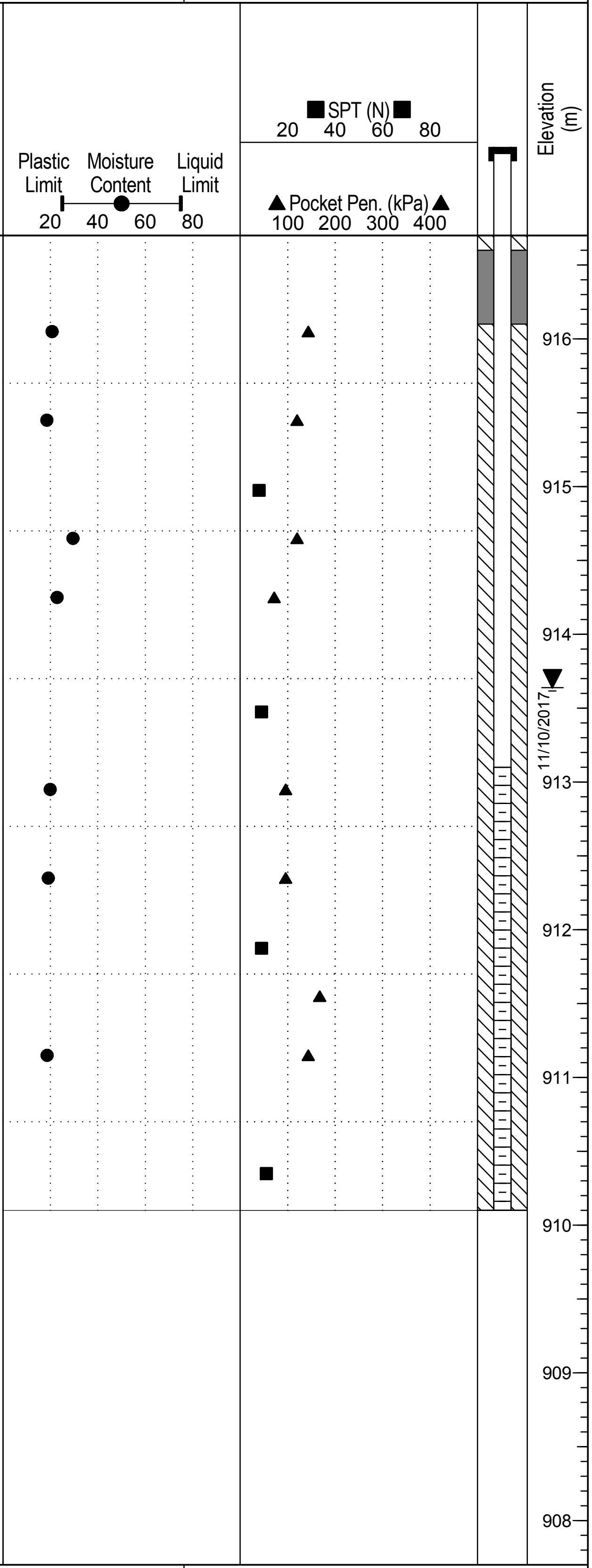
Soil Description	Sample Number	SPT (N)	Moisture Content (%)
TOPSOIL - clay, sandy, silty, moist, dark brown, roots, organics, trace red shale inclusions			
CLAY (FILL) - silty, some sand, moist, stiff, medium plastic, brown with dark brown mottling, trace organic inclusions, trace red shale inclusions	B1		20.7
CLAY - silty, some sand, moist, stiff, medium plastic, brown	B2		18.5
... moist to very moist, firm to stiff			
... coal and oxide specks	D1	8	
... trace sand, moist, stiff, high plastic, brown with dark greyish brown mottling	B3		29.5
CLAY (TILL) - silty, some sand, very moist, firm, medium plastic, brown with greyish brown mottling, coal and oxide specks, silt and sand pockets	B4		22.8
... moist to very moist, firm to stiff	D2	9	
	B5		19.9
	B6		19.1
	D3	9	
... moist, stiff	B7		
	B8		18.6
... 200 mm some sand to sandy, very moist, firm, low to medium plastic clay pocket			
	D4	11	

End of Borehole @ 6.6 m

No Seepage or Sloughing Upon Completion
Slotted 25 mm PVC Standpipe Installed to 6.6 m
Indicated Water Level Measured on November 10, 2017

Depth (m): 0 1 2 3 4 5 6 7 8 9

11/10/2017



Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 6.6 m
Drilling Rig Type: 150mm SOLID STEM AUGER	Start Date: October 31, 2017
Logged By: SS	Completion Date: October 31, 2017
Reviewed By: MS	Page 1 of 1

TETRA TECH

FIORINO HOMES LTD.

Borehole No: **17BH004**

Project: RURAL COUNTRY RESIDENTIAL SUBDIVISION	Project No: ENG.LGEO03581-01
Location: SOUTH 1/2 SEC 14-9-22 W4M	Ground Elev: 917 m
LETHBRIDGE, AB I N:5510102 , E:364137	PROJECT ENGINEER: JIEJUN ZHAO

Method: Solid stem auger

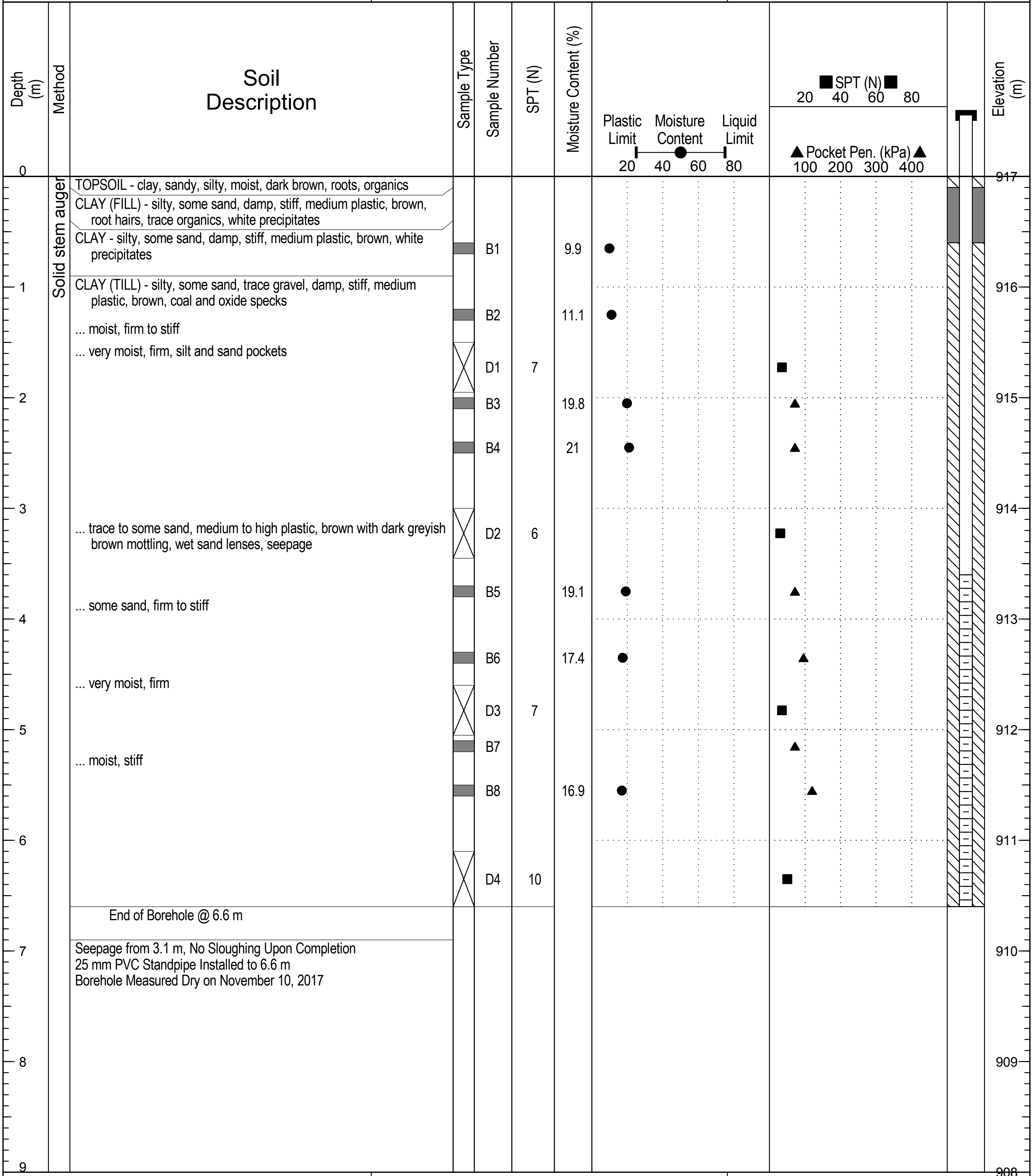
Soil Description

- TOPSOIL - clay, sandy, silty, moist, dark brown, roots, organics
- CLAY (FILL) - silty, some sand, damp, stiff, medium plastic, brown, root hairs, trace organics, white precipitates
- CLAY - silty, some sand, damp, stiff, medium plastic, brown, white precipitates
- CLAY (TILL) - silty, some sand, trace gravel, damp, stiff, medium plastic, brown, coal and oxide specks
- ... moist, firm to stiff
- ... very moist, firm, silt and sand pockets
- ... trace to some sand, medium to high plastic, brown with dark greyish brown mottling, wet sand lenses, seepage
- ... some sand, firm to stiff
- ... very moist, firm
- ... moist, stiff

End of Borehole @ 6.6 m

Seepage from 3.1 m, No Sloughing Upon Completion
25 mm PVC Standpipe Installed to 6.6 m
Borehole Measured Dry on November 10, 2017

Sample Type	Sample Number	SPT (N)	Moisture Content (%)
▨	B1		9.9
▨	B2		11.1
☒	D1	7	
▨	B3		19.8
▨	B4		21
☒	D2	6	
▨	B5		19.1
▨	B6		17.4
☒	D3	7	
▨	B7		
▨	B8		16.9
☒	D4	10	



Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 6.6 m
Drilling Rig Type: 150mm SOLID STEM AUGER	Start Date: October 31, 2017
Logged By: SS	Completion Date: October 31, 2017
Reviewed By: MS	Page 1 of 1

TETRA TECH

FIORINO HOMES LTD.

Borehole No: **17BH005**

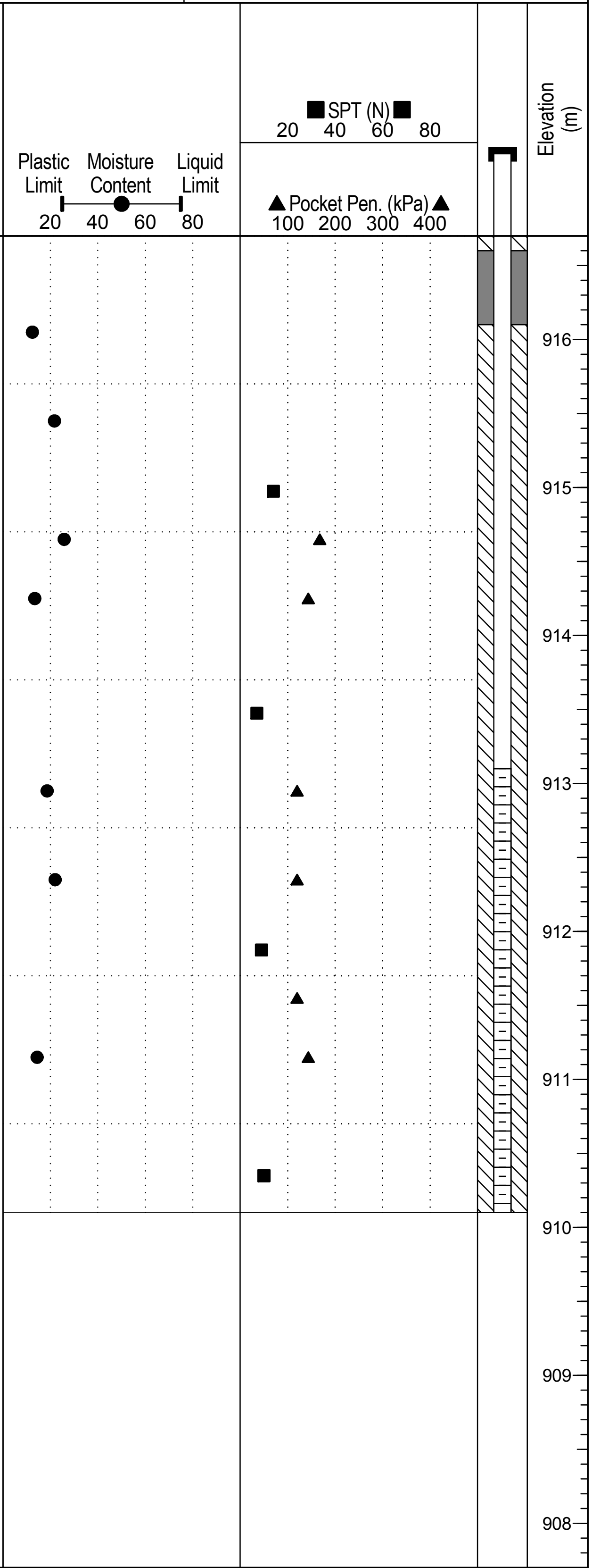
Project: RURAL COUNTRY RESIDENTIAL SUBDIVISION
Project No: ENG.LGEO03581-01
Location: SOUTH 1/2 SEC 14-9-22 W4M
Ground Elev: 916.7 m
LETHBRIDGE, AB | N:5510293 , E:364166
PROJECT ENGINEER: JIEJUN ZHAO

Method: Solid stem auger

Soil Description	Sample Number	SPT (N)	Moisture Content (%)
TOPSOIL - clay, sandy, silty, moist, dark brown, roots, organics, trace red shale inclusions			
CLAY (FILL) - silty, some sand, damp, stiff, medium plastic, brown, trace organics, oxide specks			
CLAY - silty, trace sand, damp, stiff, medium plastic, brown	B1		12.4
... damp to moist, very stiff			
... trace white precipitates	B2		21.7
... moist			
	D1	14	
... brown with greyish brown mottling	B3		25.8
CLAY (TILL) - silty, some sand, trace gravel, moist, stiff, medium plastic, brown with greyish brown mottling, coal and oxide specks, silt and sand pockets	B4		13.4
... firm			
	D2	7	
... moist to very moist, stiff			
	B5		18.6
	B6		22
... firm to stiff			
	D3	9	
... moist			
... stiff	B7		
	B8		14.4
	D4	10	

End of Borehole @ 6.6 m

No Seepage or Sloughing Upon Completion
Slotted 25 mm PVC Standpipe Installed to 6.6 m
Borehole Measured Dry on November 10, 2017



Depth (m): 0 1 2 3 4 5 6 7 8 9

TETRA TECH

Contractor: CHILAKO DRILLING SERVICES LTD.
Completion Depth: 6.6 m
Drilling Rig Type: 150mm SOLID STEM AUGER
Start Date: October 31, 2017
Logged By: SS
Completion Date: October 31, 2017
Reviewed By: MS
Page 1 of 1

FIORINO HOMES LTD.

Borehole No: **17BH006**

Project: RURAL COUNTRY RESIDENTIAL SUBDIVISION	Project No: ENG.LGEO03581-01
Location: SOUTH 1/2 SEC 14-9-22 W4M	Ground Elev: 915.5 m
LETHBRIDGE, AB I N:5510181 , E:364266	PROJECT ENGINEER: JIEJUN ZHAO

Depth (m) 0–9; Method: Solid stem auger; water level 11/10/2017

Soil Description

TOPSOIL - clay, sandy, silty, moist, dark brown, roots, organics

CLAY (FILL) - silty, some sand, damp, stiff, medium plastic, brown, root hairs, white precipitates

CLAY (TILL) - silty, some sand, trace gravel, damp, firm to stiff, medium plastic, brown, coal and oxide specks, trace white precipitates

... moist

... high plastic clay inclusions to 25 mm

... 200 mm high plastic clay pocket

... stiff

... moist to very moist, firm to stiff

... trace to some sand, medium to high plastic

... oxide staining, silt lenses

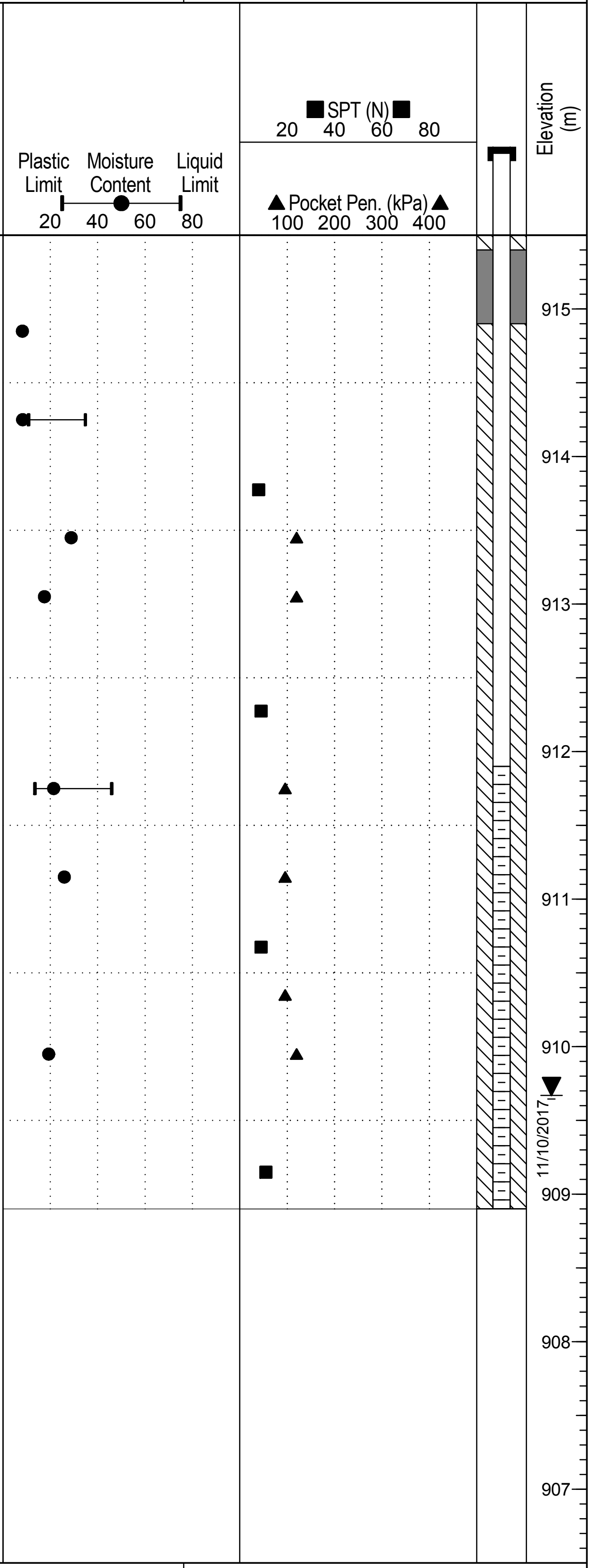
... 150 mm very moist, firm pocket

... some sand, stiff, medium plastic

End of Borehole @ 6.6 m

No Seepage or Sloughing Upon Completion
Slotted 25 mm PVC Standpipe Installed to 6.6 m
Indicated Water Level Measured on November 10, 2017

Sample Type	Sample Number	SPT (N)	Moisture Content (%)
▬	B1		8.2
▬	B2		8.3
☒	D1	8	
▬	B3		28.8
▬	B4		17.5
☒	D2	9	
▬	B5		21.4
▬	B6		25.9
☒	D3	9	
▬	B7		
▬	B8		19.3
☒	D4	11	



Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 6.6 m
Drilling Rig Type: 150mm SOLID STEM AUGER	Start Date: October 31, 2017
Logged By: SS	Completion Date: October 31, 2017
Reviewed By: MS	Page 1 of 1

TETRA TECH

FIORINO HOMES LTD.

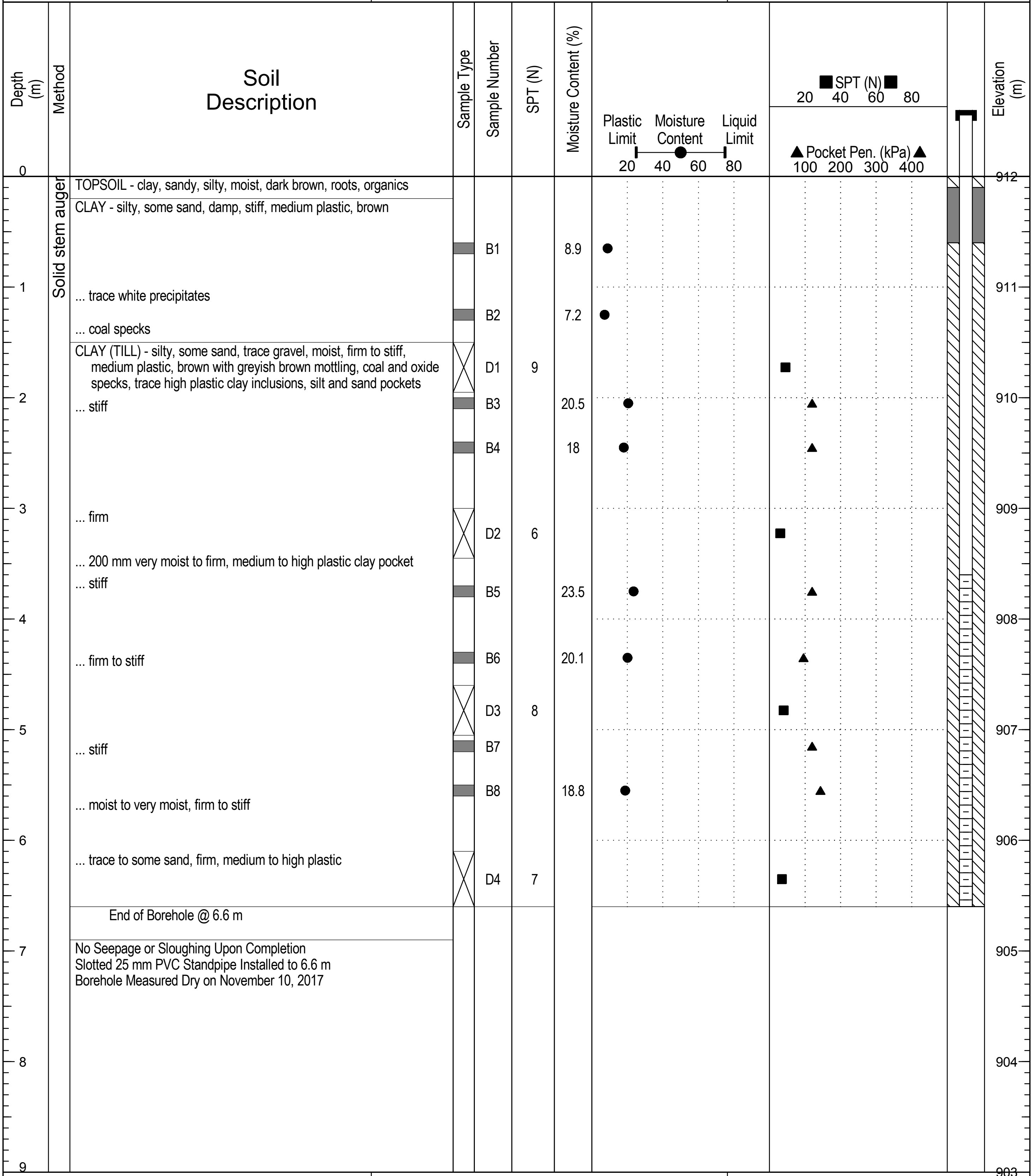
Borehole No: **17BH007**

Project: RURAL COUNTRY RESIDENTIAL SUBDIVISION	Project No: ENG.LGEO03581-01
Location: SOUTH 1/2 SEC 14-9-22 W4M	Ground Elev: 912 m
LETHBRIDGE, AB I N:5510305 , E:364578	PROJECT ENGINEER: JIEJUN ZHAO

Method: Solid stem auger

Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
TOPSOIL - clay, sandy, silty, moist, dark brown, roots, organics				
CLAY - silty, some sand, damp, stiff, medium plastic, brown				
	▬	B1		8.9
... trace white precipitates				
	▬	B2		7.2
... coal specks				
CLAY (TILL) - silty, some sand, trace gravel, moist, firm to stiff, medium plastic, brown with greyish brown mottling, coal and oxide specks, trace high plastic clay inclusions, silt and sand pockets	☒	D1	9	
... stiff	▬	B3		20.5
	▬	B4		18
... firm				
	☒	D2	6	
... 200 mm very moist to firm, medium to high plastic clay pocket				
... stiff				
	▬	B5		23.5
... firm to stiff	▬	B6		20.1
	☒	D3	8	
... stiff	▬	B7		
	▬	B8		18.8
... moist to very moist, firm to stiff				
... trace to some sand, firm, medium to high plastic				
	☒	D4	7	
End of Borehole @ 6.6 m				

No Seepage or Sloughing Upon Completion
Slotted 25 mm PVC Standpipe Installed to 6.6 m
Borehole Measured Dry on November 10, 2017



TETRA TECH

Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 6.6 m
Drilling Rig Type: 150mm SOLID STEM AUGER	Start Date: October 31, 2017
Logged By: SS	Completion Date: October 31, 2017
Reviewed By: MS	Page 1 of 1

FIORINO HOMES LTD.

Borehole No: **17BH008**

Project: RURAL COUNTRY RESIDENTIAL SUBDIVISION	Project No: ENG.LGEO03581-01
Location: SOUTH 1/2 SEC 14-9-22 W4M	Ground Elev: 910 m
LETHBRIDGE, AB I N:5510052 , E:364720	PROJECT ENGINEER: JIEJUN ZHAO

Depth (m) | Method: Solid stem auger

Soil Description

TOPSOIL - clay, sandy, silty, moist, dark brown, roots, organics

CLAY (FILL) - silty, some sand, damp, stiff, medium plastic, brown, root hairs

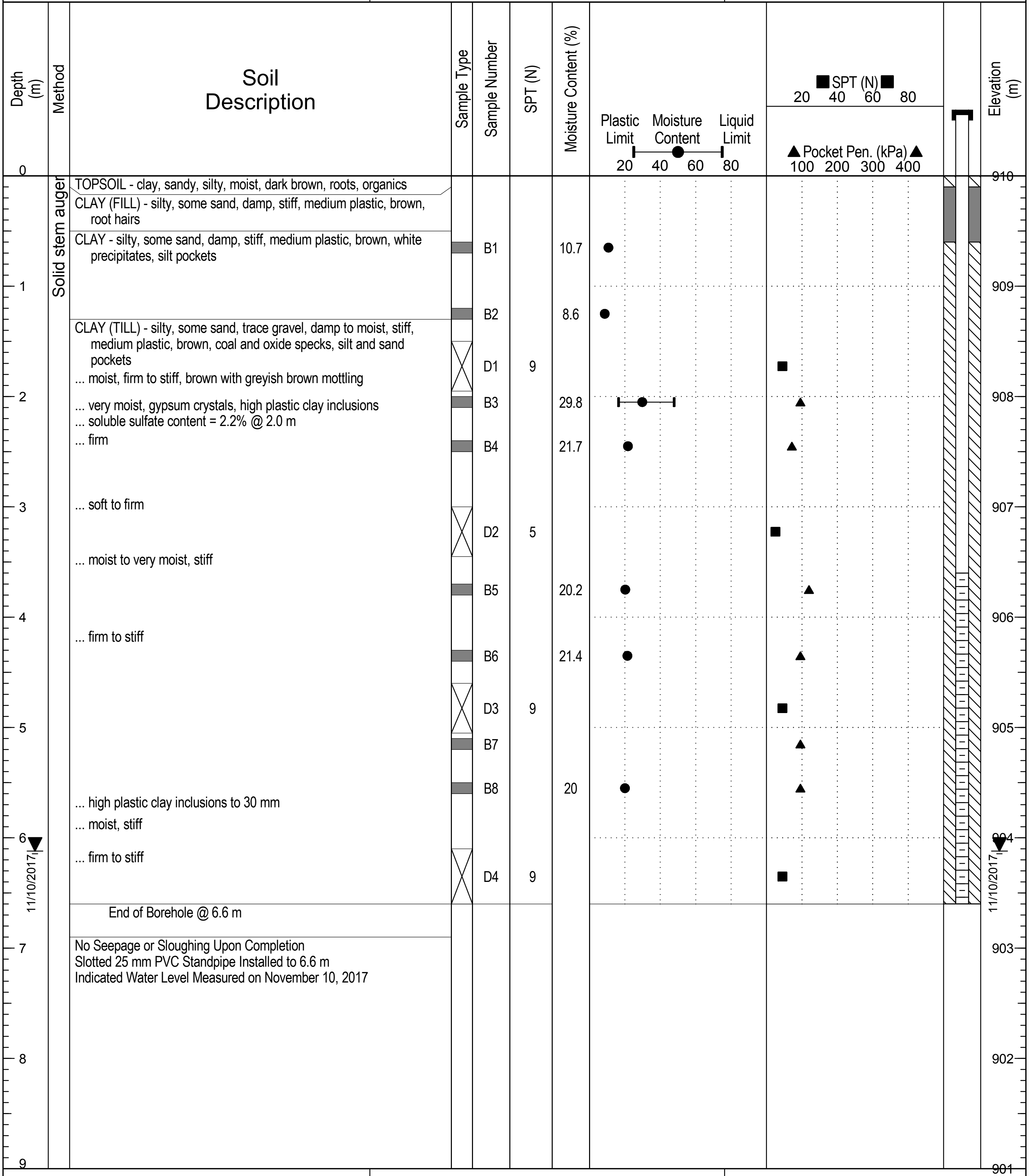
CLAY - silty, some sand, damp, stiff, medium plastic, brown, white precipitates, silt pockets

CLAY (TILL) - silty, some sand, trace gravel, damp to moist, stiff, medium plastic, brown, coal and oxide specks, silt and sand pockets
... moist, firm to stiff, brown with greyish brown mottling
... very moist, gypsum crystals, high plastic clay inclusions
... soluble sulfate content = 2.2% @ 2.0 m
... firm
... soft to firm
... moist to very moist, stiff
... firm to stiff
... high plastic clay inclusions to 30 mm
... moist, stiff
... firm to stiff

End of Borehole @ 6.6 m

No Seepage or Sloughing Upon Completion
Slotted 25 mm PVC Standpipe Installed to 6.6 m
Indicated Water Level Measured on November 10, 2017

Sample Number	SPT (N)	Moisture Content (%)
B1		10.7
B2		8.6
D1	9	
B3		29.8
B4		21.7
D2	5	
B5		20.2
B6		21.4
D3	9	
B7		
B8		20
D4	9	



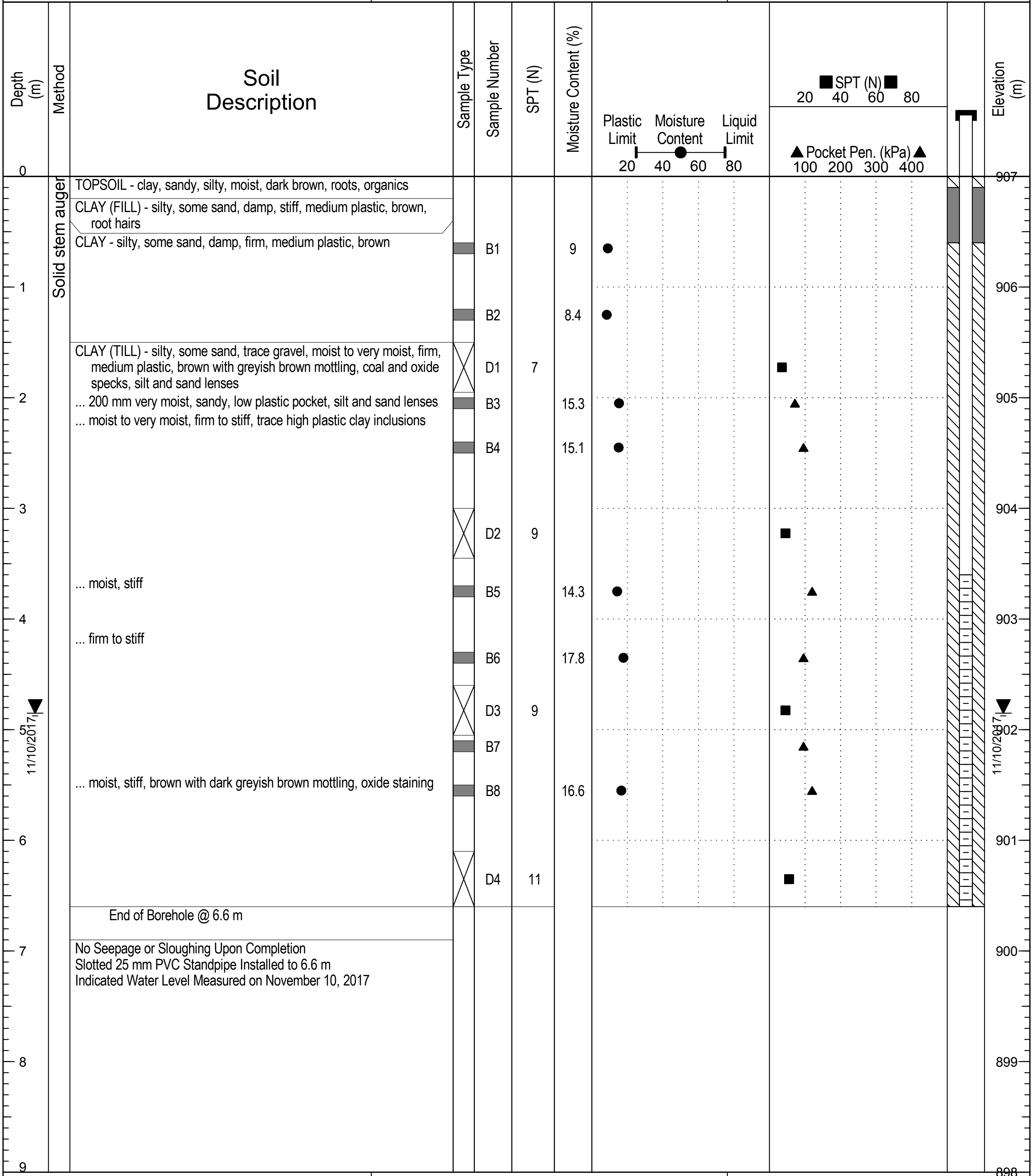
TETRA TECH

Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 6.6 m
Drilling Rig Type: 150mm SOLID STEM AUGER	Start Date: October 31, 2017
Logged By: SS	Completion Date: October 31, 2017
Reviewed By: MS	Page 1 of 1

FIORINO HOMES LTD.

Borehole No: **17BH009**

Project: RURAL COUNTRY RESIDENTIAL SUBDIVISION
Project No: ENG.LGEO03581-01
Location: SOUTH 1/2 SEC 14-9-22 W4M
Ground Elev: 907 m
LETHBRIDGE, AB | N:5510102 , E:36493
PROJECT ENGINEER: JIEJUN ZHAO



Soil Description	Sample Number	SPT (N)	Moisture Content (%)
TOPSOIL - clay, sandy, silty, moist, dark brown, roots, organics			
CLAY (FILL) - silty, some sand, damp, stiff, medium plastic, brown, root hairs			
CLAY - silty, some sand, damp, firm, medium plastic, brown	B1		9
	B2		8.4
CLAY (TILL) - silty, some sand, trace gravel, moist to very moist, firm, medium plastic, brown with greyish brown mottling, coal and oxide specks, silt and sand lenses	D1	7	
... 200 mm very moist, sandy, low plastic pocket, silt and sand lenses	B3		15.3
... moist to very moist, firm to stiff, trace high plastic clay inclusions	B4		15.1
	D2	9	
... moist, stiff	B5		14.3
... firm to stiff	B6		17.8
	D3	9	
	B7		
... moist, stiff, brown with dark greyish brown mottling, oxide staining	B8		16.6
	D4	11	
End of Borehole @ 6.6 m			

No Seepage or Sloughing Upon Completion
Slotted 25 mm PVC Standpipe Installed to 6.6 m
Indicated Water Level Measured on November 10, 2017

TETRA TECH

Contractor: CHILAKO DRILLING SERVICES LTD.
Completion Depth: 6.6 m
Drilling Rig Type: 150mm SOLID STEM AUGER
Start Date: October 31, 2017
Logged By: SS
Completion Date: October 31, 2017
Reviewed By: MS
Page 1 of 1

APPENDIX C

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 in accordance with the applicable design code of the local jurisdiction.

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.

Foundation excavations and bearing surfaces should be protected from rain, snow, freezing temperatures, excessive drying, and the ingress of free water before, 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 against inclement weather and provide a working surface for construction.

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 inspected by a qualified geotechnical engineer to check that the recommendations contained in this report have been followed.

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 below:

- “Structural engineered fill” should comprise clean, well-graded granular soils.
- “Lean-mix concrete” should be low strength concrete having a minimum 28-day compressive strength of 3.5 MPa.

CONSTRUCTION EXCAVATIONS

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

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

Shallow excavations up to about 3 m depth may use temporary sideslopes 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 Tetra Tech 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. Tetra Tech 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 degrees from the horizontal from the base of foundations of adjacent structures intersects the extent of the proposed excavation, these structures may require underpinning or special shoring techniques to avoid damaging earth movements. The need for any underpinning or special shoring techniques and the scope of monitoring required can be determined when details of the service ducts and vaults, foundation configuration of existing buildings and final design excavation levels are known.

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

BACKFILL MATERIALS AND COMPACTION (GENERAL)

1.0 DEFINITIONS

“Landscape fill” is typically used in areas such as berms and grassed areas where settlement of the fill and noticeable surface subsidence can be tolerated. “Landscape fill” may comprise soils without regard to engineering quality.

“General engineered fill” is typically used in areas where a moderate potential for subgrade movement is tolerable, such as asphalt (i.e., flexible) pavement areas. “General engineered fill” should comprise clean, granular or clay soils.

“Select engineered fill” is typically used below slabs-on-grade or where high volumetric stability is desired, such as within the footprint of a building. “Select engineered fill” should comprise clean, well-graded granular soils or inorganic low to medium plastic clay soils.

“Structural engineered fill” is used for supporting structural loads in conjunction with shallow foundations. “Structural engineered fill” should comprise clean, well-graded granular soils.

“Lean-mix concrete” is typically used to protect a subgrade from weather effects including excessive drying or wetting. “Lean-mix concrete” can also be used to provide a stable working platform over weak subgrades. “Lean-mix concrete” should be low strength concrete having a minimum 28-day compressive strength of 3.5 MPa.

Standard Proctor Density (SPD) as used herein means Standard Proctor Maximum Dry Density (ASTM Test Method D698). Optimum moisture content is defined in ASTM Test Method D698.

2.0 GENERAL BACKFILL AND COMPACTION RECOMMENDATIONS

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

Exterior backfill adjacent to footings, foundation walls, grade beams and pile caps and within 600 mm of final grade should comprise inorganic, cohesive “general engineered fill”. Such backfill should provide a relatively impervious surficial zone to reduce seepage into the subsoil against the structure.

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 deflections are 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 1 m of retaining walls or basement walls. If compacted fill is to be placed on both sides of the wall, they should be filled together so that the level on either side is within 0.5 m of each other.

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

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

Excavation and construction operations expose materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration of performance. Unless otherwise specifically indicated in this report, the walls and floors of excavations, and stockpiles, must be protected from the elements, particularly moisture, desiccation, frost, and construction activities. Should desiccation occur, bonding should be provided between backfill lifts. For fine-grained materials the previous lift should be scarified to the base of the desiccated layer, moisture-conditioned, and recompacted and bonded thoroughly to the succeeding lift. For granular materials, the surface of the previous lift should be scarified to about a 75 mm depth followed by proper moisture-conditioning and recompaction.

3.0 COMPACTION AND MOISTURE CONDITIONING

“Landscape fill” material should be placed in compacted lifts not exceeding 300 mm and compacted to a density of not less than 90% of SPD unless a higher percentage is specified by the jurisdiction.

“General engineered fill” and “select engineered fill” materials should be placed in layers of 150 mm compacted thickness and should be compacted to not less than 98% of SPD. Note that the contract may specify higher compaction levels within 300 mm of the design elevation. Cohesive materials placed as “general engineered fill” or “select engineered fill” should be compacted at 0 to 2% above the optimum moisture content. Note that there are some silty soils which can become quite unstable when compacted above optimum moisture content. Granular materials placed as “general engineered fill” or “select engineered fill” should be compacted at slightly below (0 to 2%) the optimum moisture content.

“Structural engineered fill” material should be placed in compacted lifts not exceeding 150 mm in thickness and compacted to not less than 100% of SPD at slightly below (0 to 2%) the optimum moisture content.

4.0 “GENERAL ENGINEERED FILL”

Low to medium plastic clay is considered acceptable for use as “general engineered fill,” assuming this material is inorganic and free of deleterious materials.

Materials meeting the specifications for “select engineered fill” or “structural engineered fill” as described below would also be acceptable for use as “general engineered fill.”

5.0 “SELECT ENGINEERED FILL”

Low to medium plastic clay with the following range of plasticity properties is generally considered suitable for use as “select engineered fill”:

Liquid Limit = 20 to 40%

Plastic Limit = 10 to 20%

Plasticity Index = 10 to 30%

Test results should be considered on a case-by-case basis.

“Pit-run gravel” and “fill sand” are generally considered acceptable for use as “select engineered fill.” See exact project or jurisdiction for specifications.

The “pit-run gravel” should be free of any form of coating and any gravel or sand containing clay, loam or other deleterious materials should be rejected. No material oversize of the specified maximum sieve size should be tolerated. This material would typically have a fines content of less than 10%.

The materials above are also suitable for use as “general engineered fill.”

6.0 "STRUCTURAL ENGINEERED FILL"

Crushed gravel used as "structural engineered fill" should be hard, clean, well graded, crushed aggregate, free of organics, coal, clay lumps, coatings of clay, silt, and other deleterious materials. The aggregates should conform to the requirement when tested in accordance with ASTM C136 and C117. See exact project or jurisdiction for specifications. This material would typically have a fines content of less than 10%.

In addition to the above, further specification criteria identified below should be met:

"Structural Engineered Fill" – Additional Material Properties

Material Type	Percentage of Material Retained on 5 mm Sieve having Two or More Fractured Faces	Plasticity Index (<400 μm)	L.A. Abrasion Loss (percent Mass)
Various sized Crushed Gravels	See exact project or jurisdiction for specifications	See exact project or jurisdiction for specifications	See exact project or jurisdiction for specifications

Materials that meet the grading limits and material property criteria are also suitable for use as "select engineered fill."

7.0 DRAINAGE MATERIALS

"Coarse gravel" for drainage or weeping tile bedding should be free draining. Free-draining gravel or crushed rock generally containing no more than 5% fine-grained soil (particles passing No. 200 sieve) based on the fraction passing the 3/4-inch sieve or material with sand equivalent of at least 30.

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

"Coarse Sand" Drainage Material – Percent Passing by Weight

Sieve Size	Coarse Sand*
10 mm	100
5 mm	95 – 100
2.5 mm	80 – 100
1.25 mm	50 – 90
630 μm	25 – 65
315 μm	10 – 35
160 μm	2 – 10
80 μm	0 – 3

* From CSA A23.1-09, Table 10, "Grading Limits for Fine Aggregate", Class FA1

Note that the "coarse sand" above is also suitable for use as pipe bedding material. See exact project or jurisdiction for specifications.

8.0 BEDDING MATERIALS

The "Coarse Sand "gradation presented above in Section 7.0 is suitable for use as pipe bedding and as backfill within the pipe embedment zone, however see exact project or jurisdiction for specifications.

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 or abandoned pile foundation 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 engineered fill placement. If proof-rolling reveals any soft or loose spots, these should be excavated and the desired grade restored by engineered fill placement. The subgrade should be compacted to a depth of not less than 0.3 m to a density of not less than 98 percent Standard Proctor Maximum Dry Density (ASTM Test Method D698).

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

A levelling course of well graded granular fill (with maximum size of 20 mm), at least 150 mm in compacted thickness, is recommended directly beneath all slabs-on-grade. The type of granular fill should be selected based on the design floor loadings. Alternatively a minimum thickness of 150 mm of 80 mm pit-run gravel overlain by a minimum thickness of 50 mm of 20 mm crushed gravel may be used. Coarse gravel particles larger than 25 mm diameter should be avoided directly beneath the slab-on-grade to limit potential stress concentrations within the slab. All levelling courses directly under floor slabs should be compacted to 100 percent of Standard Proctor Maximum Dry Density (ASTM Test Method D698).

Engineered fill, pit-run gravel and crushed gravel are defined under the heading 'Backfill Materials and Compaction' elsewhere in this Appendix.

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 before, during, and after the construction period.

TETRA TECH

January 30, 2018

ISSUED FOR USE
FILE: ENG.LGEO03581-01

Martin Geomatic Consultants Ltd.
255 – 31 Street North
Lethbridge, AB T1H 3Z4

Attention: Mr. Raymond Martin, P.Eng.

Subject: Geotechnical Evaluation Amendment
Rural Country Residential Subdivision
Fiorino Homes Ltd.
Lethbridge County, Alberta

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Fiorino Homes Ltd. to conduct a detailed geotechnical evaluation, including a slope stability assessment, for the proposed Rural Country Residential Subdivision to be located in the south half of SEC 14 TWP 9 RGE 22 W4M, in the Lethbridge County, Alberta.

The geotechnical evaluation was completed in 2017 and a report titled, "*Geotechnical Evaluation Rural Country Residential Subdivision Development Lethbridge County, Alberta*", dated December 2017 was issued. Section 6.0 of that report detailed the slope stability evaluation conducted for the proposed project, including recommendations for safe development setback requirements for the proposed residential lots.

Martin Geomatic Consultants Ltd., following a review of the geotechnical evaluation report, requested Tetra Tech's review of one area of the subdivision with respect to the safe development setback distances provided in the report.

Specific to this geotechnical amendment to the report referenced above, is the recommendation for the safe development setback for the residential access way between Lot 6 and Lot 7. The development setback distance recommended in the December 2017 Tetra Tech report for this access way was 20 m (refer to attached Figure 5 from that report). The revised setback line is now recommended to be 17 m from Top-of-Bank, as defined in the 2017 Tetra Tech report.

Tetra Tech confirms that we have reviewed the cross-section of the existing slope profile for this area and confirm that with a safe development setback distance of 17 m, a Factor of Safety of minimum 1.5 is still provided against slope instability impacting the property on the north side of the recommended safe development setback line.

All other conditions and recommendations contained in the Tetra Tech report (ENG.LGEO3581-01) dated December 2017 are still valid.

Tetra Tech Canada Inc.
442 - 10 Street N.
Lethbridge, AB T1H 2C7 CANADA
Tel 403.329.9009 Fax 403.328.8817

2.0 CLOSURE

This geotechnical amendment remains subject to the Limitations on Use of This Document, which were incorporated into the referenced report.

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

MARC J. SABOURIN

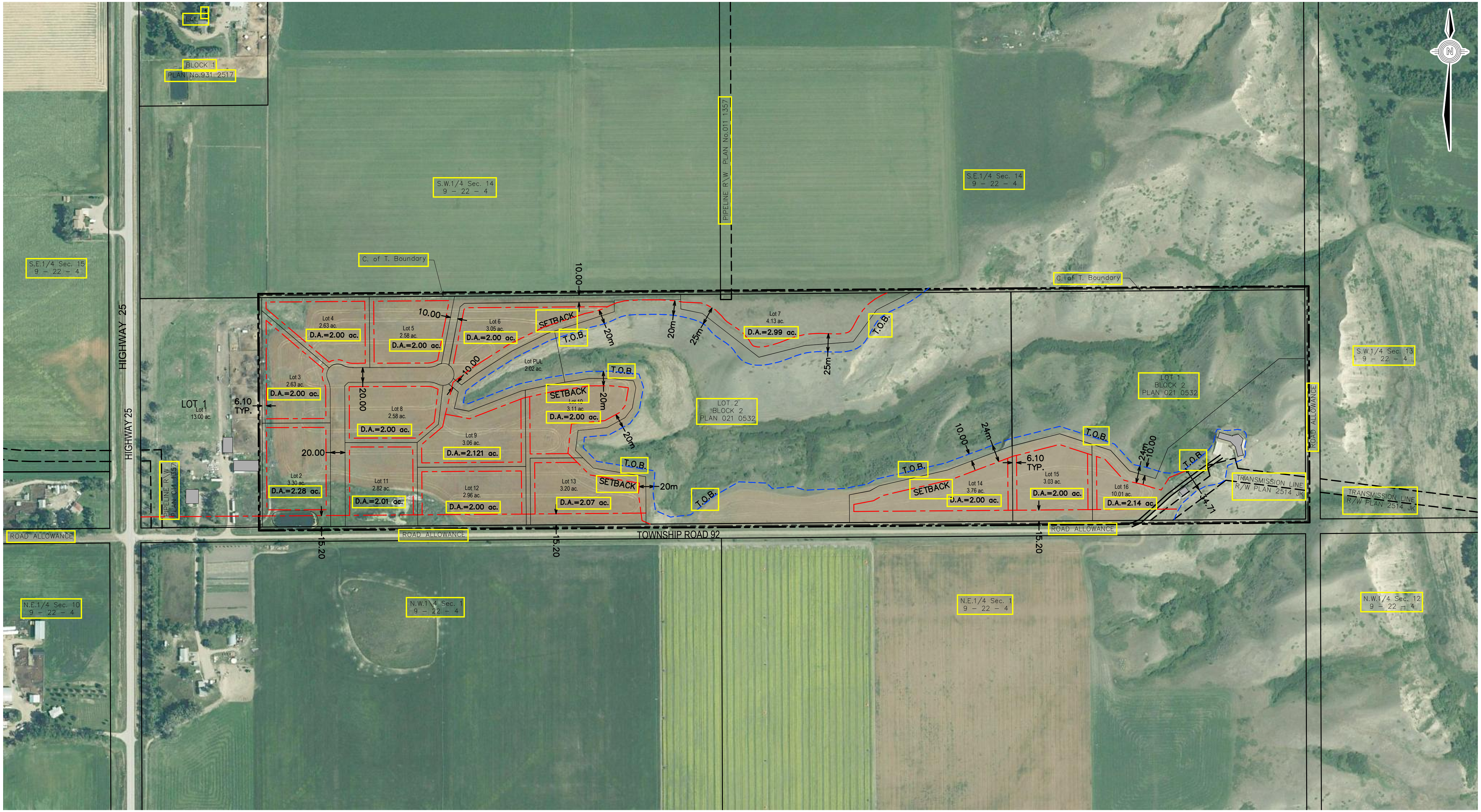
JAN 30/18

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
Signature
Date JANUARY 30, 2018
PERMIT NUMBER: P13774
The Association of Professional Engineers and Geoscientists of Alberta

Marc J. Sabourin, P.Eng.
Vice President – Western Canada
Engineering Practice
Direct Line: 403.359.6518
marc.sabourin@tetratech.com

/tlp

Attachments: Figure 5 – Development Setback Limits (Tetra Tech Report ENG.LGEO03581-01)
Drawing Number CO.1 Martin Geomatic Consultants Ltd. dated January 9, 2018



C:\Lethbridge\Drafting\ENG.LGEO\LGEO03581\LGEO03581-01-001 Figure 5 Slope Stability.dwg [FIGURE 5] December 11, 2017 - 4:36:24 pm (BY: HUGHES, LEANNE)

LEGEND

- SITE BOUNDARY
- TOF OF BANK
- SETBACK LINE

0 250m

Scale: 1:5,000 @ 11"x17"

NOTES

GOOGLE EARTH IMAGERY DATED 2015

CLIENT

Fiorino Homes Ltd.

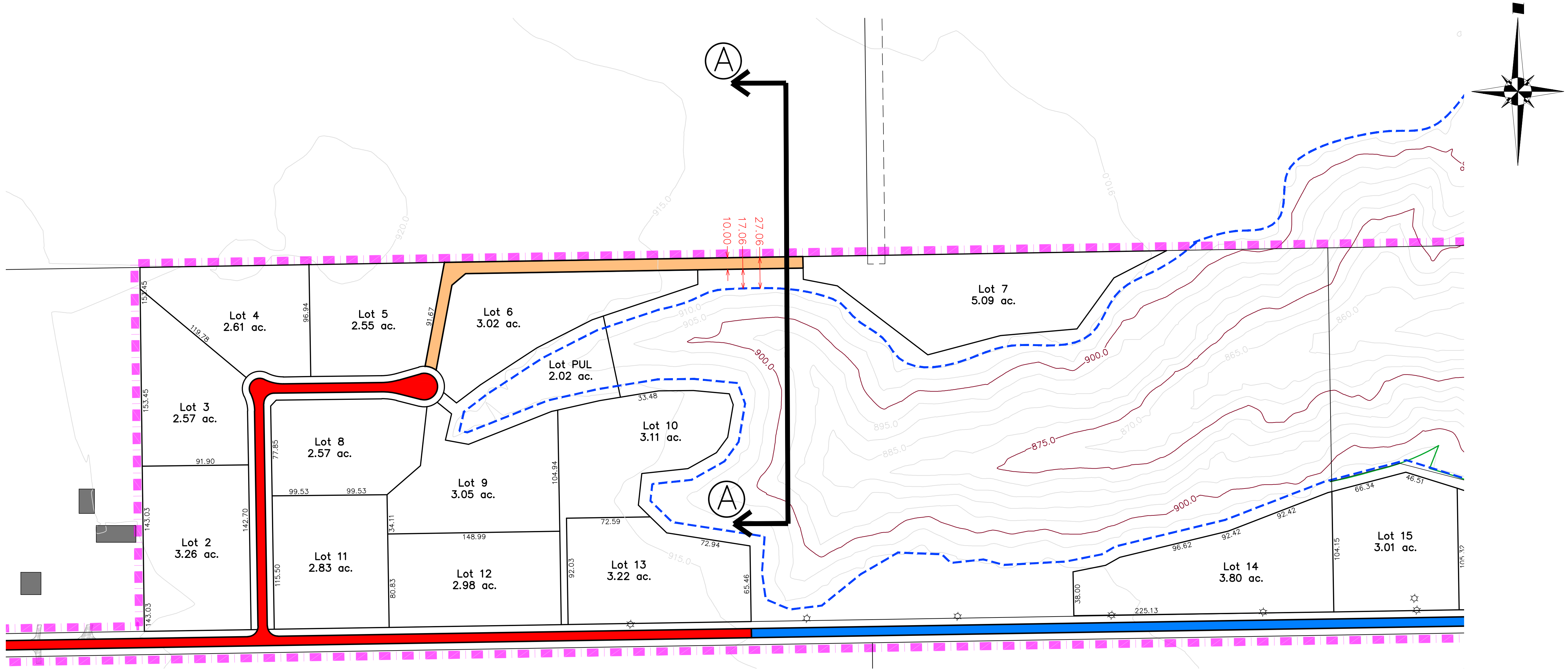
TETRA TECH

RURAL COUNTRY RESIDENTIAL SUBDIVISION

DEVELOPMENT SETBACK LIMITS

PROJECT NO.	DWN	CKD	REV
LGEO03581-01.001	LCH	MJS	0
OFFICE	DATE		
TT LETH	December 2017		

Figure 5



SECTION A–A

REVISIONS	BY	Y	M	D
0 FOR REVIEW	RM	2016	11	24

PERMIT

PERMIT TO PRACTICE
Martin Geomatic Consultants Ltd.
PERMIT NUMBER: **P 5852**
The Association of Professional Engineers
and Geoscientists of Alberta

SEAL

MARTIN
GEOMATIC CONSULTANTS LTD
Consulting Engineers, Planners, and Land Surveyors
255–31st Street North Lethbridge, Alberta T1H 3Z4
Ph: (403) 329–0050 E–mail: geomart@mgcl.net Fax: (403) 329–6594

SCALE AS SHOWN

DRAWN: RJM
APPROVED: MR
DESIGN: MR
DATE: JAN 9, 2018

OWNER
PETE FIORINO

PROJECT
AREA STRUCTURE PLAN

TITLE
PLAN / PROFILE

PROJECT NUMBER
166729CE

DRAWING NUMBER
C0.1

Saved Date: Thursday, January 11, 2018 10:12:30 AM – By: [robm–local]

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce–asp – jan09–2018.dwg

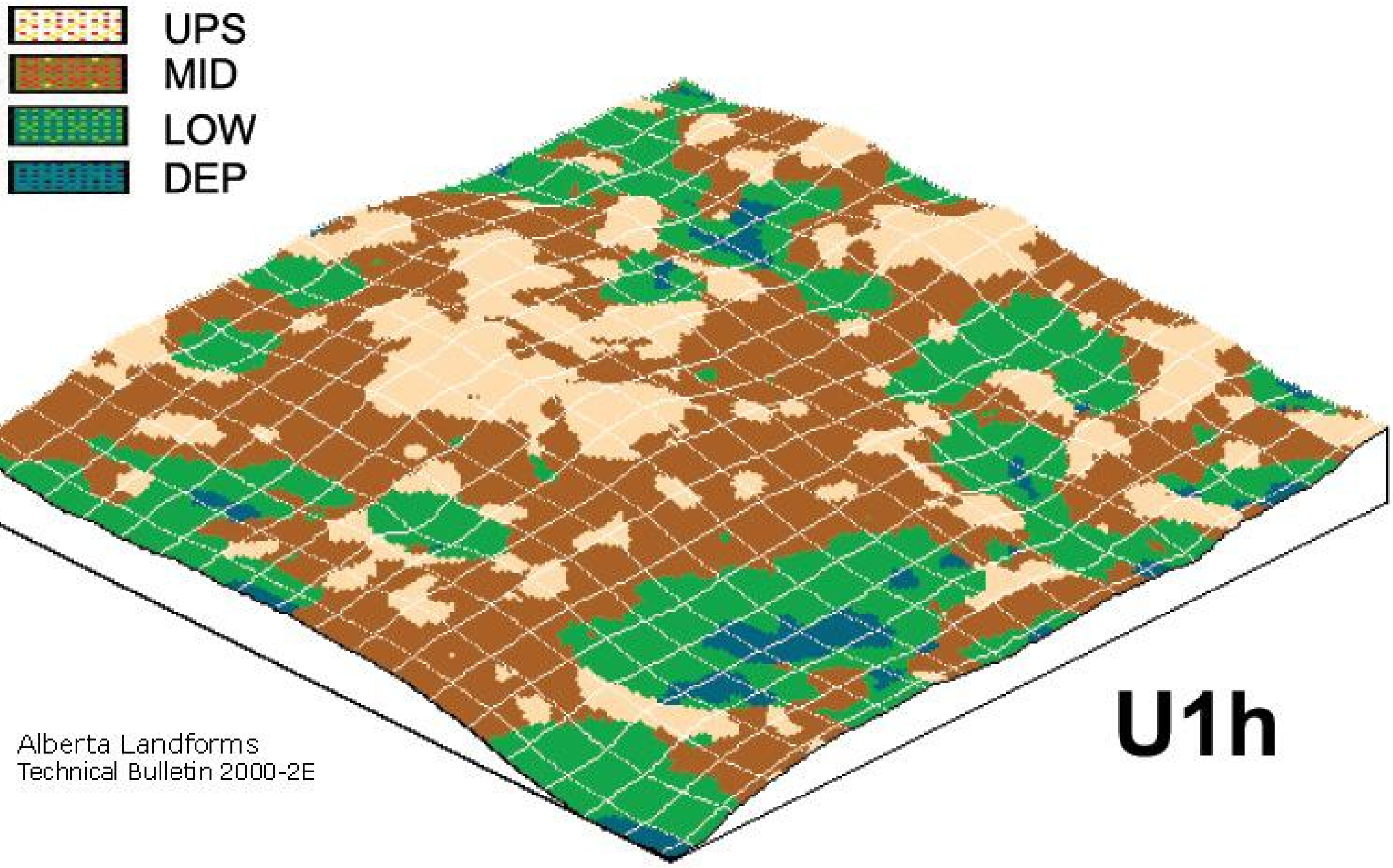
Report on Soil Polygon: 5822

Variable	Value
POLY_ID	5822
Map Unit Name	LEWN5/U1h
Landform	U1h - undulating - high relief
LSRS Rating (Spring Grains)	3M(10)

Landscape Model Descriptions:
Orthic Dark Brown Chernozem on medium textured (L, SiL) sediments deposited by wind and water (LET).
Orthic Dark Brown Chernozem on medium textured (L, SiCL, CL) materials over medium (L, CL) or fine (C) textured till (WNY).
The polygon includes soils that are finer textured than the dominant or co-dominant soils (5).
Undulating, high relief landform with a limiting slope of 4% (U1h).

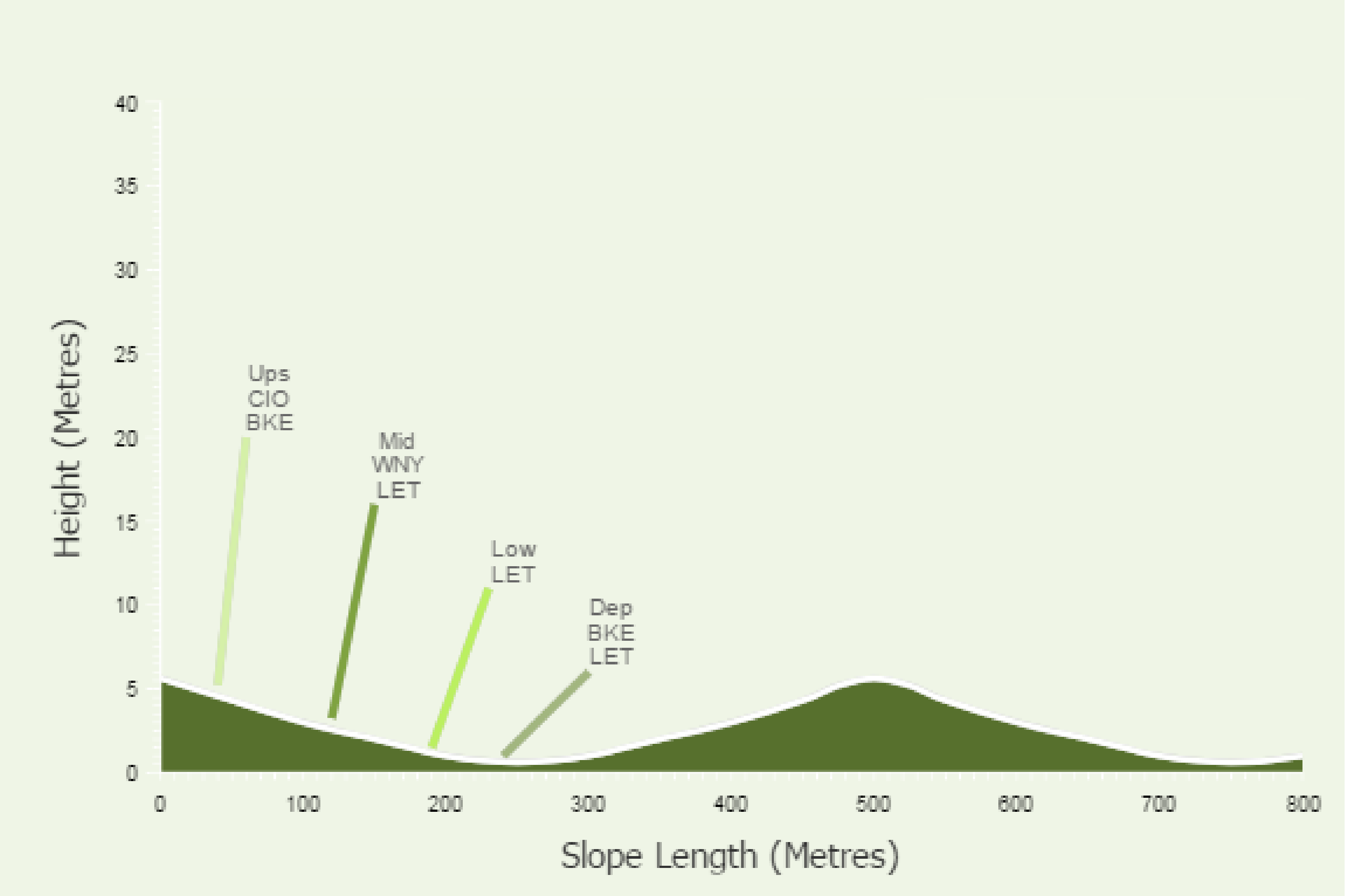
Image:

Landform Model:



Alberta Landforms
Technical Bulletin 2000-2E

Landform Profile:



Report on Soil Polygon: 5392

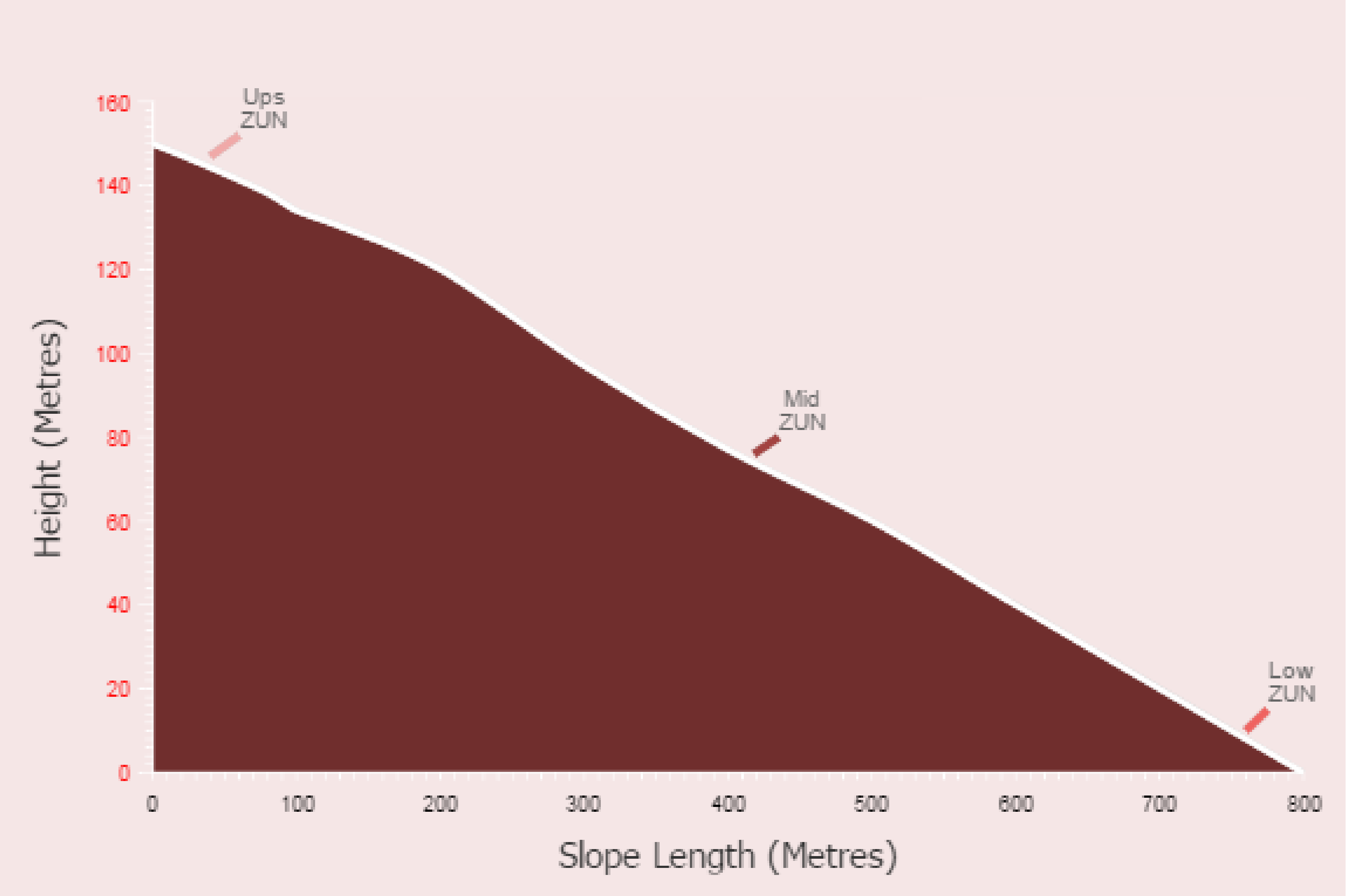
Variable	Value
POLY_ID	5392
Map Unit Name	ZUN1/I4h
Landform	I4h - inclined with BR - high relief
LSRS Rating (Spring Grains)	5TM(10)

Landscape Model Descriptions:
Miscellaneous undifferentiated mineral soils (ZUN).
The polygon may include soils that are not strongly contrasting from the dominant or co-dominant soils (1).
Inclined with bedrock, high relief landform with a limiting slope of 35% (I4h).

Image:

Landform Model:
No landform model.

Landform Profile:



APPENDIX

APPENDIX 3 ~ ENVIRONMENTAL SITE ASSESSMENT

TETRA TECH

Phase I Environmental Site Assessment
Plan 0210532, Block 2, Lots 1&2
Lethbridge County, Alberta

PRESENTED TO

FIORINO HOMES LTD.

DECEMBER 2017
ISSUED FOR USE
FILE: ENG.LGEO03581-01.004

Tetra Tech Canada Inc.
442 - 10 Street N.
Lethbridge, AB T1H 2C7 CANADA
Tel 403.329.9009 Fax 403.328.8817

This page intentionally left blank.

EXECUTIVE SUMMARY

Foreword

Fiorino Homes Ltd. retained Tetra Tech Canada Inc. (Tetra Tech) to conduct a Phase I Environmental Site Assessment (ESA) for two adjoining properties located within Lethbridge County, legally described as Plan 0210532, Block 2, Lot 1 and Plan 0210532, Block 2, Lot 2 (the site). The properties are located within portions of legal land descriptions (LSDs) 1 through 4, 14-009-22 W4M.

The objective of the Phase I ESA is to comment on whether any past or present land use, either off site or on site, may have a potential to cause environmental impairment to the site. Tetra Tech understands that this assessment is required for due diligence purposes in support of property redevelopment for rural country residential acreages.

In general terms, there are two distinct types of potential environmental risk to any property. The first risk of contamination is from on-site land use, including accidental spills or on-site activities that could contaminate the property directly. The second risk of contamination is from adjacent property owners, where impacts may be transported through the subsurface soils by groundwater, or in overland runoff onto the site.

Potential for Impairment from On-site Sources

There were three apparent potential sources of environmental impairment identified relating to the site from historical and/or current on-site land uses. The following table outlines the areas of potential environmental concern (APEC).

Potential On-site Sources of Environmental Impairment

APEC	Source of Potential Impairment	Source of Information	Tetra Tech Evaluation
1	Fill material at the location of the former dugout / low lying area on the northwestern portion of the site.	Aerial photograph review	There is the potential for uncharacterized fill to have been placed at this location.
2	Fill / debris material within and around the eastern dugout.	Site visit	Miscellaneous debris (wood, plastic, metal, and asphalt shingles) was observed within and around this location. There is a potential for impacts to the soil, groundwater, and surface water at this location.
3	Fill material at the location of the southern coulee near the approximate middle of the site.	Site visit	Fill soil and concrete was observed at this location. The chemical quality of the fill material is unknown, or whether other debris has been buried.

Potential for Impairment from Off-site Sources

There were no apparent potential sources of environmental impairment identified relating to the site from historical and/or current off-site land uses.

Further Action/Rendering an Opinion

Based on the present study, Tetra Tech recommends that further work is warranted at this time to assess the soil, groundwater, and/or surface water quality at the three APECs identified. The following is provided for consideration:

- If buried debris, soil staining, or organic material is encountered during future site development, a qualified environmental professional should be contacted.
- The septic system should be decommissioned by a professional service provider when no longer required.
- Any disturbance to a surface waterbody should be done in accordance with the Alberta Water Act

TABLE OF CONTENTS

LIST OF TABLES IN TEXT

APPENDIX SECTIONS

FIGURES

APPENDICES

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Fiorino Homes Ltd. and their agents. Tetra Tech Canada Inc. (Tetra Tech) 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 Fiorino Homes Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech's Limitations on the Use of This Document which are provided in Appendix A of this report.

1.0 INTRODUCTION

1.1 General

Fiorino Homes Ltd. retained Tetra Tech Canada Inc. (Tetra Tech) to conduct a Phase I Environmental Site Assessment (ESA) for two adjoining properties located within Lethbridge County, legally described as Plan 0210532, Block 2, Lot 1 and Plan 0210532, Block 2, Lot 2 (the site). The properties are located within portions of legal land descriptions (LSDs) 1 through 4, 14-009-22 W4M.

The objective of the Phase I ESA is to comment on whether any past or present land use, either off site or on site, may have a potential to cause environmental impairment to the site. Tetra Tech understands that this assessment is required for due diligence purposes in support of property redevelopment for rural country residential acreages.

The Phase I ESA was completed in general accordance with the Alberta Environment and Parks (AEP) Alberta Environmental Site Assessment Standard and with the methods outlined in the document titled "Canadian Standards Association Standard (CSA) Z768-01 Phase I ESA", published by the CSA (reaffirmed 2016).

1.2 Authorization

Mr. Pete Fiorino, President of Fiorino Homes Ltd., provided written authorization to proceed with the present study to Tetra Tech on October 4, 2017.

1.3 Scope of Work

Tetra Tech conducted the following scope of work for the Phase I ESA:

- Conducted a records review for the site and surrounding properties, for a minimum search distance of 100 m. The records review included the following current and historical information searches:
  - Provincial regulatory information including the Petroleum Tank Management Association of Alberta (PTMAA); Alberta Energy Regulator (AER) via Abacus Datagraphics Database (AbaData); AEP's ESA Repository (ESAR), Online Water Well Database, and Authorization Viewer; and the Alberta Land Titles Spatial Information System (SPIN 2),
  - Regional and municipal regulatory information,
  - Historical information sources including business directories, fire insurance plans (FIPs), land titles, and historical aerial photographs, and
  - Geological and hydrogeological information including published topographic, geologic, soil, and groundwater maps and reports.
- Conducted a site visit to evaluate the extent and manner that current and historical surrounding activities may impact upon the site and the environment. Sampling was not included in the Phase I ESA.
- Conducted interviews with persons familiar with the site and surrounding properties.
- Evaluated the results and prepared this report discussing the site history, and identified any potential for environmental concerns resulting from past or present land use on site and in the surrounding area.

1.4 Qualifications of Assessors

Mr. Jaymes Going, B.Sc., EP, conducted the site visit, historical review, and wrote this report. Mr. Going is an Environmental Scientist with Tetra Tech's Environment and Water Practice and has over nine years of experience in the environmental industry.

Mr. Henri Carriere, P.Eng., M.N.R.M., provided the senior review of this report. Mr. Carriere is a Senior Project Engineer with Tetra Tech's Environment and Water Practice in Calgary, Alberta. Mr. Carriere has over 24 years of experience in the environmental industry.

1.5 General Site Details

The site is located within portions of LSDs 1 through 4, 14-009-22 W4M in Lethbridge County. The site is currently separated into two legal properties, Lot 1 and Lot 2. Lot 1 encompasses approximately the eastern 1/3rd of the site and consists of an area of cultivated agricultural land, natural coulee/valley grassland, and a rural residence that was constructed in 2002. Lot 2 encompasses approximately the western 2/3rd of the site and consists of cultivated agricultural land, and natural coulee/valley grassland. The coulee/valley draw is generally oriented in a west to east direction and occupies a large portion of the site. The cultivated agricultural land is located south and west of this coulee/valley draw. Two dugouts are located on the southwestern portion of the site and it is noted that fill material (debris) was observed around and within the easterly dugout. An electric transmission line is located along the southern site boundary, and the access road to the rural residence is located parallel to the southern site boundary.

The site is bound to the north and south by cultivated agricultural cropland and natural coulee/valley grassland. East of the site is the Oldman River valley. A rural farm residence with several buildings, farm style above-ground storage tanks (ASTs), and corrals is located adjacent to the west of the site. Further west of the site is Highway No. 25.

Figure 1 shows the site location plan and Figure 2 shows the detailed site plan showing surrounding land use. Photographs of the site are provided in Appendix B.

2.0 RECORDS REVIEW

The results of regulatory searches are provided in Appendix C. Records were reviewed for the site and for adjacent properties within a minimum distance of 100 m of the site boundary.

2.1 Legal Description, Location, Size and Ownership

The site is located in Lethbridge County, Alberta. The legal description, location size, and ownership are summarized in Table A.

Table A: Legal Description, Location, Size, and Ownership

Legal Description	Location	Size*	Ownership**
Plan 0210532, Block 2, Lot 1	S 14-009-22 W4M	12.68 hectares (31.33 acres)	Peter Fiorino
Plan 0210532, Block 2, Lot 2	S 14-009-22 W4M	5.26 hectares (13.00 acres)	1463770 Alberta Ltd.

* Size obtained from the current land title.
** Ownership obtained from the current land title

2.2 Historical Records Review

2.2.1 Historical Land Title Records

A historical and current land title search was initiated for the site. The results of the land title search is summarized in Table B. The current land title is included in Appendix C.

Table B: Land Title Summary – Plan 0210532, Block 2, Lot 1 and 2

Legal Description	Year(s) of Ownership	Owner(s)	Tetra Tech Evaluation
Plan 0210532, Block 2, Lot 2	August 24, 2017 to current*	1463770 Alberta Ltd.	No obvious potential for environmental concern.
Plan 0210532, Block 2, Lot 1	2013 to current	Peter Fiorino	
	2002 to 2013	Sheryl M Brooks and Peter Fiorino	
Portion of the S1/2 14-009-22 W4M	1953 to 2002	George and Margaret Brooks	
	1948 to 1953	Kenneth Thom	
	1926 to 1948	The Board of Trustees of the Lethbridge Northern Irrigation District	
	1910 to 1926	The Alberta Railway and Irrigation Company	Based on the name, there is the potential for environmental concern; however, these companies owned large tracts of land and operations may not have been associated with the site.
	1891 to 1910	The Canada North West Land Company Limited	No obvious potential for environmental concern.

*Subdivision plan to separate Plan 0210532, Block 2, Lot 1 into Plan 0210532, Block 2, Lot 1 and Lot 2.

2.2.2 Aerial Photographs

Aerial photographs provide visual evidence of site occupancy, operational activities, and general site details. Aerial photographs capture a view of the site and the surrounding areas at a given time. The results of the aerial photograph review are summarized in Table C.

Table C: Historical Aerial Photograph Summary

Year	Scale	Observations
1950	1:40,000	**On Site:** The site appears to be agricultural land (pasture). The dugout located near the southwest corner of the site is visible.
		Off Site: Surrounding land use to the north and south appear to be agricultural (pasture and cultivated). Structures/buildings associated with the farm residences to the west and southwest are visible. The low lying area to the south of the site is also visible.
1961	1:31,680	**On Site:** Similar to the previous aerial photograph, although a couple of irregular-shaped linear features are visible (possibly drainage channels).
		Off Site: Similar to the 1950 aerial photograph.
1973	1:24,000	**On Site:** A second dugout appears to have been constructed east of the dugout identified in the 1950 aerial photograph. There also appear to be corrals located north of the west dugout.
		Off Site: Generally similar to the 1961 aerial photograph.
1985	1:30,000	**On Site:** The easterly dugout now appears larger and approximately the same size as the westerly dugout. An additional area appears fenced to the east of the corrals. North of the westerly dugout, what appears to be a smaller dugout is visible near the northern property boundary. A road is also visible north of this northerly dugout, and to the east of this dugout is an area that appears to be bare ground.
		Off Site: Similar to the 1973 aerial photograph.
1989	1:20,000	**On Site:** Generally similar to the 1985 aerial photograph, although the dugout on the northern portion of the site is no longer visible.
		Off Site: Similar to the 1985 aerial photograph.
2005	**	**On Site:** The corrals on the western portion of the site are not as clearly visible. A few small structures are visible on the northwest portion of the site (possibly livestock shelters), and is an area where unidentifiable material has been placed. The area where the northern dugout was visible in the 1985 aerial photograph now appears as a low lying area. At the location of the coulee valley/draw on the southern portion of the site (approximate middle), the area appears disturbed (possibly fill placement). The rural residence on the eastern most portion of the site and the site access road and powerline located on the south boundary has been constructed.
		Off Site: Similar to the 1989 imagery.
2012	**	**On Site:** No features are visible on the western portion of the site (corrals, structures, or low lying area), and the site appears to be primarily pasture land. The easterly dugout appears to have been almost entirely filled in, and a bare area is visible adjacent to the northeast boundary of this dugout (possibly debris).
		Off Site: Similar to the 2005 imagery.
2016	**	**On Site:** Similar to the 2012 imagery, although the land now appears to be cultivated.
		Off Site: Similar to the 2012 imagery.

Notes:
The aerial photographs are enlarged (where possible) for the review.
* * Aerial photograph was obtained from Google Earth's satellite image archive.

The site and surrounding area appear to have consisted of predominately agricultural land (pasture and/or cultivated). A portion of the western site of the site appeared to have been used for livestock corrals between 1973 and 2005, and the site residence on Lot 1 was constructed between 1989 and 2005.

2.2.3 Library and Museum Archives

Tetra Tech searched the Galt Museum archives for indications of historical land use at the site and the surrounding area. Museum personnel indicated that no information was available for the site.

2.2.3.1 Business Directories

No business directories were available for Tetra Tech to review for the site or surrounding area.

2.2.3.2 Fire Insurance Plans

No fire insurance plans were available for Tetra Tech to review for the site or surrounding area.

2.2.3.3 Other Archival Records

No additional archival records were reviewed by Tetra Tech for the site.

2.3 Provincial Regulatory Information

Tetra Tech completed searches with provincial authorities and searched databases for information pertaining to the site. The following sections summarize the information provided by these authorities. Database results and copies of these responses are presented in Appendix C of this report.

2.3.1 Petroleum Tank Management Association of Alberta

Tetra Tech contacted the PTMAA regarding the potential for registered petroleum storage tanks (PSTs) at the site. The PTMAA response indicated that no records exist for the site:

- Plan 0210532, Block 2, Lots 1&2 and S1/2 14-009-22 W4M.

The PTMAA requires that all underground storage tanks (USTs) be registered; however, only ASTs with a capacity greater than 2,500 L require registration. The database is based on a limited survey conducted in 1992 and voluntary information submitted thereafter; therefore, it is not considered a comprehensive inventory of PSTs in Alberta. Appendix C contains a copy of the search results.

2.3.2 Alberta Energy Regulator

Tetra Tech acquires AER database information through AbaData. The AbaData database was searched to determine if oil/gas wells and/or pipelines exist or have existed at the site and on the surrounding properties. The information provided by the AER indicated that there were no oil and/or gas wells, facilities, or spills or complaints within 100 m of the site boundaries.

AbaData identifies a low pressure gas line transecting the northwest portion of the site oriented west to east through LSD 4 where it then trends south through LSD 3. From there it trends easterly and parallel to the north side of the access road to the private residence in LSD 1. AbaData also identifies a transmission line right-of-way (ROW) within the southeast portion of LSD 1, and a coal mine location within the adjacent section to the east.

High pressure pipeline and well information provided by AbaData is current to September 31, 2017 and information on low pressure pipelines is current to June 30, 2013.

The Coal Mine Atlas was reviewed and it was determined that no abandoned or active coal mines are present at the site. An abandoned underground mine (Mine No. 1576) was formerly located within the adjacent section to the east (13-009-22 W4M). The mine was owned by Kerralta Coal Co. and operated from 1941 to 1944 and produced

11 kilotonnes of high volatile bituminous coal. The coal was located approximately 100 m below prairie surface, minimizing environmental concerns to the site. This mine is not suspected to be an environmental concern to the site.

2.3.3 Alberta Environment and Parks

2.3.3.1 Environmental Site Assessment Repository

The AEP ESAR is an online, searchable database that provides scientific and technical information about assessed sites throughout Alberta. The search of the site and surrounding lands within 100 m of the site boundary returned no records (correspondence or environmental reports). ESAR identifies a reclamation certificate for a well site located within LSD 6-14-009-22 W4M. This well site is located approximately 400 m north of the site boundary and is not considered to be of environmental concern to the site.

2.3.3.2 Water Well Information Database

The water well information database search listed no record of water wells within the site boundaries. However, the search identified one record relating to water wells located off-site on an adjacent property within 800 m of the site. The following table summarizes the information on this water well. The water well record is attached in Appendix C.

Table D: Water Well Details

Location	Distance and Direction from Site (m)	Owner / Well ID	Drilling Dates	Depth	Tetra Tech’s Evaluation
LSD 16-10-009-22 W4M	A minimum of 150 m west of the site	Unknown / 109522	1960s	4.8 m	Due to the distance from the site, this well is not considered to be a concern to the site.

2.3.3.3 Online Authorization Viewer

The AEP Online Authorization Viewer allows the public to view approvals, licenses, registrations, and permits issued under the Water Act and Environmental Protection and Enhancement Act. There were no approvals, licenses, registrations, and/or permits for the site (Plan 0210532, Block 1, Lot 1 or Plan 0210532, Block 2, Lot 2.) There were also no records available for LSDs 1 through 4 14-009-22 W4M.

2.3.4 Alberta Government – Alberta Land Titles Spatial Information System

The Alberta Government SPIN 2 website provides information pertaining to legal land locations, ownership, and transportation and utility ROWs. The SPIN 2 search identifies the government road allowance that bounds the site to the south, as well as the powerline ROW that is located on the site within a portion of Lot 1.

2.4 Regional and Municipal Regulatory Information

This section describes the results of regional and municipal regulatory searches.

2.4.1 Lethbridge County

Tetra Tech contacted Lethbridge County for available historical information at or near the site. At the time of report issuance, a response had not been received. If the response changes the findings of this report, an addendum letter will be issued.

2.5 Landforms and Geology

2.5.1 Topography

Surface topography can influence the direction of migration of contaminants at the soil surface. The local topography describes the landscape at the site; whereas, regional topography applies to the overall expression of the land surface in a given region. The local topography of the site is generally flat where the site is cultivated on the western portion of the site, and slopes moderately to steeply within the coulee draw that occupies a large portion of the eastern portion of the site. The regional topography in the area is generally flat to undulating, and slopes easterly toward the Oldman River valley.

2.5.2 Geology

The surficial geology in the area is characterized by moraine till deposits with sporadic lenses of gravel, sand, and silt (Shetsen 1981).

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 Bearpaw Formation, both of the late Cretaceous Age (Tokarsky 1973). The bedrock has a relatively flat surface dipping slightly to the northeast and is locally encountered at about geodetic elevation 843 m. The bedrock strata consist of thin beds of predominantly weak mudstones, siltstones, and sandstones with occasional bentonite and coal seams.

2.5.3 Hydrogeology

Groundwater has the potential to be of significance as a means of contaminant transport. Regional groundwater flow is the overall direction of groundwater flow in a given region. Groundwater in a local area within the region may travel in a different direction from the regional flow due to influence by local topography and/or subsurface soil conditions.

The nearest surface waterbody is the dugout and waterbody located on the southwestern portion of the site. An additional waterbody is located within 100 m of the southern site boundary, and the Oldman River is approximately 900 east of the site. Regional groundwater flow is expected to be easterly, toward the Oldman River. Perched groundwater tables have also been encountered in many areas of Lethbridge. The depth to these perched tables can vary from approximately 2 m below ground level to considerable depths within gravel, sand, and/or silt seams. The flow of these perched tables can also vary in any direction or be still, dependent on the horizontal and vertical dip, and the extent of the sand and/or silt seams.

It should be noted that topography, geologic materials, land development, and soil disturbances can also cause localized variances in groundwater movement and pattern. As well, groundwater levels will fluctuate seasonally and in response to climatic conditions.

2.6 Other Information Sources

There were no other information sources reviewed for the site.

3.0 SITE VISIT

Mr. Jaymes Going, of Tetra Tech, visited the site on October 31, 2017. The site visit included a visual inspection of the site and observations of adjacent properties to identify evidence of impairment, or potential sources of impairment, which may adversely affect the site.

3.1 Building Details and Site Servicing

The private residence on Lot 1 was constructed in 2002, and was not accessed as part of this assessment.

The following table (Table E) describes the site servicing.

Table E: Site Servicing

Item	Present	Type	Comments
Water Supply	Yes	Storage tanks	There are two tanks located at the private residence, one for potable water and one for grey water use (washing and irrigation). Potable water is trucked to the site as required, and grey water is piped from the western dugout.
Storm Sewer	No	N/A	N/A
Sanitary Sewer	Yes	Septic system	N/A
Dugouts	Yes	N/A	Fill material and debris was observed within and around the eastern dugout.
Pits	No	None observed	No pits or lagoons were observed on the site during the site visit or aerial photograph review. The City of Lethbridge municipal wastewater lagoons are located approximately 1 km southeast of the site.
Lagoons	No	None observed	

3.2 Special Attention Items

Table F summarizes special attention items that may present potential environmental impairment to a site; further background information on these materials is provided in Appendix D.

Table F: Special Attention Items

Item	Presence/ Potential	Comments
Asbestos	Low	Based on the age of the site buildings (2002), the potential for these substances is low.
Polychlorinated Biphenyls (PCBs)		
Lead		
Urea Formaldehyde Foam Insulation (UFFI)		
Ozone-depleting Substances (ODS)	Present	Air conditioning and refrigeration units should be maintained by qualified professionals and disposed of accordingly at the end of their useful life.
Radon	High	There was no radon gas testing reported for the site; however, natural radon concentrations are considered moderate to high in Alberta. A radon test was not completed by Tetra Tech as part of this investigation. There were no anthropogenic sources of radon gas identified.
Methane	Moderate	Fill areas were identified during the site visit within and around the eastern dugout and at the southern portion of the coulee draw near the approximate middle of the site. The aerial photograph review also identified potential fill areas near the western portion of the site associated with the

Table F: Special Attention Items

Item	Presence/ Potential	Comments
		former corrals and former dugout/low lying area. There was no methane gas testing reported for the site.
Electromagnetic Fields (EMF)	Low	A transmission line is located along the southern site boundary which is a potential source of EMF. No EMF assessment was completed by Tetra Tech for the site.
Noise and Vibration	Low	Noise and vibration was noted as low during the site visit.

The above evaluation is based on the basic site observations. Intrusive investigation and sampling is not within the scope of a Phase I ESA.

3.3 Site Observations

This section describes observations made of the site during the site visit on October 31, 2017.

3.3.1 Surficial Stains

There were no surficial stains observed during the site visit.

3.3.2 Vegetation

The site was primarily covered in agricultural cropland stubble and natural grassland at the time of the site visit.

3.3.3 Ponding of Water

No ponding of water was observed at the site during the site visit other than water observed within the dugouts located on the southwestern portion of the site.

3.3.4 Washouts and Erosion

There were no washouts or indications of erosion observed during the site visit other than naturally occurring erosion processes within the coulee valley.

3.3.5 Fill Areas and Soil Conditions

Fill areas were identified at the site during the site visit. Soil and concrete fill was observed at the southern portion of the coulee draw near the approximate middle of the site, and fill material (wood, asphalt shingles, and miscellaneous debris) was observed within and around the eastern dugout.

The aerial photograph review also identified potential fill areas near the western portion of the site associated with the former corrals and former dugout/low lying area.

A geotechnical evaluation was also completed for the site and reported under separate cover (ENG.LGEO03581-01.001, dated December 2017). The drilling assessment for this geotechnical evaluation identified clay fill material in eight of the nine boreholes drilled. The thickness of clay fill ranged from 0.3 m at several locations to 0.8 m north of the western dugout. The borehole positioned in close proximity to the location of the former northern dugout, and one positioned where former corals were located identified trace organics in the clay fill.

3.3.6 Oil/Gas Wells and Pipelines

No oil or gas wells were observed at the site during the site visit. Refer to Section 2.3.2 for AER information.

3.3.7 Waste Storage

There was no waste storage observed at the site during the site visit.

3.3.8 Chemical Storage

There was no chemical storage observed at the site during the site visit.

3.3.9 Transformers

There was one pole mounted transformer observed at the site near the site residence on Lot 1. There was no evidence of leaks observed on the ground in the general vicinity of the transformer.

3.3.10 Hydraulic Elevators and Hoists

There were no hydraulic elevators or hoists present at the site.

3.3.11 Vent Pipes and Underground Storage Tanks

There were no vent pipes or indications of USTs observed at the site during the site visit.

3.3.12 Above-ground Storage Tanks and Drum Storage

There were no ASTs or drum storage areas identified during the site visit.

3.3.13 General Housekeeping

The general housekeeping of the overall site was generally good with no obvious evidence of illegal dumping observed during the site visit, other than within and around the eastern dugout and at the southern portion of the coulee draw near the approximate middle of the site.

3.4 Off-site Observations

Tables G summarizes the surrounding land use.

Table G: Surrounding Land Use

Direction	Land Use*	Observations	Tetra Tech Evaluation
North	Agricultural cropland and coulee/valley	Undeveloped agricultural cropland and grassland (coulee/valley). No building or structures noted within 100 m of the site boundaries.	No obvious concerns which may cause environmental impairment to the site were identified. It is noted that the farm style ASTs are not a concern due to the small volume and distance from the site (approximately 50 m).
South	Agricultural cropland and coulee/valley		
West and southwest	Rural residence	Farm residences with several buildings. Farm style ASTs and corrals on the adjacent property to the west.	
East	Coulee/valley (Oldman River valley)	Undeveloped grassland (coulee/valley). No building or structures noted within 100 m of the site boundaries.	

* Land use inferred from observations made during the site visit.

Key surrounding land use is indicated on Figure 2.

4.0 PERSONNEL INTERVIEWS

Tetra Tech interviewed the following personnel during the Phase I ESA. The findings of the personnel interviews, which have been incorporated into this report, are in general agreement with the records review conducted for the site.

Table H: Interview Summary

Item	Description
Interviewee	Mr. Peter Fiorino
Interviewee Position	Landowner
Length of Involvement with Site	Greater than 15 years
Information Provided	Provided general information on the site and surrounding land.
Tetra Tech Evaluation	Information provided was in agreement with the records review conducted for the site.

5.0 DISCUSSION AND CONCLUSIONS

5.1 General

In general terms, there are two distinct types of potential environmental risk to any property. The first risk of contamination is from on-site land use, including accidental spills or on-site activities that could contaminate the property directly. The second risk of contamination is from adjacent property owners, where impacts may be transported through the subsurface soil by groundwater, or in overland runoff onto the site.

5.2 Potential for Impairment from On-site Sources

There were three apparent potential sources of environmental impairment identified relating to the site from historical and/or current on-site land uses. Table I identifies the areas of potential environmental concern (APEC), and they are identified on Figure 2.

Table I: Potential On-site Sources of Environmental Impairment

APEC	Source of Potential Impairment	Source of Information	Tetra Tech Evaluation
1	Fill material at the location of the former dugout / low lying area on the north western portion of the site.	Aerial photograph review	There is the potential for uncharacterized fill to have been placed at this location.
2	Fill / debris material within and around the eastern dugout	Site visit	Miscellaneous debris (wood, plastic, metal, and asphalt shingles) was observed within and around this location. There is a potential for impacts to the soil, groundwater, and surface water at this location.
3	Fill material at the location of the southern coulee near the approximate middle of the site	Site visit	Fill soil and concrete was observed at this location. The chemical quality of the fill material is unknown, or whether other debris has been buried.

5.3 Potential for Impairment from Off-site Sources

There were no apparent potential sources of environmental impairment identified relating to the site from historical and/or current off-site land uses.

6.0 FURTHER ACTION/RENDERING AND OPINION

Based on the present study, Tetra Tech recommends that further work is warranted at this time to assess the soil, groundwater, and/or surface water quality at the three APECs identified. The following is provided for consideration:

- If buried debris, soil staining, or organic material is encountered during future site development, a qualified environmental professional should be contacted.
- The septic system should be decommissioned by a professional service provider when no longer required.
- Any disturbance to a surface waterbody should be done in accordance with the Alberta Water Act.

7.0 CLOSURE

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

Respectfully submitted,
Tetra Tech Canada Inc.

M P CARRIERE

December 7, 2017

Prepared by:
Jaymes Going, B.Sc., EP
Environmental Scientist
Environment & Water Practice
Direct Line: 403.359.6512
Jaymes.Going@tetratech.com

Reviewed by:
Henri Carriere, P.Eng., M.N.R.M.
Senior Project Engineer
Environment & Water Practice
Direct Line: 403.723.6874
Henri.Carriere@tetratech.com

/jmt

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
Signature ____________
Date Dec 7, 2017
PERMIT NUMBER: P13774
The Association of Professional Engineers and Geoscientists of Alberta

REFERENCES

ABACUS DataGraphics Website. Updated October 31, 2017. AbaData database http://www.abacusdatagraphics.com/.

Alberta Energy and Utilities Board and Alberta Geological Survey. 1999. Geological Map of Alberta. Edmonton, Alberta Scale 1:1,000,000.

Alberta Environment and Parks. Authorization/Approval Viewer. http://aep.alberta.ca/lands-forests/land-industrial/programs-and-services/authorization-viewer.aspx

Alberta Environment and Parks. Environmental Site Assessment Repository. http://www.esar.alberta.ca/esarmain.aspx.

Alberta Environment and Parks. 2016. Alberta Environmental Site Assessment Standard. ISBN No. 978-1-4601-0796-6 (On-line Edition).

Alberta Environment and Parks. Water Well Database. http://groundwater.alberta.ca/WaterWells/d/

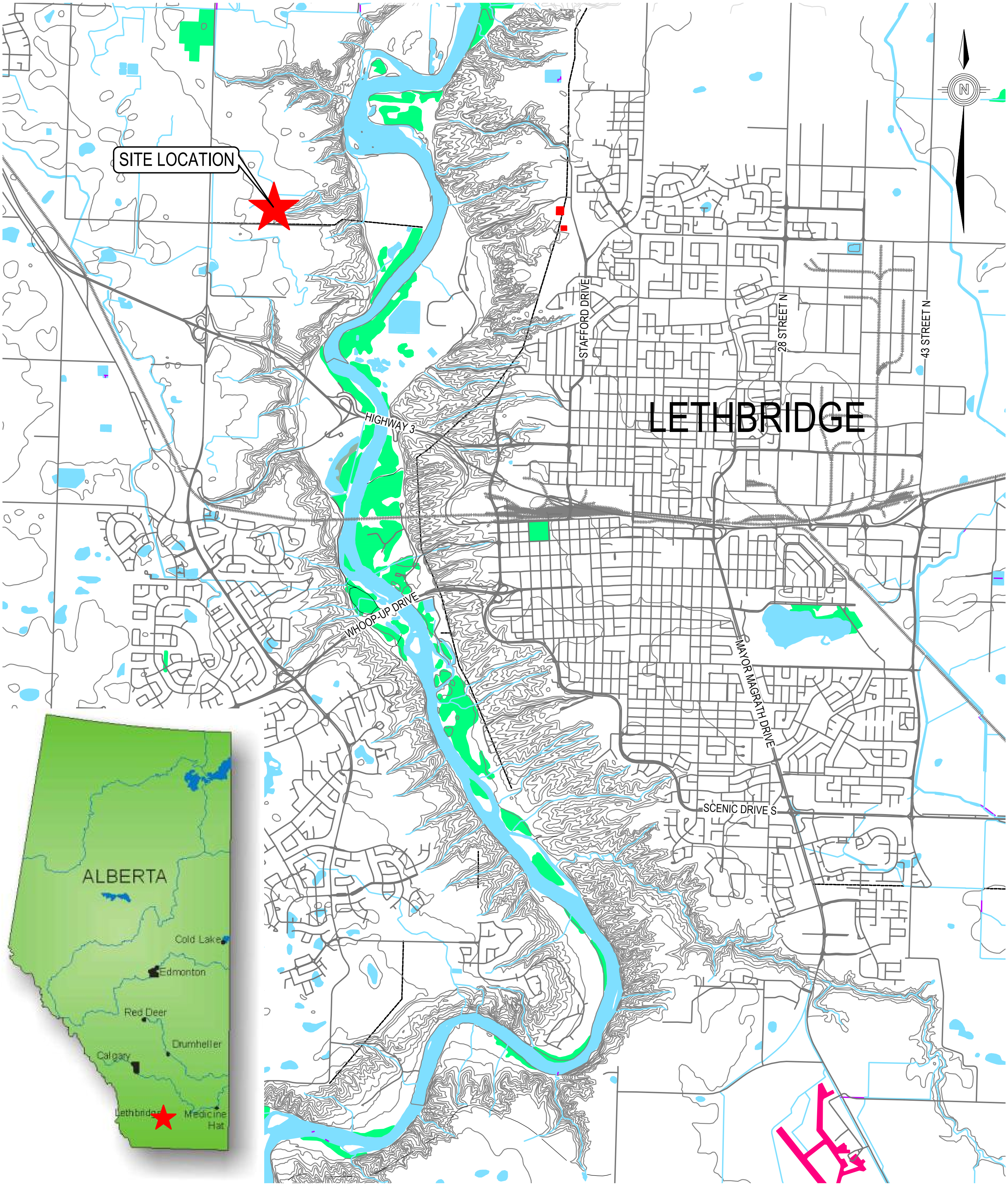
Canada Standards Association. 2012. Z768-01, Phase I Environmental Site Assessment. Published November 2001, reaffirmed 2016.

The Alberta Government Spin II Website. http://alta.registries.gov.ab.ca/SpinII/SearchSelectType.aspx

Shetsen, I. 1981. Surficial Geology Lethbridge, Alberta. Alberta Research Council, Edmonton, Alberta.

Tokarsky, O. 1973. Hydrogeological Map – Lethbridge-Fernie, Alberta (NTS 82G-H). Alberta Research Council, Edmonton, Alberta.

FIGURES



NOTES
DRAWING PROVIDED BY "© Department of Natural Resources Canada. All rights reserved."

0 3,000 m
Scale: 1:60,00 @ 8.5"x11"

CLIENT

Fiorino Homes Ltd.

TETRA TECH

PHASE I ENVIRONMENTAL SITE ASSESSMENT
PLAN 0210532, BLOCK 2, LOTS 1 & 2
LETHBRIDGE COUNTY

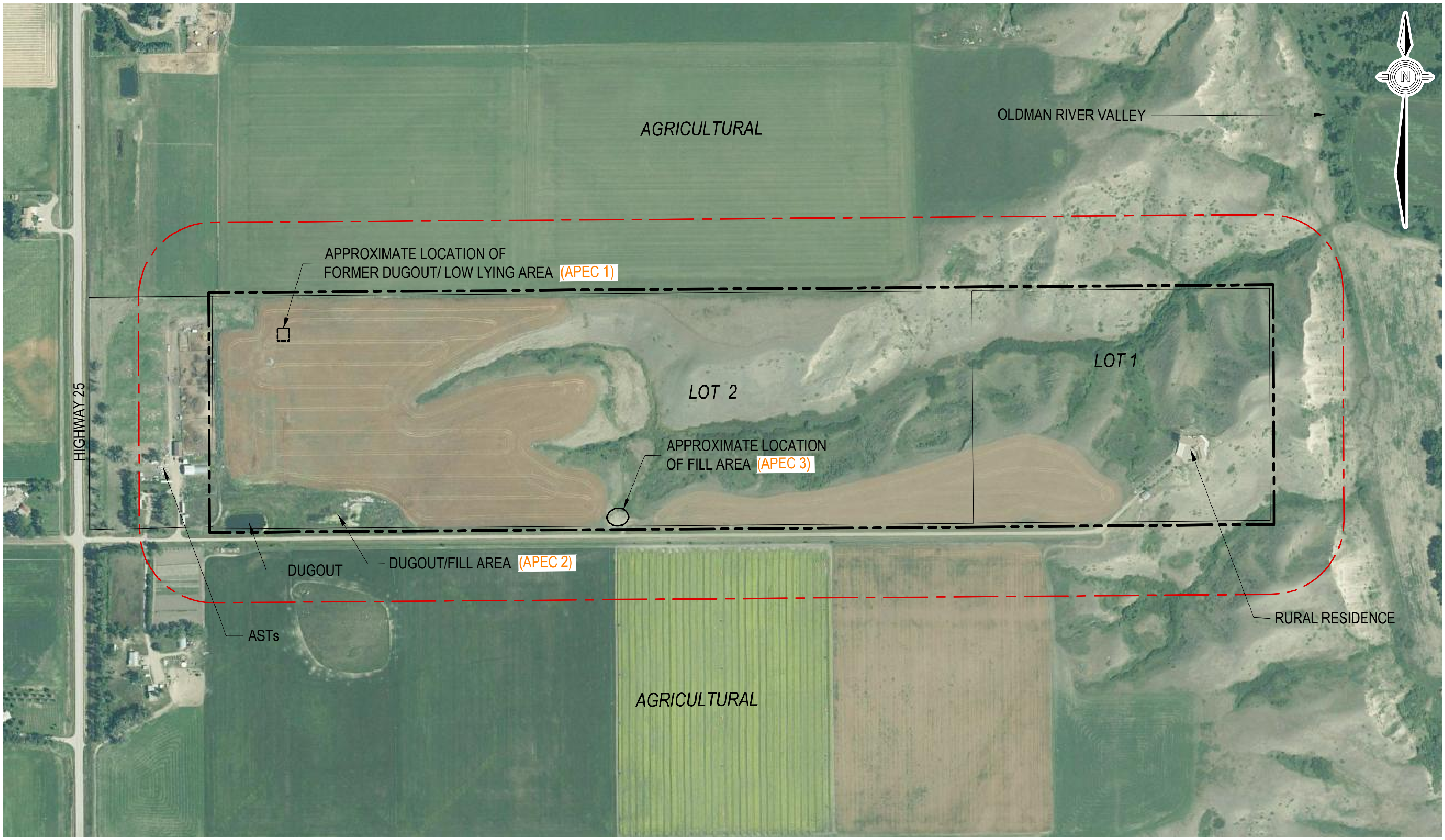
SITE LOCATION PLAN

PROJECT NO.	DWN	CKD	REV
LGEO03581-01.004	LCH	JG	0

OFFICE	DATE
TT LETH	November 2017

Figure 1

C:\Lethbridge\Drafting\ENG.LGEO\LGEO03581\LGEO03581-01-004 Figure 1.dwg [FIGURE 1] November 02, 2017 - 4:09:48 pm (BY: HUGHES, LEANNE)



LEGEND

▬ ▪ ▪ ▬ SITE BOUNDARY

— - — 100 m BUFFER

0 250m

Scale: 1:7,500 @ 8.5"x11"

NOTES
GOOGLE EARTH IMAGERY DATED 2015

CLIENT

Fiorino Homes Ltd.

TETRA TECH

PHASE I ENVIRONMENTAL SITE ASSESSMENT
PLAN 0210532, BLOCK 2, LOTS 1 & 2
LETHBRIDGE COUNTY

SITE PLAN SHOWING SURROUNDING LAND USE

PROJECT NO.	DWN	CKD	REV
LGEO03581-01.004	LCH	JG	0

OFFICE	DATE
TT Leth	December 2017

Figure 2

APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOENVIRONMENTAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, 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. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH 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 further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document 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 conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH 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.

1.7 NOTIFICATION OF AUTHORITIES

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 TETRA TECH in its reasonably exercised discretion.

APPENDIX B

SITE PHOTOGRAPHS

Photo 1: View looking east at the site access road and dugout located on the southwest corner of the site.

Photo 2: View looking north from the southwest corner of the site.

Photo 3: View of eastern dugout and fill/debris material around and within the dugout.

Photo 4: View looking east along the northern boundary of the site from the northwest corner of the site.

Photo 5: View of adjacent land use to the north of the site.

Photo 6: View looking easterly at the coulee valley/draw located on the site.

Photo 7: View looking at fill material placed within the coulee valley/draw near the approximate middle of the site along the southern boundary.

Photo 8: View of site looking westerly from near the boundary of Lot 1.

Photo 9: View looking northeasterly at the adjacent land use to the east, the Oldman River valley.

Photo 10: View looking easterly at the site residence on Lot 1.

Photo 11: View looking west at the site access road and southern boundary of the site.

Photo 12: View of adjacent land use the south.

APPENDIX C

REGULATORY SEARCHES

GOVERNMENT OF THE PROVINCE OF ALBERTA

LAND TITLE CERTIFICATE

S

LINC	SHORT LEGAL	TITLE NUMBER
0029 217 908	0210532;2;1	131 233 076

LEGAL DESCRIPTION

DESCRIPTIVE PLAN 0210532
BLOCK 2
LOT 1
EXCEPTING THEREOUT ALL MINES AND MINERALS
AREA: 12.68 HECTARES (31.33 ACRES) MORE OR LESS

ATS REFERENCE: 4;22;9;14;S
ESTATE: FEE SIMPLE

MUNICIPALITY: LETHBRIDGE COUNTY

REFERENCE NUMBER: 021 058 088

REGISTERED OWNER(S)

REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
131 233 076	13/09/2013	TRANSFER OF LAND	$1,320,000	SEE INSTRUMENT

OWNERS

PETER FIORINO
OF 1106-3 AVE N
LETHBRIDGE
ALBERTA T1H 0H6

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER		DATE (D/M/Y)	PARTICULARS
8691EX	.		RESTRICTIVE COVENANT
5619DI	.	06/05/1926	RESTRICTIVE COVENANT
1084EJ	.	31/07/1931	CAVEAT RE : EASEMENT CAVEATOR - LETHBRIDGE NORTHERN IRRIGATION DISTRICT.

(CONTINUED)

```
7337JP  .      25/11/1966 CAVEAT
                          CAVEATOR - CANADIAN WESTERN NATURAL GAS COMPANY
                          LIMITED.

741 091 031   27/09/1974 IRRIGATION ORDER/NOTICE
                          THIS PROPERTY IS INCLUDED IN THE LETHBRIDGE
                          NORTHERN IRRIGATION DISTRICT

841 181 508   05/11/1984 UTILITY RIGHT OF WAY
                          GRANTEE - FORTISALBERTA INC.
                          320 - 17 AVENUE S.W.
                          CALGARY
                          ALBERTA T2S2Y1
                          "PORTION DESCRIBED"
                               (DATA UPDATED BY: TRANSFER OF UTILITY RIGHT
                               OF WAY 001287703)
                               (DATA UPDATED BY: CHANGE OF NAME 051014950)

861 050 204   25/03/1986 CAVEAT
                          RE : AMENDING AGREEMENT
                          CAVEATOR - ALTALINK MANAGEMENT LTD.
                          2611 - 3 AVE SE
                          CALGARY
                          ALBERTA T2A7W7
                               (DATA UPDATED BY: TRANSFER OF CAVEAT
                               021189410)
                               (DATA UPDATED BY: CHANGE OF ADDRESS 081422776)

861 050 205   25/03/1986 CAVEAT
                          RE : AMENDING AGREEMENT
                          CAVEATOR - ALTALINK MANAGEMENT LTD.
                          2611 - 3 AVE SE
                          CALGARY
                          ALBERTA T2A7W7
                               (DATA UPDATED BY: TRANSFER OF CAVEAT
                               021189410)
                               (DATA UPDATED BY: CHANGE OF ADDRESS 081422776)

011 333 554   08/11/2001 UTILITY RIGHT OF WAY
                          GRANTEE - ATCO GAS AND PIPELINES LTD.

021 058 051   20/02/2002 CAVEAT
                          RE : DEFERRED RESERVE
                          CAVEATOR - COUNTY OF LETHBRIDGE.
                          C/O OLDMAN RIVER INTERMUNICIPAL SERVICE AGENCY
                          #B, 905 - 4 AVENUE SOUTH
                          LETHBRIDGE
                          ALBERTA T1J0P4
                          AGENT - OLDMAN RIVER INTERMUNICIPAL SERVICE AGENCY.
```

(CONTINUED)

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
7072IZ .	27/08/1964	UTILITY RIGHT OF WAY GRANTEE - ALTALINK MANAGEMENT LTD. 2611 - 3 AVE SE CALGARY ALBERTA T2A7W7 AS TO PORTION OR PLAN:2514JK "ENDORSED BY 051034527 ON 20050126" (DATA UPDATED BY: CHANGE OF ADDRESS 091108519)
131 233 077	13/09/2013	MORTGAGE MORTGAGEE - ROYAL BANK OF CANADA. 10 YORK MILLS ROAD 3RD FLOOR TORONTO ONTARIO M2P0A2 ORIGINAL PRINCIPAL AMOUNT: $1,350,000

TOTAL INSTRUMENTS: 012

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 25 DAY OF OCTOBER, 2017 AT 07:21 A.M.

ORDER NUMBER: 33951423

CUSTOMER FILE NUMBER: LGEO03581-01

END OF CERTIFICATE

GOVERNMENT OF THE PROVINCE OF ALBERTA

LAND TITLE CERTIFICATE

S

LINC	SHORT LEGAL	TITLE NUMBER
0037 664 075	0210532;2;2	171 188 317 +1

LEGAL DESCRIPTION

DESCRIPTIVE PLAN 0210532
BLOCK 2
LOT 2
EXCEPTING THEREOUT:

A) PLAN	NUMBER	HECTARES	(ACRES)	MORE OR LESS
SUBDIVISION	1711734	5.26	13.00	

EXCEPTING THEREOUT ALL MINES AND MINERALS

ATS REFERENCE: 4;22;9;14;S
ESTATE: FEE SIMPLE

MUNICIPALITY: LETHBRIDGE COUNTY

REFERENCE NUMBER: 091 280 016

REGISTERED OWNER(S)

REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
171 188 317	24/08/2017	SUBDIVISION PLAN		

OWNERS

1463770 ALBERTA LTD.
OF 1106-3 AVENUE NORTH
LETHBRIDGE
ALBERTA T1H 0H6

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
8691EX .		RESTRICTIVE COVENANT
5619DI .	06/05/1926	RESTRICTIVE COVENANT
1084EJ .	31/07/1931	CAVEAT RE : EASEMENT

(CONTINUED)

```
                         CAVEATOR - LETHBRIDGE NORTHERN IRRIGATION DISTRICT.

7073IZ  .     27/08/1964 UTILITY RIGHT OF WAY
                         GRANTEE - ALTALINK MANAGEMENT LTD.
                         2611 - 3 AVE SE
                         CALGARY
                         ALBERTA T2A7W7
                         "PORTION DESCRIBED"
                              (DATA UPDATED BY: TRANSFER OF UTILITY RIGHT
                              OF WAY 021217402)
                              (DATA UPDATED BY: CHANGE OF ADDRESS 091108519)

741 091 031   27/09/1974 IRRIGATION ORDER/NOTICE
                         THIS PROPERTY IS INCLUDED IN THE LETHBRIDGE
                         NORTHERN IRRIGATION DISTRICT

801 167 573   16/10/1980 UTILITY RIGHT OF WAY
                         GRANTEE - CANADIAN WESTERN NATURAL GAS COMPANY
                         LIMITED.

861 050 204   25/03/1986 CAVEAT
                         RE : AMENDING AGREEMENT
                         CAVEATOR - ALTALINK MANAGEMENT LTD.
                         2611 - 3 AVE SE
                         CALGARY
                         ALBERTA T2A7W7
                              (DATA UPDATED BY: TRANSFER OF CAVEAT
                              021189410)
                              (DATA UPDATED BY: CHANGE OF ADDRESS 081422776)

861 050 205   25/03/1986 CAVEAT
                         RE : AMENDING AGREEMENT
                         CAVEATOR - ALTALINK MANAGEMENT LTD.
                         2611 - 3 AVE SE
                         CALGARY
                         ALBERTA T2A7W7
                              (DATA UPDATED BY: TRANSFER OF CAVEAT
                              021189410)
                              (DATA UPDATED BY: CHANGE OF ADDRESS 081422776)

011 333 554   08/11/2001 UTILITY RIGHT OF WAY
                         GRANTEE - ATCO GAS AND PIPELINES LTD.

021 026 046   22/01/2002 UTILITY RIGHT OF WAY
                         GRANTEE - LETHBRIDGE NORTHERN IRRIGATION DISTRICT.
                         AS TO PORTION OR PLAN:0111357
                         TAKES PRIORITY OF CAVEAT 001165849
                         REGISTERED ON JUNE 20, 2000

101 216 514   21/07/2010 UTILITY RIGHT OF WAY
```

(CONTINUED)

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
		GRANTEE - LETHBRIDGE NORTH COUNTY POTABLE WATER CO-OP LTD.
121 057 227	08/03/2012	MORTGAGE MORTGAGEE - CANADIAN WESTERN BANK. 744-4 AVE. SOUTH LETHBRIDGE ALBERTA T1J0N8 ORIGINAL PRINCIPAL AMOUNT: $388,000
121 057 228	08/03/2012	CAVEAT RE : ASSIGNMENT OF RENTS AND LEASES CAVEATOR - CANADIAN WESTERN BANK. C/O NORTH & COMPANY LLP 600, 220-4 ST SOUTH LETHBRIDGE ALBERTA T1J4J7 AGENT - DOUGLAS R LINT
171 092 770	04/05/2017	UTILITY RIGHT OF WAY GRANTEE - ALTALINK MANAGEMENT LTD.
171 188 316	24/08/2017	CAVEAT RE : ROADWAY CAVEATOR - HER MAJESTY THE QUEEN IN RIGHT OF ALBERTA AS REPRESENTED BY MINSTER OF TRANSPORTATION C/O ALBERTA TRANSPORTATION 2ND FLOOR, TWIN ATRIA BUILDING 4999 - 98 AVENUE NW EDMONTON ALBERTA T6B2X3

TOTAL INSTRUMENTS: 015

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 25 DAY OF OCTOBER, 2017 AT 07:21 A.M.

ORDER NUMBER: 33951423

CUSTOMER FILE NUMBER: LGEO03581-01

END OF CERTIFICATE

(CONTINUED)

PETROLEUM TANK
MANAGEMENT
ASSOCIATION
OF ALBERTA

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

October 26, 2017

Jaymes Going
Tetra Tech EBA Inc.
442 10 Street N
Lethbridge, AB
T1H 2C7

Dear Jaymes Going:

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:

> Plan 0210532, Block 2, Lots 1 & 2, Lethbridge
> S1/2 14-009-22-W4

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

Wednesday, October 25, 2017

1:7,556

0 90 180 360 m

AbaData

The ESA marker represents an approximate location of a site where the Government of Alberta has received scientific and/or technical information. The marker is an arbitrary, 40 meter diameter circle centered on the property for which this information is attached. For locations or other site information, see the document results table.

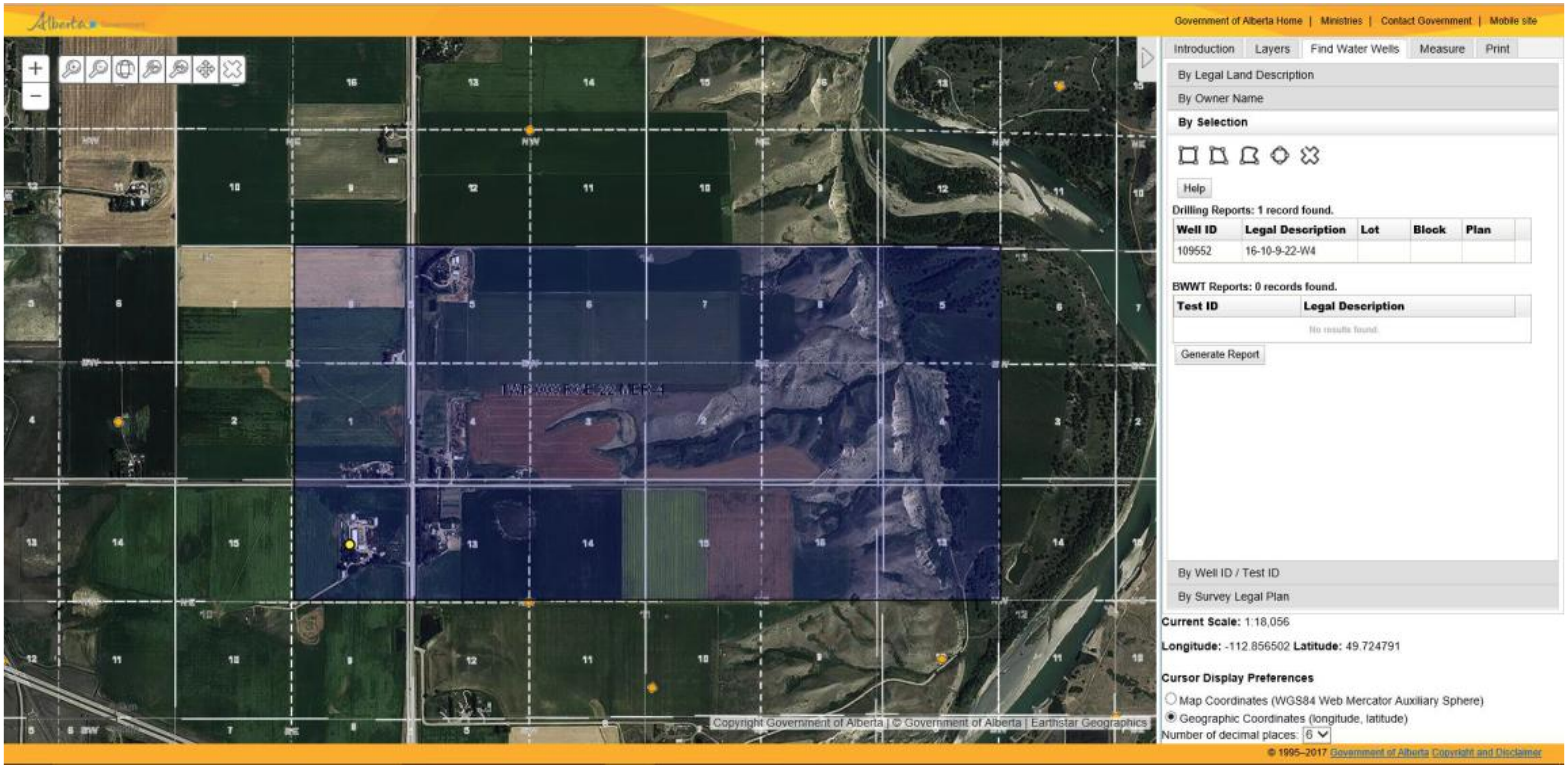
Spatial Search provided by the Alberta Land Titles SPIN 2 System

A designated location identifies a site where Alberta Environment and Parks has received scientific or technical information for that site and does not imply anything regarding the current state or condition of the site. Please refer to the studies and reports to determine the condition of the site.

Meridian W - 4
Range 22
Township 9
Section 14
[Quarter]

Ready ...

X:153932.7870 Y:5507703.3506



Drilling Reports: 1 record found.

Well ID	Legal Description	Lot	Block	Plan
109552	16-10-9-22-W4			

BWWT Reports: 0 records found.

Test ID	Legal Description
No results found.	

Current Scale: 1:18,056

Longitude: -112.856502 **Latitude:** 49.724791

Cursor Display Preferences

○ Map Coordinates (WGS84 Web Mercator Auxiliary Sphere)
● Geographic Coordinates (longitude, latitude)
Number of decimal places: 6

Water Well Drilling Report

View in Imperial **Export to Excel**

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 109552
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

GOWN ID

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	16	10	9	22	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 49.725456 Longitude -112.894675
How Location Obtained
Not Verified

Elevation 923.54 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Hand Dug

Proposed Well Use
Unknown

Type of Work
Well Inventory

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1964/08/01		2.44

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
4.88 m			1956/01/01

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	4.88

Surface Casing (if applicable)

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack

Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Water Well Drilling Report

View in Imperial **Export to Excel**

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 109552
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

GOWN ID

Well Identification and Location

Measurement in Metric

Owner Name *Address* *Town* *Province* *Country* *Postal Code*

Location	*1/4 or LSD*	*SEC*	*TWP*	*RGE*	*W of MER*	*Lot*	*Block*	*Plan*	*Additional Description*
	16	10	9	22	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 49.725456 *Longitude* -112.894675
How Location Obtained
Not Verified

Elevation 923.54 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 0.00 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) *Depth* m
Well Disinfected Upon Completion
Gas *Depth* m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD
Additional Comments on Well

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	*Start Time*	*Static Water Level*
1964/08/01	12:00 AM	2.44 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	*Amount Taken*	*Diversion Date & Time*
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner *Date approval holder signed*

Authorization Viewer -
Search Results

The Search Used the Following Values:

Area Parcel:	Plan: 0210532 Block: 2 Lot: 1
Act / Document Type:	Water Act, EPEA
Show Inactive Authorizations:	Yes

The resulting Authorizations based on the search criteria will be displayed below. A will appear next to the Authorization when documentation is available for viewing or downloading. Please click Viewer Help if you encounter problems viewing the Authorization document.

0 Result(s)

Comments regarding the Authorization Viewer page may be directed to the Regulatory Approvals Centre RAC.Environment@gov.ab.ca.

©1995 - 2017 Government of Alberta Copyright and Disclaimer Using This Site Staff Access Privacy

Authorization Viewer -
Search Results

The Search Used the Following Values:

Area Parcel:	Plan: 0210532 Block: 2 Lot: 2
Act / Document Type:	Water Act, EPEA
Show Inactive Authorizations:	Yes

The resulting Authorizations based on the search criteria will be displayed below. A PDF will appear next to the Authorization when documentation is available for viewing or downloading. Please click Viewer Help if you encounter problems viewing the Authorization document.

0 Result(s)

Comments regarding the Authorization Viewer page may be directed to the Regulatory Approvals Centre RAC.Environment@gov.ab.ca.

Authorization Viewer -
Search Results

The Search Used the Following Values:

Legal Land Location:	1 14-009-22-W4
Act / Document Type:	Water Act, EPEA
Show Inactive Authorizations:	Yes

The resulting Authorizations based on the search criteria will be displayed below. A PDF will appear next to the Authorization when documentation is available for viewing or downloading. Please click Viewer Help if you encounter problems viewing the Authorization document.

0 Result(s)

Comments regarding the Authorization Viewer page may be directed to the Regulatory Approvals Centre RAC.Environment@gov.ab.ca.

Authorization Viewer -
Search Results

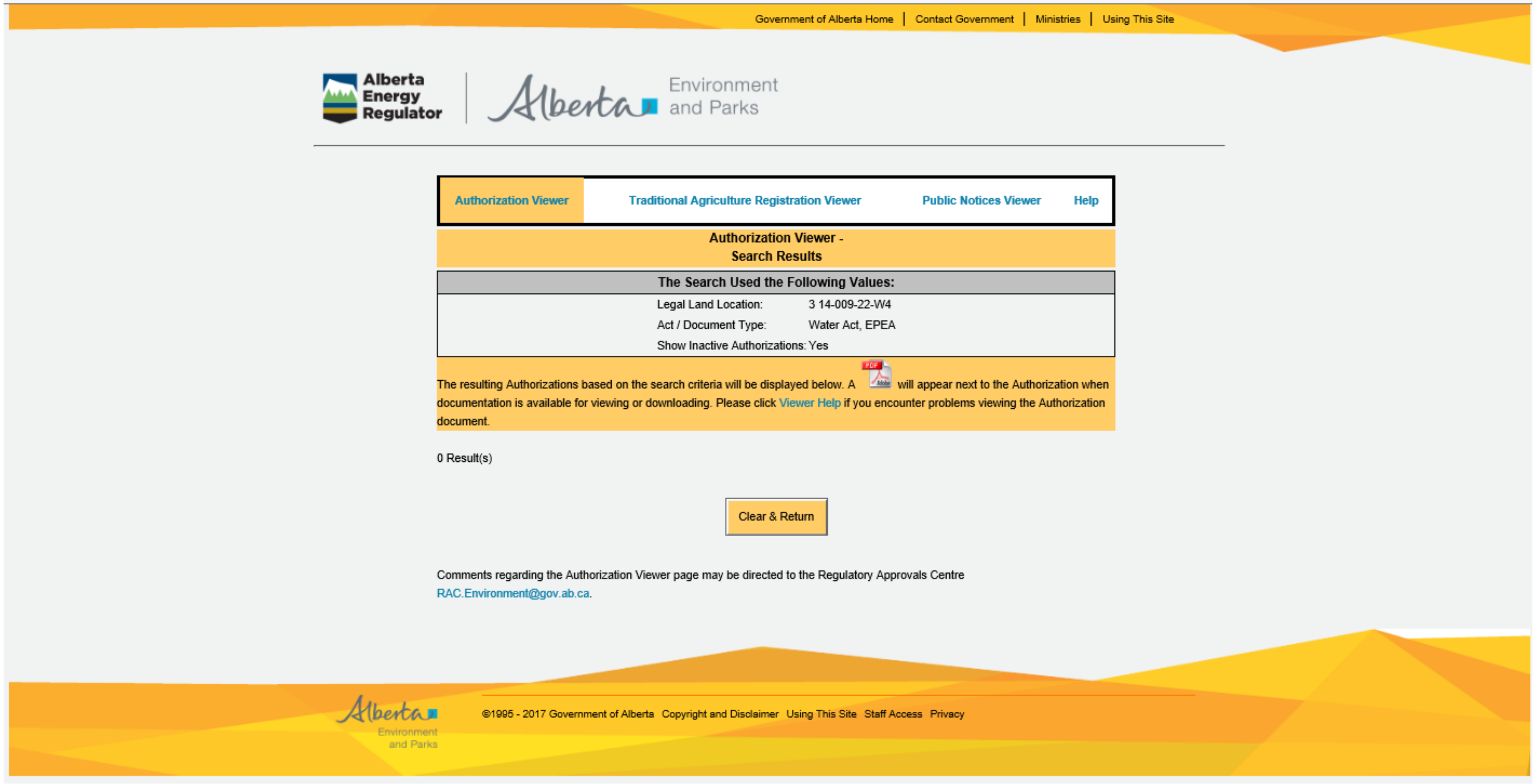
The Search Used the Following Values:

Legal Land Location:	2 14-009-22-W4
Act / Document Type:	Water Act, EPEA
Show Inactive Authorizations:	Yes

The resulting Authorizations based on the search criteria will be displayed below. A PDF will appear next to the Authorization when documentation is available for viewing or downloading. Please click Viewer Help if you encounter problems viewing the Authorization document.

0 Result(s)

Comments regarding the Authorization Viewer page may be directed to the Regulatory Approvals Centre RAC.Environment@gov.ab.ca.



Authorization Viewer -
Search Results

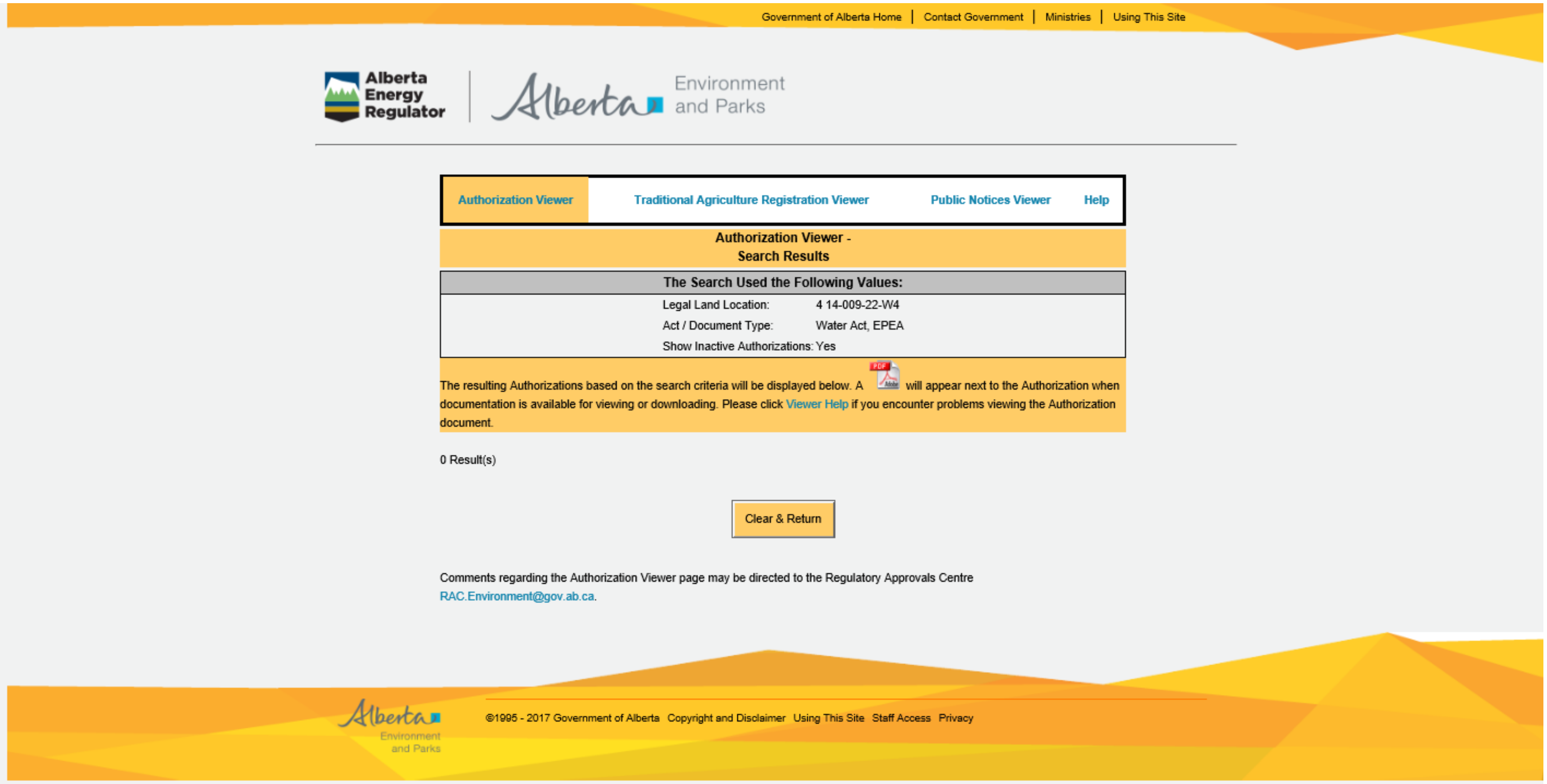
The Search Used the Following Values:

Legal Land Location:	3 14-009-22-W4
Act / Document Type:	Water Act, EPEA
Show Inactive Authorizations:	Yes

The resulting Authorizations based on the search criteria will be displayed below. A will appear next to the Authorization when documentation is available for viewing or downloading. Please click Viewer Help if you encounter problems viewing the Authorization document.

0 Result(s)

Comments regarding the Authorization Viewer page may be directed to the Regulatory Approvals Centre RAC.Environment@gov.ab.ca.



Authorization Viewer -
Search Results

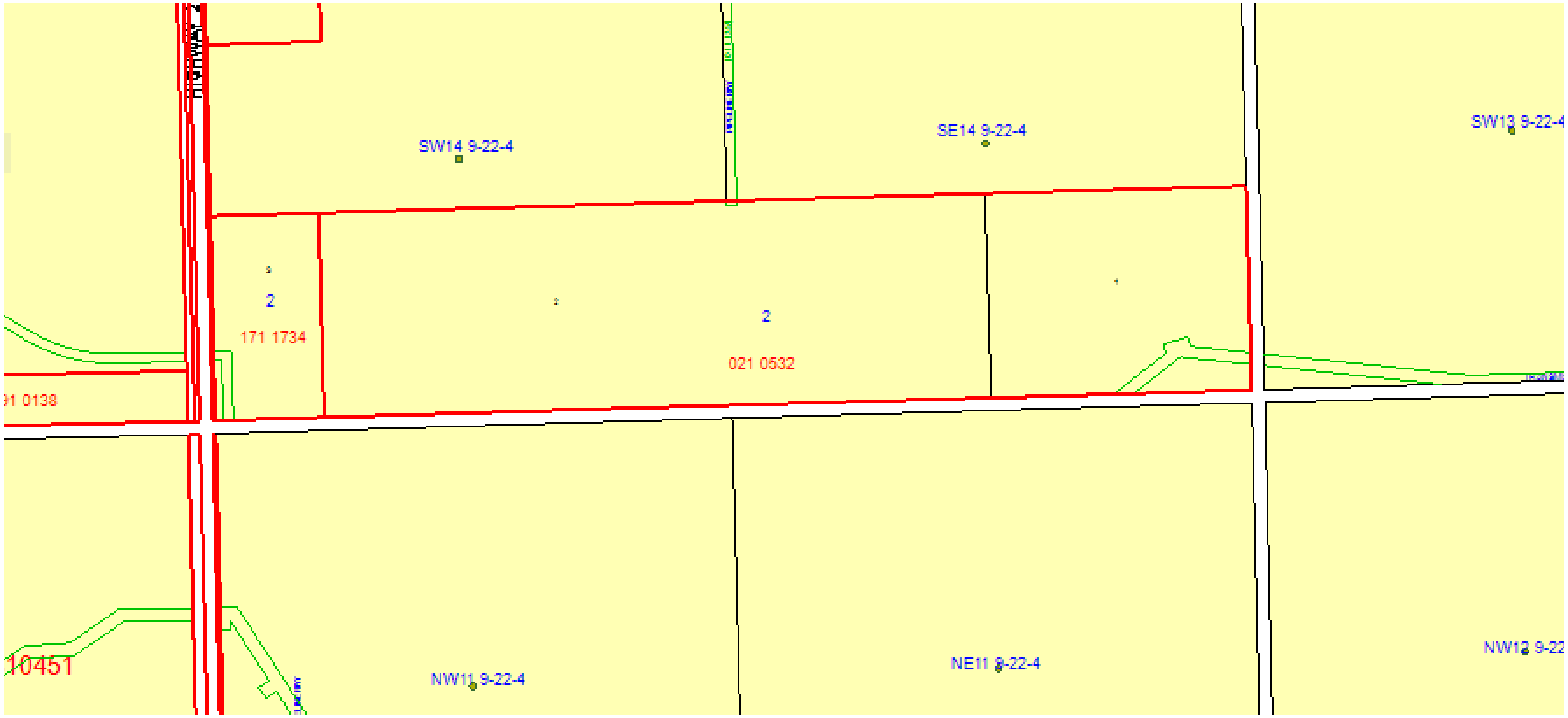
The Search Used the Following Values:

Legal Land Location: 4 14-009-22-W4
Act / Document Type: Water Act, EPEA
Show Inactive Authorizations: Yes

The resulting Authorizations based on the search criteria will be displayed below. A PDF will appear next to the Authorization when documentation is available for viewing or downloading. Please click Viewer Help if you encounter problems viewing the Authorization document.

0 Result(s)

Comments regarding the Authorization Viewer page may be directed to the Regulatory Approvals Centre RAC.Environment@gov.ab.ca.


HIGHWAY 2
SW14 9-22-4
SE14 9-22-4
SW13 9-22-4
2
171 1734
2
021 0532
91 0138
10451
NW11 9-22-4
NE11 9-22-4
NW12 9-22

APPENDIX D

SPECIAL ATTENTION ITEMS – BACKGROUND INFORMATION

SPECIAL ATTENTION ITEMS – BACKGROUND INFORMATION

D1 Asbestos

Construction materials used prior to the late 1970s were known to possibly contain asbestos (i.e., ceiling or floor tiles, drywall, and insulation for the walls, boiler, piping, and/or ducts). Asbestos is considered a health hazard if it is friable, airborne, and exposed to humans.

D2 Polychlorinated Biphenyls (PCBs)

The federal Environmental Contaminants Act (1976) has restricted the use and controlled the phase out of polychlorinated biphenyls (PCBs) in Canada. Additionally, the storage and disposal of PCBs is regulated. The Act prohibited the use of PCBs in electrical equipment installed after July 1, 1980. PCBs are commonly found in light ballasts, electrical transformers (pole or ground mounted) and various other types of electrical equipment (i.e., rectifiers) dating back to the early 1980s or earlier.

PCB-containing light ballasts or electrical equipment should be disposed of appropriately at the end of their useful life.

D3 Ozone-depleting Substances (ODS)

In December of 1998, The Government of Canada enacted the Ozone-depleting Substances (ODS) Regulations, which governs the use, handling, and release of ODS. ODS may include, but are not limited to, chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl bromide. ODS are usually associated with operations such as fire extinguishing systems, foam manufacturing, fumigant and pesticide application, prescription metered dose inhalers, refrigeration and air conditioning units, and solvent cleaning and degreasing facilities. ODS are not a health issue for people in the building, but are more a maintenance issue to limit or prevent their release. This is accomplished by regular maintenance by trained personnel.

D4 Lead

Lead can be associated with paints, plumbing solder, pipes, and other products such as wall shielding in x-ray rooms. Lead-based paint was withdrawn from the market in the late 1970s. If present, lead-based paint is typically concealed beneath multiple layers of paint applied over the years during renovations. Lead-based paint and plumbing equipment are not a direct health risk when concealed (sealed behind layers of non-lead paint) and/or in good condition. It should, however, be considered when planning future renovations, when particles from lead-based paint could be released and/or ingested in the course of the work.

D5 Urea Formaldehyde Foam Insulation (UFFI)

Insulation materials used during the 1970s and 1980s were known to possibly contain urea formaldehyde foam insulation (UFFI). UFFI was banned in 1980 under the federal Hazardous Products Act.

D6 Radon

Radon gas is a product of the decay series that begins with uranium. Radon is produced directly from radium that can be commonly found in bedrock that contains black shale and/or granite. Radon gas can migrate through the ground and enter buildings through porous concrete or fractures. Cross-Canada Survey of Radon Concentrations in Homes, Final Report, Health Canada, published in March 2012 states that:

“*There are no areas of the country that are 'radon free'. The results of this study show that even for those provinces where the overall results indicate a lower incidence of homes with elevated radon levels, there were still areas of those provinces with high radon levels and a significant number of homes with radon concentrations above the guideline.” “The only way to know if a home has an elevated level of radon is to test, regardless of location.*”

D7 Methane

Methane gas is a product of anaerobic decomposition of organic material (e.g., buried fill high in organic material). Methane is also associated with natural gas deposits. Methane gas can migrate through the ground and enter buildings through porous concrete, joints, or fractures. Methane presents a potential explosive hazard when it accumulates to concentrations greater than the lower explosive limit (LEL) in the presence of an ignition source.

APPENDIX

APPENDIX 4 ~ HISTORICAL RESOURCE ASSESSMENT

Historical Resources Statement of Justification

This document contains sensitive information about Historic Resources that are protected under the provisions of the Alberta *Historical Resources Act.* This information is to be used to assist in planning the proposed project only. It is not to be disseminated, and no copies of this document are to be made without written permission of the Historic Resources Management Branch, Alberta Culture and Tourism.

PART I

(1) Purpose:

Provision of *Historical Resources Act* (*HRA*) approval

(2) Project Name/Identifier:

Fiorino Residential Subdivision S1/2 14-9-22 W4

(3) Disposition Type & Number:

(4) Developer/Proponent:

Contact Name: Matt Redgrave, as agent for Peter Fiorino
Company: Martin Geomatic Consultants Ltd.
Phone number: 403 329 0050
E-mail address: mattr@mgcl.ca

(5) Project Type and Description:

The project is a proposed residential subdivision within the County of Lethbridge. The project consists of the development of 16 residential lots for new single family dwellings. The lots range in size from 2.58 to 13.0 acres.

(6) Project Size (ha):

50

(7) Anticipated Ground Disturbance

The project will consist of normal residential development with construction of new accesses and related infrastructure in addition to residential buildings. Ground disturbance will, or is likely, to include levelling and grading for proposed new access, excavation for water, sewer, gas and electrical infrastructure and included excavated trenches to more than 1 m deep and excavations for building foundations, landscape grading and other surface disturbance that may be 2 m or more. All of the significant surface disturbance will occur on level prairie upland in areas of pre-existing disturbance.

The plan includes “Lot PUL” that occupies 2.02 acres and includes the head of a coulee. This area could be used storm water retention and so could include a

dyke or dam at or near the east end of that lot as shown the accompany subdivision plan.

(8) Lands Affected:

Legal Description	Land Ownership Type	HRV
11,2,3,4-14-9-22 W4	*freehold*	5p

(9) Existing Disturbance:

The residential subdivision area is located in currently cultivated terrain, in an existing disturbed farmyard and a small area that was previously broken. This latter area is occupied by Lot 7 on the existing plan. The subdivision surrounds a deep, steep-sided west to east draining coulee that has not been disturbed.

(10) Landscape and Environmental Information:

The project occupies level prairie upland and is directly adjacent to the Oldman River valley. While project related development is essentially restricted to prairie upland, the project surrounds a steep-sided and deeply incised coulee that drains into the Oldman River east of the subdivision boundary. This coulee is over 300 m at its widest point within the project's boundary. There is no visible exposed bedrock in the coulee and, on the basis of exposures along the river valley in this area, glacial ground moraine and glaciolacustrine sediments are in excess of 20 m in the project area. The bottom of the coulee is up to 50 m below the prairie upland near the eastern end of the subdivision. Natural vegetation on prairie upland in this area is shortgrasses and related common herbaceous plants. Coulee vegetation includes woody brush in the bottom and on north facing slopes and generally xeric vegetation on south facing slopes. There is no active, permanent water course on the upland or in the coulee and the modern channel of the Oldman River is ca. 800 m or more from the eastern boundary of the project area.

(11) Attached Illustrative Materials and Digital Data:

NTS 1:50000 NTS 82H/10 section with subdivision location shown.

Project plan map provided by Martin Geomatic Consultants Ltd.

PART II

(12) Historic Resource Types:

Archaeology: ☒	Palaeontology: ☐
Historic Structures: ☐	Aboriginal Traditional Use: ☐

(13) Archaeological Resources:

Site Borden #	**HRV**	**Relationship to Activity and Anticipated Impacts**
No recorded sites		There are no recorded sites within 500 m of the development

Permit Number(s)	**Relationship to Project or Activity**
None	The project footprint boundary has not had a previous HRIA.

Evaluation:

The project footprint is located in previously disturbed terrain (cultivation, an existing farmyard) previously cultivated terrain and there are no recorded archaeological sites within 500 m of the project boundary. The proposed development will occur on prairie upland that, in our opinion, would have had potential for the presence of surface archaeological features prior to it being broken for agriculture, but if any existed they would have been previously destroyed. The subdivision has a required geotechnical setback for development from the coulee that occupies the east central part of the project boundary and no development will occur on the coulee side of that setback. Based on observation of exposed glacially deposited sediments at and 20 m or more below the surface of the area, it is our view that there is little potential for intact historical resources within the project footprint.

Note that the eastern portion of the project area has a designated HRV 5(P), indicating that it has potential for palaeontological remains. This designation is based on the coulee topography and the presence of deeply buried fossiliferous bedrock that outcrops in the Oldman River valley and in some coulee walls in the general area. There are no identified outcrops in this coulee area within the subdivision and the project will not impact or disturb existing coulee slopes. Note the geotechnical setback boundary as illustrated on the Fioriono ASP concept plan.

Recommendations:

We recommend HRA approval for the project subdivision footprint with the condition that no impacts occur on the coulee side of the delineated geotechnical setback. We note that there is potential for development of a storm water retention facility with the area identified as Lot PUL on the attached plan. It is our view that there is little potential for the presence of intact historical resources in this area, however, this area should be considered for a small scale HRIA if it is used for storm water retention in the future.

Recommendations made by:

Name: Neil Mirau
Company: Arrow Archaeology Limited
Phone number: 403 345 2812
Fax number:
E-mail address: nmirau@shaw.ca
Date: 10/11/2017
Recommendations endorsed by: as above

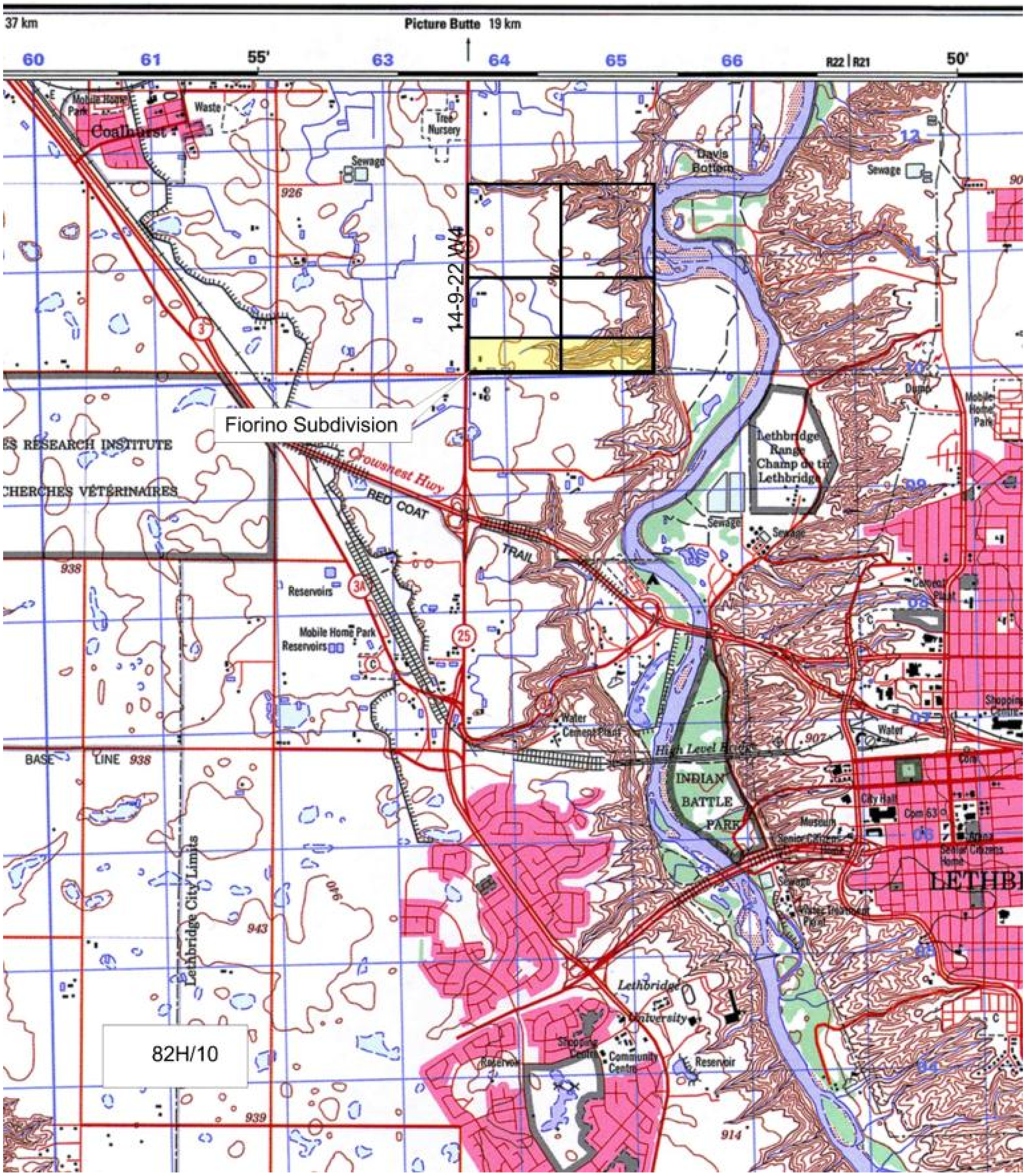


Figure 1. Project location on NTS 1:50000 section.

Historical Resource Values

Historical Resource Values (HRVs) are assigned to legally-described lands (legal subdivisions, quarter sections, sections etc.) by Alberta based on recorded historical resources within those sections or portions thereof, or the potential of those lands to contain unrecorded historical resources. The potential to contain unrecorded historical resources is based primarily on landscape information, for example, the area’s proximity to a river, stream, lake or other water body, local topography, geological exposures and the distribution and location of nearby historical resources. HRVs are maintained by the province and a list of updated HRVs for the entire province is issued every six months. Each assessed parcel of land is given a ranking of 1 to 5. Many legally-described lands in Alberta have no assigned value and this means that they are considered to have no potential to contain historical resources or that they have not been adequately assessed.

An HRV of 1 a provincial historic resource and is the highest ranking and 5 is the lowest assigned ranking where high means the area has provincially recognized historical resources and 5 means the land so ranked has no recorded historical resources, but has potential to contain unrecorded resources. Those sites with ranking of 1 are highly significant due to their uniqueness, rarity, scientific, historical, or traditional importance (or a combination of those factors.) A ranking of 2 is a registered historical resource and this ranking is mostly restricted to historical buildings and other elements of the built environment. The Whitney House (Ideal Farm house) in south Lethbridge, for example, has an HRV of 2. An HRV of 3 is a known and significant archaeological or other historical resource that is or may be a candidate for designation as provincial historical resource, (it may become an HRV 1 site in the future). An HRV 4 indicates that there is a known and recorded historical resource in the area. The site may be considered to be not highly significant and there is no real possibility that it will be given a higher ranking or that it is not sufficiently well studied to be able to draw any firm conclusions about its significance. A ranking of 5, as described earlier, means that the land so ranked has the potential to contain resources on the basis of its biogeophysical attributes.

Borden Blocks

In Canada, all archaeological sites and many other historical resources are coded by location using the Borden System. The Borden System uses a series of 4 letters and a number for each recorded site. The letters designate general location and the number is a chronological ordering of sites within the location as specified by the Borden System. The 4 letter series conveys latitudinal and longitudinal information. The first letter in the sequence is a capital letter and designates a major Borden Block latitude coordinate. The letters A through U are used to designate units of 2 degrees latitude from south to north. The third letter in the sequence is also a capital letter and designates a major Borden Block longitude coordinate. The letters A through V are used to designate units of 4 degrees longitude from east to west. Each 2 degree by 4 degree major block is subdivided into smaller blocks of 10 minutes latitude by 10 minutes longitude and each of these smaller or minor Borden Blocks are designated by lower case letters. The lower case 2nd letter in the sequence denotes a zone of 10 minutes latitude and the lower case 4th letter in the sequence denotes a zone of 10 minutes longitude. (The system changes slightly north of 62 degrees north latitude.) Borden Block EbPc is thus located between 50º10 and 50º20 north latitude and 112º20 and 112º30 west longitude. The number following the letter series simply provides the chronological number of the specific site recorded in that block. The first archaeological site or historical resource in a block is designated one, the second is designated two and so on. Borden Block designations, again, are used throughout Canada and are considered official site designation. All formally recorded sites are provided with a Borden Block number by the province or territory in which the site is situated and all provincial governments maintain a permanent record of all recorded sites within their respective borders.

Culture and Tourism

HRA Number: 4835-17-0096-001
December 19, 2017

Historical Resources Act Requirements

Proponent: Fiorion Subdivision
c/o Martin Geomatic Consultants Ltd., 255 - 31 Street N., Lethbridge, AB T1H EZ4
Contact: Matt Redgrave

Agent: Arrow Archaeology Limited
Contact: Neil Mirau

Project Name: **Fiorino Residential Subdivision S1/2 14-9-22 W4**

Project Components: Residential Subdivision

Application Purpose: Requesting HRA Approval / Requirements

Pursuant to Section 37(2) of the *Historical Resources Act*, a Historic Resources Impact Assessment is required for all or portions of those activities described in this application and its attached plan(s)/sketch(es). The Historic Resources Impact Assessment is to be conducted in accordance with the instructions outlined in the following schedule.

David Link
Assistant Deputy Minister

SCHEDULE OF REQUIREMENTS

ARCHAEOLOGICAL RESOURCES

Pursuant to Section 37(2) of the *Historical Resources Act*, a Historic Resources Impact Assessment for archaeological resources is to be conducted on behalf of the proponent by an archaeologist qualified to hold an archaeological research permit within the Province of Alberta. A permit must be issued by Alberta Culture and Tourism prior to the initiation of any archaeological field investigations. Please allow ten working days for the permit application to be processed.

1. The Historic Resources Impact Assessment is to be carried out prior to the initiation of any land surface disturbance activities under snow-free, unfrozen ground conditions. Should the project require field studies under winter conditions, directions in the Archaeological Survey Information Bulletin: Winter Conditions must be followed.
2. The Historic Resources Impact Assessment must target areas of native prairie above the coulee slopes. A recommended target area is indicated in the attached map and shapefile. Cultivated or otherwise disturbed areas as well as sloping terrain within the coulee do not require assessment.

SCHEDULE OF REQUIREMENTS (continued)

PALAEONTOLOGICAL RESOURCES

There are no *Historical Resources Act* requirements associated with palaeontological resources; however, the proponent must comply with standard conditions under the *Historical Resources Act*, which are applicable to all land surface disturbance activities in the Province.

ABORIGINAL TRADITIONAL USE SITES

There are no Historical Resources Act requirements associated with Aboriginal traditional use sites of a historic resource nature; however, the proponent must comply with standard conditions under the Historical Resources Act, which are applicable to all land surface disturbance activities in the Province.

HISTORIC STRUCTURES

There are no Historical Resources Act requirements associated with historic structures; however, the proponent must comply with standard conditions under the Historical Resources Act, which are applicable to all land surface disturbance activities in the Province.

PROVINCIALLY DESIGNATED HISTORIC RESOURCES

There are no Historical Resources Act requirements associated with Provincially Designated Historic Resources; however, the proponent must comply with standard conditions under the Historical Resources Act, which are applicable to all land surface disturbance activities in the Province.

SPECIAL CONDITIONS

1. In addition to any specific conditions detailed above, the proponent must abide by all Standard Conditions under the *Historical Resources Act*.

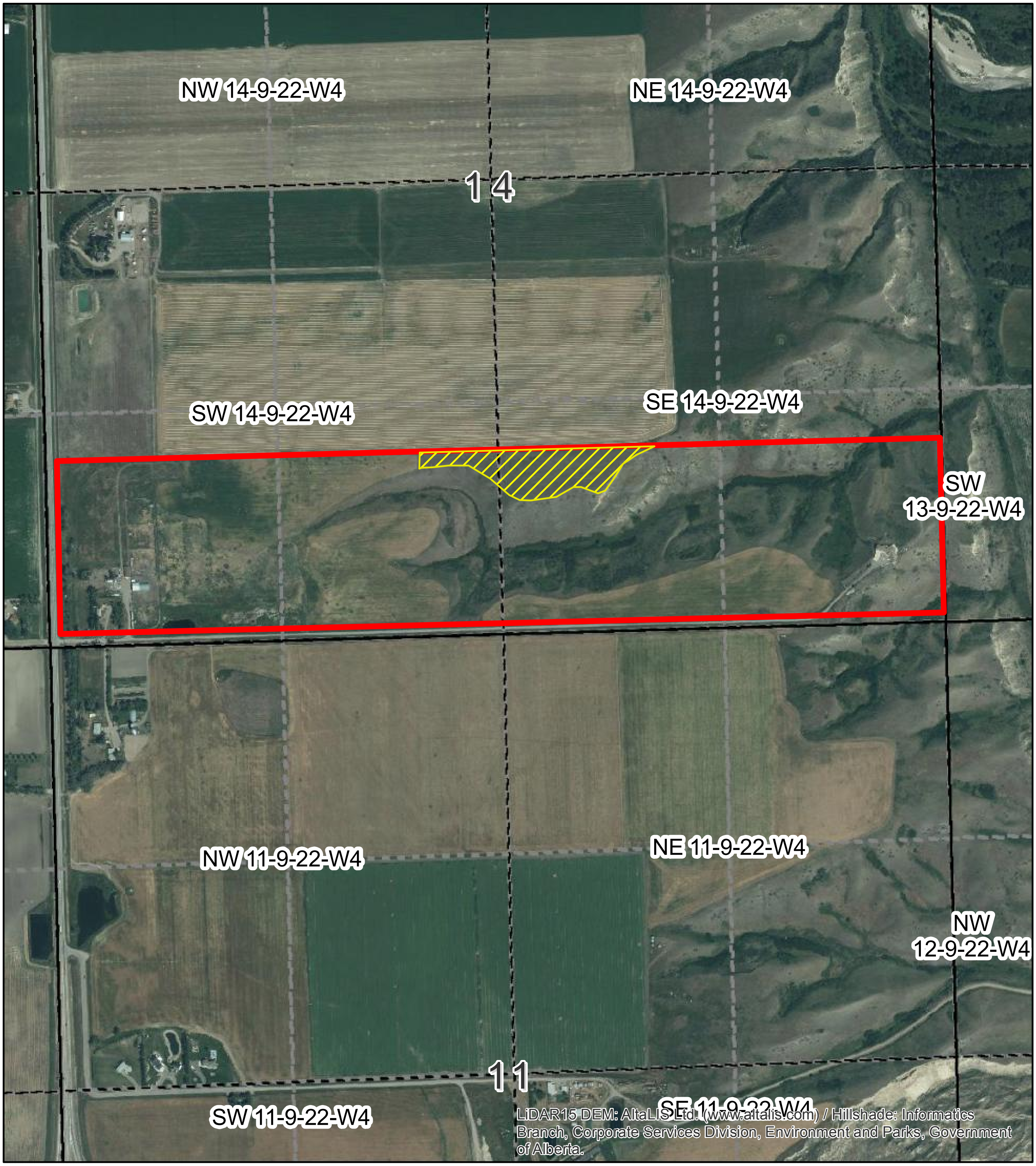
Lands Affected: All New Lands

Proposed Development Area:

MER	RGE	TWP	SEC	LSD List
4	22	9	14	1-4

Documents Attached:

Document Name	Document Type
map indicating target area	Miscellaneous
project plan map	Illustrative Material
target area	GIS Data File



LiDAR15 DEM: AltaLIS Ltd. (www.altalis.com) / Hillshade: Informatics Branch, Corporate Services Division, Environment and Parks, Government of Alberta.

NORTH

0 240

Meters

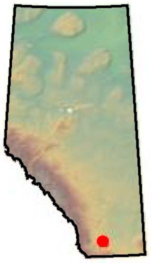
This document contains sensitive information and is to be used in planning the proposed project only. It is not to be shared for any other

4835-17-0096-001
Fiorino Residential Subdivision S1/2 14-9-22 W4
Archaeological Target Area

Legend

▨ Archaeological Target Area

🟥 4835-17-0096-001



APPENDIX

APPENDIX 5 ~ CORRESPONDANCE

Lethbridge North County
Potable Water Co-op
P.O. Box 426, Picture Butte, AB, T0K 1V0

March 7, 2018

Matt Redgrave
Project Manager
Martin Geomatic Consultants Ltd.
255 -31st. Street
Lethbridge, Alberta, T1H 3Z4

Dear Matt

With respect to our conversation of Mar. 6, 2018 about the supply of water to the Coulee View (Fiorino) subdivision in Lots 1&2 Block 2 Plan 021 0532, the Lethbridge North County Potable Water Co-op can make assurances that we are ready and able to provide this resource.

The LNCPWC distribution system can supply water on a unit basis to a maximum of 2160 litres per day. End users will become co-op members and would have the option of purchasing additions units of water at the time of attachment to the system. Included in the unit pricing is the installation of each individual curb stop and the installation of the drip system assembly.

Each end user would be responsible for the installation of the connector line between the ¾' curb stops and their cisterns. This line must be ¾" CTS HDPE 200 PSI rated pipe.

Martin Nordstrom WD1
Operations Manager

Martin Nordstrom

Alberta Transportation

Delivery Services Division
Box 314
3rd Floor, Administration Building
909 Third Avenue North
Lethbridge, Alberta T1H 0H5
Telephone: 403/381-5426
Fax: 403/382-4057
www.transportation.alberta.ca

Our Reference: 2512-S½ 14-9-22-W4M (25)
Your Reference: Bylaw No. 18-010

March 28, 2018

Hilary Janzen
Senior Planner
Lethbridge County
#100, 905 - 4 Avenue South
Lethbridge, AB T1J 4E4

Dear Ms. Janzen:

RE: COULEE VIEW AREA STRUCTURE PLAN

Reference your file to adopt Bylaw 18-010 being the Coulee View Area Structure Plan (CVASP).

Alberta Transportation's primary objective is to allow subdivision and development of properties that are subject to review and comment by the department pursuant to the control lines stipulated in the Highways Development and Control Regulation, being Alberta Regulation 326/2009, and the Subdivision and Development Regulation, being Alberta Regulation 43/2002 consolidated up to 188/2017 ("the regulation"), in a manner that will not compromise the integrity and associated safe operational use or the future expansion of the provincial highway network.

To that end and pursuant to Section 14(e) of the regulation, the department is in receipt of and has reviewed the CVASP, which was prepared by Martin Geomatic Consultants Ltd. on behalf of Peter Fiorino. As the subject lands are within the referral and control lines, strictly from Alberta Transportation's point of view, the CVASP will provide for the orderly and efficient development of the plan area.

The document reflects sound planning principles and development strategies. The document is also well organized and thoroughly addresses all the issues that are pertinent when establishing a framework for subsequent land use redesignation, subdivision, and development within a plan area.

The CVASP adequately addresses any transportation related requirements of said Section 14. Given this, and as ministerial approval would only be a formality in this instance, rather than formal endorsement by the minister, this application, for all intents and purposes, will be considered to be in accordance with Section 14(e) of the regulation, and the department's position will be expressly based on and subject to the aforementioned CVASP document.

Notwithstanding the foregoing, subdivision and development of the area will be subject to the referral process as outlined in the regulation and the Highways Development and Protection Act and the corresponding Highways Development and Protection Regulation, being Alberta Regulation 326/2009.

.../2

Alberta Transportation accepts no responsibility for the noise impact of highway traffic upon any development or occupants thereof. Noise impact and the need for attenuation should be thoroughly assessed. The applicant is advised that provisions for noise attenuation are the sole responsibility of the developer and should be incorporated as required into the subdivision/development design.

Any peripheral lighting (yard lights/area lighting) that may be considered a distraction to the motoring public or deemed to create a traffic hazard will not be permitted.

Given the foregoing, strictly from Alberta Transportation's point of view, we do not have any concerns with the CVASP as proposed and/or the document being adopted by the Lethbridge County subdivision and development land use authorities.

Please provide our department with notification when the plan is adopted.

Thank you for the referral and opportunity to comment.

Yours truly,

Leah Olsen

Leah Olsen
Development/Planning Technologist

LO/jb

cc: Oldman River Regional Services Commission – steveharty@orrsc.com

Alberta Health Services

April 2, 2018

Attention: Hilary Janzen
Senior Planner/Development Officer
Lethbridge County

Re: Coulee View Area Structure Plan County of Lethbridge - Plan 0210532 Block 2 Lots 1 and 2 in S1/2 14-9-22-W4

Thank you for the opportunity to provide comment on the aforementioned area structure plan. The plan has been reviewed by our office and our comments are noted below.

- Since this proposed development will be accessing an existing drinking water co-op, the proponent should ensure all approvals are in place with Alberta Environment and Parks to ensure additional water allocation is available through this co-op.
- All lot holders should be advised that the source water may not be considered potable in its raw state. Information should be provided stating that the source water should be tested and appropriate household treatment be installed to ensure the safety of the drinking water.
- Provisions for garbage collection should be included in the plan
- 43% of Albertans don't get enough physical activity. This development presents an excellent opportunity to encourage outdoor physical activity. AHS recommends incorporating a walking/hiking network along and through the coulee associated with this development.

If you require further clarification, please don't hesitate to contact me at 403-627-1230

Sincerely,

Mike Swystun, BSc, BEH, CPHI(C)
Public Health Inspector/ Executive Officer
Environmental Public Health – South Zone
Michael.swystun@ahs.ca

TOWN of

COALHURST

Municipal Excellence network

March 29, 2018

Hilary Janzen, RPP, MCIP
Senior Planner/Development Officer
Lethbridge County
100, 905 – 4 Avenue South
Lethbridge, Alberta T1J 4E4

Dear Ms. Janzen:

Re: Coulee View Area Structure Plan (Bylaw 18-010)
Plan 0210532, Block 2, Lots 1 & 2 in S1/2 14-9-22-W4

This is to acknowledge receipt of and presentation to Council your letter of March 14, 2018 in regards to the above stated Area Structure Plan application.

As a result of the Council of the Town of Coalhurst's review of the Area Structure Plan application, at their March 27, 2018 Regular meeting, the following resolution was passed:

> "*…moved that the Council of the Town of Coalhurst hereby authorizes Chief Administrative Officer Hauta to submit a letter to Lethbridge County indicating that the Town has concerns with the Coulee View Area Structure Plan (Bylaw 18-010) at the location of Plan 0210532, Block 2, Lots 1 and 2 in S1/2 14-9-22-W4, as presented in a March 14, 2018 application, in terms of the impact/increased pressure on the intersection of Township Road 9-2 and Highway No. 25 and direct competition with future Town of Coalhurst residential subdivisions.*"

Thank you for the opportunity to provide some comments on the Area Structure Plan. If you require anything further, please feel free to contact me.

Yours truly,

R.K. Hauta

R.K. Hauta
Chief Administrative Officer

Rkh/ll

BOX 456, COALHURST, ALBERTA TOL OVO
TELEPHONE: (403) 381-3033 FAX: (403) 381-2924
e-mail: main@coalhurst.ca
www.coalhurst.ca

Matt Redgrave

From: Maureen Gaehring [Maureen.Gaehring@lethbridge.ca]
Sent: Friday, March 23, 2018 2:41 PM
To: Hilary Janzen
Subject: RE: Lethbridge County Bylaw 18-010 - Coulee View Area Structure Plan

Hi Hilary,

The City of Lethbridge does not object to the Area Structure Plan but would offer the following comments:

1. Lot 18 should be consolidated with Lot 15 if is it is not going to be an Environmental Reserve parcel.
2. Chief Fire Marshall Heath Wright acknowledges that Coalhurst will be the primary fire response to the area however the City's Fire department has concerns regarding the access and water supply to this development in the event of a fire emergency. In Lethbridge, we have a maximum access distance of 200M on a dead end, before requiring a secondary access for a few reasons. From these drawings, it appears that a few of these lots driveways exceed the 200M distance which would not only require a secondary access due to it being a dead end, but it will also create water supply issues. Due to the length of high volume hose required, along the amount of friction loss, it doesn't appear that this would work . Without City water supply with hydrants, or a fire pump in a pond, this development would not meet the criteria to safely fight an average size residential structure fire due to access and water supply issues.

Thank you for the opportunity to comment.

Maureen Gaehring
Manager, Planning Services
City Hall, 910 4th Avenue South
Lethbridge, Ab T1J 0P6
Phone 403-320-3191

From: Hilary Janzen [mailto:hjanzen@lethcounty.ca]
Sent: Wednesday, March 14, 2018 8:51 AM
To: AB Agriculture & Rural Development (cody.metheral@gov.ab.ca); Alberta Health Services (wendy.hartley@albertahealthservices.ca); Leah Olsen (leah.olsen@gov.ab.ca); Alberta Transportation (transdevelopmentlethbridge@gov.ab.ca); FortisAlberta Inc. - Referrals (landserv@fortisalberta.com); Erica Rex - Atco Pipelines & Liquids (erica.rex@atco.com); lnid@telus.net; Maureen Gaehring; rkhauta@coalhurst.ca
Subject: Lethbridge County Bylaw 18-010 - Coulee View Area Structure Plan

Please find the link below to the Coulee View Area Structure Plan. Please have any comments back to me by April 4, 2018. If you are unable to open the documents please let me know and I will arrange to get you an electronic or hard copy.

Regards,

Hilary Janzen, RPP, MCIP
Senior Planner

Matt Redgrave

From: Rex, Erica [Erica.Rex@atco.com]
Sent: Friday, March 16, 2018 2:26 PM
To: Hilary Janzen
Cc: McNabb, Jarvis
Subject: RE: Lethbridge County Bylaw 18-010 - Coulee View Area Structure Plan

Good Afternoon Hilary,

As noted in the ASP, ATCO has natural gas facilities that run through the affected properties. When development does take place the gas facilities will need relocation to service all lots. ATCO has no issue with the ASP though.

Thank you,

Erica Rex, P.Eng, M.Sc.
District Engineer| Gas Distribution
ATCO Pipelines & Liquids Global Business Unit
410 Stafford Dr N | Lethbridge, AB T1H 2A9
T. 403.380.5421 | F. 403.380.5428
erica.rex@atco.com | www.ATCO.com

From: Hilary Janzen [mailto:hjanzen@lethcounty.ca]
Sent: Wednesday, March 14, 2018 8:51 AM
To: AB Agriculture & Rural Development (cody.metheral@gov.ab.ca) <cody.metheral@gov.ab.ca>; Alberta Health Services (wendy.hartley@albertahealthservices.ca) <wendy.hartley@albertahealthservices.ca>; Leah Olsen (leah.olsen@gov.ab.ca) <leah.olsen@gov.ab.ca>; Alberta Transportation (transdevelopmentlethbridge@gov.ab.ca) <transdevelopmentlethbridge@gov.ab.ca>; FortisAlberta Inc. - Referrals (landserv@fortisalberta.com) <landserv@fortisalberta.com>; Rex, Erica <Erica.Rex@atco.com>; lnid@telus.net; Maureen Gaehring <Maureen.Gaehring@lethbridge.ca>; rkhauta@coalhurst.ca
Subject: Lethbridge County Bylaw 18-010 - Coulee View Area Structure Plan

Please find the link below to the Coulee View Area Structure Plan. Please have any comments back to me by April 4, 2018. If you are unable to open the documents please let me know and I will arrange to get you an electronic or hard copy.

Regards,

Hilary Janzen, RPP, MCIP
Senior Planner
Lethbridge County
905 4th Ave S
Lethbridge, AB T1J 4E4

403.328.5525 office
403.328.5602 fax
www.lethcounty.ca

LETHBRIDGE
COUNTY
Pride of the Region

Matt Redgrave

From: Gary Burke LNID [gb_lnid@telus.net]
Sent: Wednesday, January 17, 2018 12:58 PM
To: Matt Redgrave
Cc: 'Janet Beck'; 'Stephen Van Essen'
Subject: FW: 166729CE-ASP - Jan03-2018.pdf
Attachments: Reply for Matt Redgrave.pdf

Hi Matt,

Please find attached a quick summary of the LNID's requirements that we would likely put on this subdivision. This list may be adjusted as required but this should be what you need for your proposal.

Gary Burke
Classification/Network Technician
Lethbridge Northern Irrigation District
2821 - 18 Ave N
Lethbridge, AB T1H6T5
(403) 327-3302

From: Matt Redgrave [mailto:mattr@mgcl.ca]
Sent: Friday, January 05, 2018 9:22 AM
To: 'Stephen Van Essen'
Subject: 166729CE-ASP - Jan03-2018.pdf

Hi Stephen,

Are you available for a quick meeting to discuss the LNID's requirements for a Group County Residential development in Lethbridge County?
We are preparing the Area structure plan and would appreciate any input and comments. Maps are attached.

Thanks,
Matt

Matt Redgrave | Project Manager | Martin Geomatic Consultants Ltd. | 255 -31st. Street No., Lethbridge, Alberta, T1H 3Z4 | Office: (403) 329-0050 | Fax: (403) 329-6594

January 17, 2018

RE: PROPOSED FIORINO SUBDIVISION AREA STRUCTURE PLAN: PT. S½ 14-09-22-4
Lethbridge County

1. The LNID requires a Utility Right of Way from the C14 drain valve on the north boundary of proposed Lot 7 to the Coulee Lot 17ER. A permanent drain pipeline may need to be installed to accommodate this. Any alteration to District works for the supply of water required as a result of this subdivision is subject to District approval and payment of all applicable costs.

2. Any future permanent structures such as buildings with footings, pilings or foundations, septic tanks/ fields/mounds, barns/shops, and silage pits, etc., must meet the minimum set-back distance of 30 meters from the centre line of the pipeline.

3. A water agreement suitable to meet the needs of the proposed 15 lot subdivision (not including PUL or ER lots) is required prior to signing of the subdivision plan. The estimated water requirement is about 23 acre-feet. A one-time capital contribution for access to the District's water licence will be payable at the time of signing of the agreement. The 2017 water licence access fee rate was $1,250.00/acre-foot of water and is subject to change annually. A community association will be invoiced for the agreement annually. The 2017 rate was $400.00, for the first three (3) acre-fee plus $25.00/acre-foot over three (3) acre-feet, plus GST.

4. Any easements required by the subdivided parcels for access to water from the District's works must be in place for the supply of domestic non potable water if required.

Note: Please be aware that this list is not inclusive and conditions may be added, deleted or adjusted as required.

APPENDIX

APPENDIX 6 ~ SEPTIC FEASIBILITY ASSESSMENT

TETRA TECH

December 14, 2017

ISSUED FOR USE
FILE: ENG.LGEO03581-01.003

Fiorino Homes Ltd.
1106 – 3 Avenue North
Lethbridge, AB T1H 0H6

Attention: Mr. Pete Fiorino, President

Subject: Septic Disposal Field Feasibility Assessment
Proposed Rural Country Residential Subdivision
Plan 0210532, Block 2, Lots 1 and 2
Near Lethbridge, Alberta

1.0 INTRODUCTION

Fiorino Homes Ltd. (Fiorino) retained Tetra Tech Canada Inc. (Tetra Tech) to conduct a septic disposal field feasibility assessment (SDFFA) within two adjoining properties located within the Lethbridge County, legally described as Plan 0210532, Block 2, Lots 1 and 2 (hereinafter referred to as the site). The site is located within portions of legal land descriptions 1 through 4 of 14-009-22 W4M, west of Lethbridge, Alberta.

The objective of this assessment was to determine the general subsurface conditions in order to assess the feasibility for soil-based septic disposal fields (also known as a sewage treatment system). The SDFFA was completed in general accordance with the Alberta Private Sewage Systems Standard of Practice (APSSSoP), Third Edition, December 2015, published by the Safety Codes Council. Neither a Topographic Survey (Part 3 of Section 7.1.1.2 – Site Evaluation) nor a Hydrogeological Site and Soil Evaluation for On-Site Sewage Systems Exceeding $9m^3$ Per Day Design Capacity (Section 7.1.1.3 of the APSSSoP) were completed as part of this SDFFA.

Authorization to proceed with the SDFFA was provided by Mr. Pete Fiorino via signed Services Agreement with Tetra Tech on October 4, 2017.

2.0 PROJECT SCOPE OF WORK

The scope of work included a field assessment, desktop review, and reporting, which are detailed in the following subsections.

2.1 Field Assessment

The field assessment portion of the project was completed by Mr. Clint Gellrich, P.Bio., of Bear Tracks Environmental Services, on November 2, 2017. The field assessment included the following:

- Completion of public above-ground and underground utility locates by Alberta One-Call, prior to the excavation of testpits.
- Preparation of a site-specific safe work form prior to field assessment and a pre-job safety meeting was undertaken prior to the excavation of testpits.
- Excavation of 14 testpits at select locations on the site to a maximum depth of 3.0 metres below ground surface (mbgs) by Hol-Hoe Contractors Ltd. (Hol-Hoe) of Coaldale, Alberta.

- Classification of soil profiles at each testpit location using the Canadian System of Soil Classification (CSSC). The individual soil strata and the interfaces between them were noted. In addition to the soil classification, a general description of site topography, vegetation (if observed), landscape position, and slope aspect was also included.
- Obtaining bulk soil samples from each excavation where a restrictive layer[1] was potentially observed to be present. Samples were submitted to Down to Earth Labs Inc., of Lethbridge, Alberta, for hydrometer analysis.
- Installation of a 25 mm diameter PVC, screened standpipe within each testpit to determine whether seasonal water infiltration was present at each location. Water levels from each standpipe were obtained on November 10, 2017.
- Evaluation of the following:
  - Topography, landscape position, vegetation, and surface drainage characteristics.
  - Surface waters, rock outcrops, and other features of note.
  - Land uses and development within approximately 50 m of the proposed area of the septic disposal fields.

2.2 Desktop Review/Reporting

To meet the objectives of the SDFFA, Tetra Tech undertook the following:

- Completed a site evaluation as per Section 7.1.1.2 of the APSSSoP including the following:
  - Reviewed available published resources including Abacus Datagraphics (AbaData), and the Online Water Well Database.
  - Reviewed geological and hydrogeological information including published topographic, geologic, soil, and groundwater maps and reports.
- Prepared this SDFFA report.

3.0 RESULTS

3.1 General

The proposed subdivision consists of 16 lots which are to be located on vacant, agricultural land, located on the west side of the Oldman River Valley near Lethbridge, Alberta. A coulee draw associated with the Oldman River intersects the middle of the site oriented in an east to west direction. Two dugouts are located on the southwest side of the site and two acreages are located to the west of the site. An additional residence is located on the east side of the site.

The following subsections outline the results of the field observations and desktop review. The approximate testpit locations and surrounding land use are shown on Figure 1. The results of the hydrometer analysis are presented in Appendix A. Soil profile descriptions are presented in Appendix B.

---

[1] Defined by the APSSSoP as ‘a soil horizon, soil layer, or other condition in the soil profile, or underlying strata, that restricts the downward movement of fluids that could cause a perched water table or saturated soil under the soil infiltration surface of the system’.

3.2 Rights-of-Way and Easements

AbaData identifies a low pressure ATCO gas line transecting the northwest portion of the site extending east through LSD 4, where it then trends south through LSD 3 and then eastward parallel to the southern boundary of the site. AbaData also identified a transmission line right-of-way (ROW) within the southeast portion of LSD 1. An abandoned underground mine (Mine No. 1576) was formerly located within the adjacent section to the east (13-009-22 W4M).

3.3 Vegetation, Topography, and Drainage

The site consists of agricultural cropland and/or pastureland. Vegetation at the time of the site assessment was senescent; however, degraded wheat stubble and dormant pasture was observed at the site. Vegetation that favours wet or saturated soils was not observed in the proposed septic disposal field locations.

The local topography describes the landscape at the site; whereas, regional topography applies to the overall expression of the land surface in a given region. The local topography of the site is generally flat where the site is cultivated, and slopes moderately to steeply within the coulee draw that occupies a large portion of the site. The regional topography in the area is generally flat to undulating, and slopes easterly toward the Oldman River valley. Surficial drainage is expected to be towards the coulee draw.

3.4 Surficial Geology

The surficial geology in the area is characterized by moraine till deposits with sporadic lenses of gravel, sand, and silt (Shetsen 1981).

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 Bearpaw Formation, both of the late Cretaceous Age (Tokarsky 1973). The bedrock has a relatively flat surface dipping slightly to the northeast and is locally encountered at about geodetic elevation 843 m. The bedrock strata consist of thin beds of predominantly weak mudstones, siltstones, and sandstones with occasional bentonite and coal seams.

A geotechnical evaluation was also completed for the site and reported under separate cover (ENG.LGEO03581-01, dated December 2017). The drilling assessment for this geotechnical evaluation identified clay fill material in eight of the nine boreholes drilled. The thickness of clay fill ranged from 0.3 m at several locations to 0.8 m north of the western dugout.

Rock outcrops were not observed at the site. A coulee draw is located within the centre of the site extending in an easterly direction towards the Oldman River Valley. Surficial drainage from lots in this area is expected to be towards the coulee draw. No other natural features that could impact the application or design of the proposed treatment system were observed during the field investigation.

3.5 Surface Water and Water Wells

The nearest surface waterbody is the dugout and waterbody located on the southwestern portion of the site. An additional waterbody is located within 100 m of the site's southern boundary, and the Oldman River is approximately 900 east of the site. Regional groundwater flow is expected to be easterly, toward the Oldman River.

The Alberta Water Well Information database search listed no record of water wells within the site boundaries; however, the search identified one record relating to water wells located off site on an adjacent property within 800 m of the site. The following table summarizes the information of this water well.

Table A: Water Well Details

Location	Distance and Direction from Site*	Owner/Well ID	Drilling Dates	Depth	Tetra Tech's Evaluation
LSD 16-10-009-22 W4M	A minimum of 150 m west of the site	Unknown/109522	1960s	4.8 m	Due to the distance from the site, this well is not considered to be a concern to the site.

* Note: Specific well locations may potentially be located at any point within the quarter section provided, as the database will place the well in the centre of the quarter section if no specific location is provided in the drilling report.

3.6 Surrounding Land Use

Table B summarizes the surrounding land use.

Table B: Surrounding land Use

Direction	Land Use*	Observations
North	Agricultural Cropland and Coulee/Valley	Undeveloped agricultural cropland and grassland (coulee/valley). No building or structures noted within 100 m of the site boundaries.
South	Agricultural Cropland and Coulee/Valley	
East	Coulee/Valley (Oldman River Valley)	Undeveloped grassland (coulee/valley). No building or structures noted within 100 m of the site boundaries.
West	Rural Residence	Farm residence with several buildings and corrals.

* Land use inferred from observations made during the site visit.

3.7 Laboratory Results

Tetra Tech performed soil texture analysis via hydrometer on 14 soil samples. The soil texture test results are summarized in Table C and laboratory certificates are included in Appendix A. The test results are consistent with the soil textures described on site and are considered representative of the soil profiles at the proposed septic field locations.

Table C: Soil Texture Analysis

Testpit Number	Sample Depth (mbgs)	% Sand	% Silt	% Clay	Soil Classification
TP01	1.2 – 1.4	14.6	31.4	51.0	Clay
TP02	2.2 – 2.4	16.2	27.8	56.0	Clay
TP03	1.2 – 1.4	22.6	49.4	28.0	Clay Loam
TP04	1.2 – 1.4	66.6	15.4	18.0	Sandy Loam
TP05	1.2 – 1.4	21.2	42.8	36.0	Clay Loam
TP06	2.2 – 2.4	17.0	35.2	47.8	Clay

Table C: Soil Texture Analysis

Testpit Number	Sample Depth (mbgs)	% Sand	% Silt	% Clay	Soil Classification
TP07	1.2 – 1.4	39.0	27.2	33.8	Clay Loam
TP08	1.2 – 1.4	13.0	27.2	59.8	Clay
TP09	1.9 – 2.1	17.0	39.2	43.8	Clay
TP10	2.7 – 3.0	93.2	5.0	1.8	Sand
TP11	1.2 – 1.4	29.0	51.2	19.8	Silt Loam
TP12	1.2 – 1.4	36.8	29.4	33.8	Clay Loam
TP13	1.2 – 1.4	23.6	44.6	31.8	Clay Loam
TP14	1.2 – 1.4	49.2	25.0	25.8	Sandy Clay Loam

3.8 Soil Profiles

The site is located in the Dark Brown Soil Zone of Alberta and soils on site consist of Calcareous Dark Brown Chernozems which are differentiated from the Orthic Dark Brown Chernozems by having a Bmk horizon where the primary alkaline earth carbonates have not been removed. Soil observations and soil profile logs for each testpit are included in Appendix B.

Fourteen (14) testpits were excavated in the area of the proposed subdivision. The general CSSC profile descriptions of the soils at the site are summarized below:

- Apk Horizon (0.00 mbgs to a maximum of ~0.11 mbgs) generally consisting of very dark greyish brown soils having a clay loam texture with weak (Grade 1), fine, granular structure. Soils were friable and moist with no coarse fragments. Weak to moderate effervescence was observed within the horizon. Difficult to differentiate between A and B horizons. Soil texture within this horizon is generally clay loam.

- Bmk Horizon (~0.11 mbgs to a maximum of ~0.34 mbgs) generally consisting of brown soils having a clay loam texture with moderate (Grade 2), fine, blocky structure. Soils were friable to firm with no coarse fragments. Weak to moderate effervescence was observed within the horizon. Difficult to differentiate between A and B horizons. Soil texture within this horizon is generally clay loam.

- Cca Horizon (~0.34 mbgs to a maximum of 1.70 mbgs) generally consisting of light olive brown soils with moderate (Grade 2), medium, subangular blocky structure. Soil texture within this horizon included clay loam, sandy clay loam, and silty clay loam. Soils were firm and moist with 2% coarse fragments. Strong effervescence was observed within the horizon.

- Ck_1 Horizon (~1.70 to 3.00 mbgs) generally consisting of dark greyish brown soils with structureless (Grade 0), coarse, massive structure. Soils were firm and moist with 2% to 5% coarse fragments. Coal and oxide inclusions, and white precipitates were observed within this horizon, as well as weak effervescence.

- Ck_2 Horizon within TP10 between 2.70 mbgs and 3.00 mbgs consisting of light olive brown soils with weak (Grade 1), very fine, single-grained structure. Soils were loose and moist with 0% coarse fragments.

High plastic clay inclusions were present within TP01, TP02, TP06, and TP09. Impermeable layers, such as bedrock and compaction, were not noted within any of the testpit locations.

3.9 Groundwater Seepage Conditions

Tetra Tech personnel visited the site on November 10, 2017 to measure the groundwater elevations within the standpipes. TP01 had water at 1.20 mbgs. No standing water was present in the remaining testpits (TP02 through TP14).

Faint mottling was observed at the following locations, indicating that a groundwater table exists within the excavation depths:

- TP01 between 0.10 mbgs and 1.20 mbgs
- TP02 between 0.11 mbgs and 1.20 mbgs
- TP03 between 0.25 mbgs and 0.75 mbgs
- TP04 between 0.20 mbgs and 1.20 mbgs

The local groundwater levels normally fluctuate seasonally and in response to climatic conditions and groundwater elevations may be reduced in winter months; therefore, spring and summer water levels may be closer to the surface. Mottling, saturated soil conditions and free water was not encountered within the remaining testpits at the time of the field investigation.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The proposed development location is agricultural cropland which is gently undulating with approximately 1% to 2% slopes. The site is located within 1 km of a lake, river, stream, or creek; the Oldman River is located approximately 900 m east of the site. Rock outcrops were not encountered within 50 m of the site; however, coulee breaks were noted within 100 m of TP10, TP11, TP12, and TP13.

Based on field classification of soils, the majority of the soil textures within the upper 3 m are considered suitable to take effluent load; however, the following soil characteristics are considered to be restrictive for design purposes:

- Presence of seasonally saturated soils within TP01, TP02, TP03, and TP04.
- Structureless (Grade 0), clay, clay loam, and/or clay fill within TP01, TP02, TP03, TP05, TP06, TP07, TP08, TP09, TP10, TP12, and TP13. Additionally, clay fill material was encountered within TP03 and was identified in various locations during the geotechnical evaluation of the site which may be considered a restrictive layer.
- In addition to structureless (Grade 0) clay loam at 1.20 mbgs to 2.70 mbgs within 17T10, a highly permeable sand layer was present between 2.70 mbgs and 3.00 mbgs which is also considered restrictive.

In accordance with the requirements of APSSSoP, a minimum vertical separation distance between the soil infiltration surface and a restrictive layer for this site shall be no less than 1,500 mm when receiving primary treated effluent. The separation distance can be reduced to 900 mm when receiving secondary treated effluent (Level 2 or better) and using a pressure distribution lateral pipe system if the site is within 2 km of a lake, river, stream, or creek. If the minimum depth of a restrictive layer is greater than 1,500 mm (600 mm embedded depth plus 900 mm separation), a field system is considered suitable. If the minimum depth of a restrictive layer is less than 1,500 mm, a mound system may be required to maintain 900 mm separation.

The soils within TP04 and TP11 are considered suitable for a soil-based treatment system provided limitations are placed on effluent loading rates as follows:

- Structureless (Grade 0), sandy loam encountered between 1.2 mbgs and 1.4 mbgs within TP04 is generally considered suitable for a soil-based sewage treatment system, with a primary effluent loading rate of 8.8 L/day/sq. metre and a secondary effluent loading rate of 17.6 L/day/sq. metre.
- Structureless (Grade 0), silt loam encountered between 1.10 mbgs and 3.00 mbgs within TP11 is generally considered to be a suitable layer for a soil-based sewage treatment system, with a primary effluent loading rate of 0.00 L/day/sq. metre and a secondary effluent loading rate of 8.8 L/day/sq. metre.

It is recommended that the local municipal authority having jurisdiction be contacted to determine what will be accepted for septic field installation. Depending on the requirements of the local municipal authority, further assessment of the soil conditions at the specific locations of proposed septic systems; as well, further site evaluation to meet the requirements of Part 7 within the APSSSoP may be required. This may include, but is not limited to, the following:

- Hydrogeological site and soil evaluation for on-site sewage systems exceeding 9 m³ per day design capacity as per Section 7.1.1.3 of the APSSSoP.

5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Fiorino Homes Ltd. and their agents. Tetra Tech Canada Inc. (Tetra Tech) 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 Fiorino Homes Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on Use of this Document attached in Appendix C or Contractual Terms and Conditions executed by both parties.

6.0 CLOSURE

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

ALBERTA INSTITUTE OF AGROLOGISTS
MIREILLE RIGAUX, P.Ag.
3831
MEMBER

Dec 14/17

Marc Sabourin

Prepared by:
Mireille Rigaux, B.Sc., P.Ag.
Environmental Consultant
Environmental Practice
Direct Line: 403.332.0323
mireille.rigaux@tetratech.com

Reviewed by:
Marc J. Sabourin, P.Eng.
Vice President – Western Canada
Engineering Practice
Direct Line: 403.359.6518
marc.sabourin@tetratech.com

/tlp

Attachments: Figure 1: Testpit Location Plan
Appendix A: Laboratory Certificates
Appendix B: Soil Observation and Soil Profile Descriptions
Appendix C: Limitation on Use of This Document

REFERENCES

ABACUS DataGraphics Website. Updated October 31, 2017. AbaData database http://www.abacusdatagraphics.com/.

Alberta Environment and Parks. Water Well Database. http://groundwater.alberta.ca/WaterWells/d/

Safety Codes Council. 2009. Alberta Private Sewage Systems Standard of Practice 2009. 174 pp.

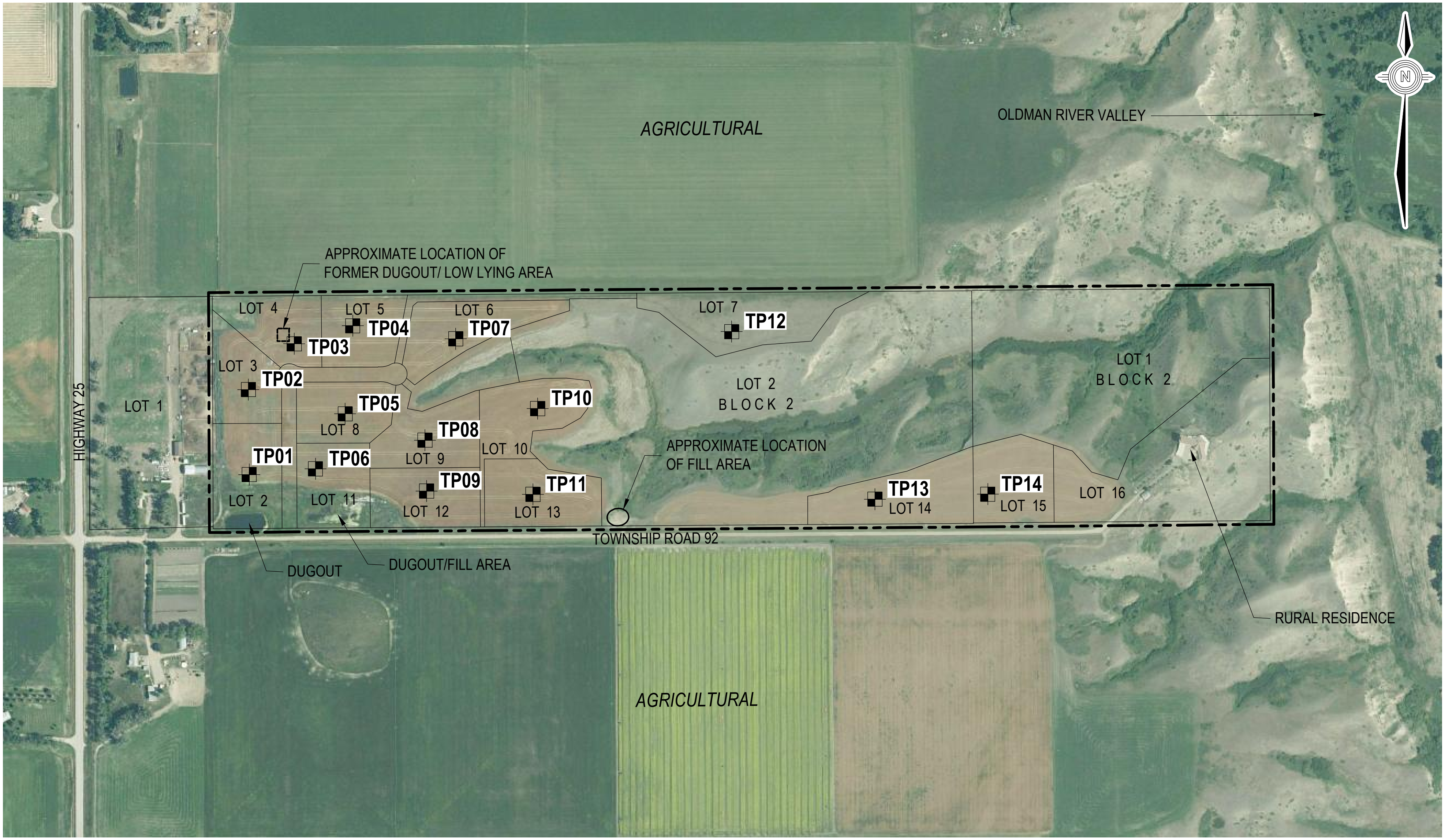
Shetson, I. 1987. Quaternary Geology, Southern Alberta. Alberta Research Council 1:5,000,000 Map.

Soil Classification Working Group. 1998. The Canadian System of Soil Classification. Agriculture and Agri-Food Canada Publication 1646 (Revised). 187 pp.

Tokarsky, O. 1973. Hydrogeological Map – Lethbridge-Fernie, Alberta (NTS 82G-H). Alberta Research Council, Edmonton, Alberta.

FIGURES

C:\Lethbridge\Drafting\ENG.LGEO\LGEO03581\LGEO03581-01-003 Figure 1.dwg [FIGURE 1] December 12, 2017 - 12:18:25 pm (BY: HUGHES, LEANNE)



LEGEND

▬ ▬ ▬ SITE BOUNDARY

▚ TESTPIT LOCATION

0 250m

Scale: 1:7,500 @ 8.5"x11"

NOTES
GOOGLE EARTH IMAGERY DATED 2015

CLIENT

Fiorino Homes Ltd.

TETRA TECH

RURAL COUNTRY RESIDENTIAL SUBDIVISION

TESTPIT LOCATION PLAN

PROJECT NO.	DWN	CKD	REV
LGEO03581-01.003	LCH	SS	0

OFFICE	DATE
TT LETH	December 2017

Figure 1

APPENDIX A

LABORATORY CERTIFICATES

Down To Earth Labs Inc.

The Science of Higher Yields

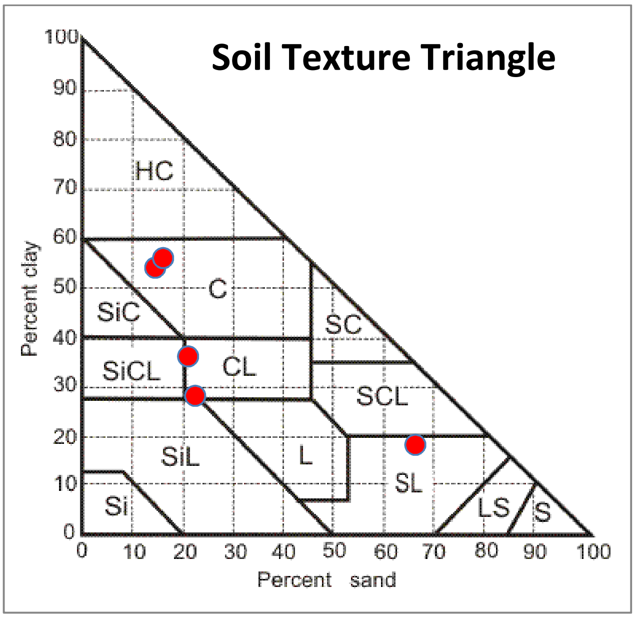
Tetra Tech Canada Inc.
442 10th St N
Lethbridge, AB T1H 2C7

Report #: 47801
Report Date: 11/21/2017
Received: 11/16/2017
Completed: 11/21/2017
Test Done: ST

Project : LGE003581-03
PO:

3510 6th Ave North
Lethbridge, AB T1H 5C3
403-328-1133
www.downtoearthlabs.com
info@downtoearthlabs.com

		Sample ID:	171116O001	171116O002	171116O003	171116O004	171116O005
		Cust. Sample ID:	TP01	TP02	TP03	TP04	TP05
Analyte	**Units**	**Limit**	1.2-1.4	2.2-2.4	1.2-1.4	1.2-1.4	1.2-1.4
Sand	%	0.1	14.6	16.2	22.6	66.6	21.2
Silt	%	0.1	31.4	27.8	49.4	15.4	42.8
Clay	%	0.1	54.0	56.0	28.0	18.0	36.0
Soil Texture	-	1	Clay	Clay	Clay Loam	Sandy Loam	Clay Loam



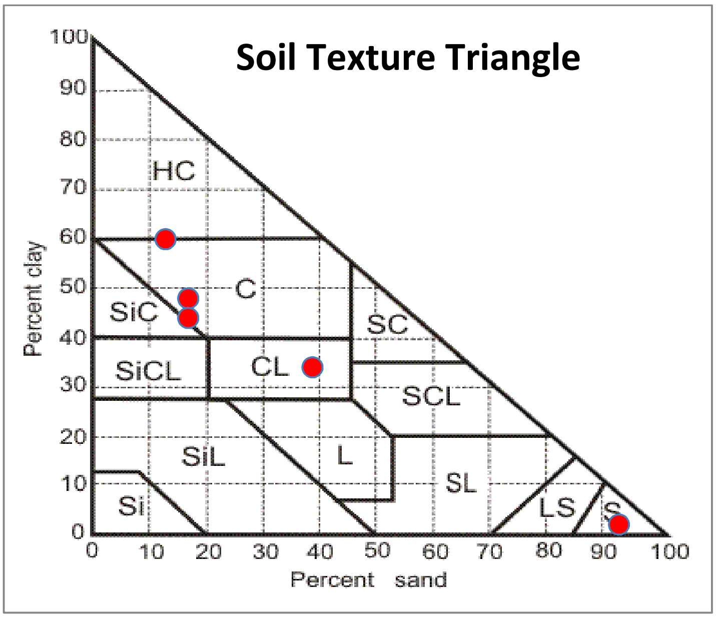
Tetra Tech Canada Inc.
442 10th St N
Lethbridge, AB T1H 2C7

Report #: 47801
Report Date: 11/21/2017
Received: 11/16/2017
Completed: 11/21/2017
Test Done: ST

Project : LGE003581-03
PO:

3510 6th Ave North
Lethbridge, AB T1H 5C3
403-328-1133
www.downtoearthlabs.com
info@downtoearthlabs.com

		Sample ID:	171116O006	171116O007	171116O008	171116O009	171116O010
		Cust. Sample ID:	TP06	TP07	TP08	TP09	TP10
Analyte	**Units**	**Limit**	2.2-2.4	1.2-1.4	1.2-1.4	1.9-2.1	2.7-3.0
Sand	%	0.1	17.0	39.0	13.0	17.0	93.2
Silt	%	0.1	35.2	27.2	27.2	39.2	5.0
Clay	%	0.1	47.8	33.8	59.8	43.8	1.8
Soil Texture	-	1	Clay	Clay Loam	Clay	Clay	Sand



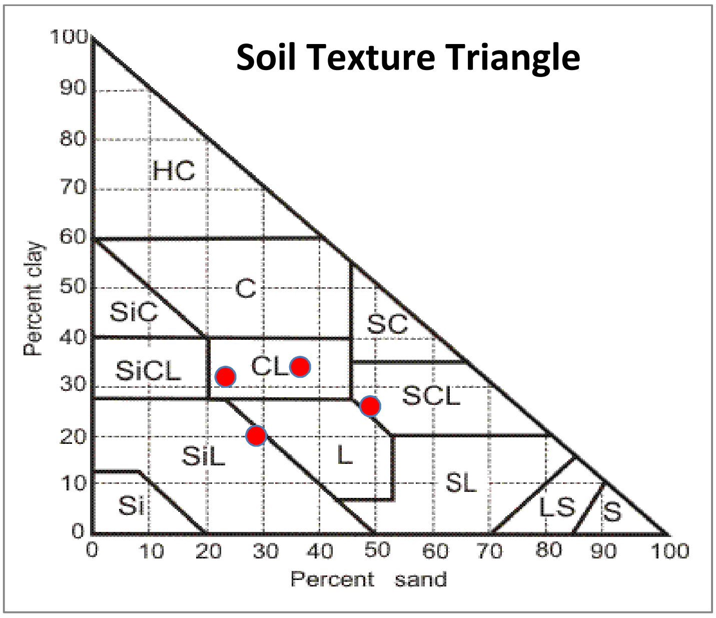
Tetra Tech Canada Inc.
442 10th St N
Lethbridge, AB T1H 2C7

Report #: 47801
Report Date: 11/21/2017
Received: 11/16/2017
Completed: 11/21/2017
Test Done: ST

Project : LGE003581-03
PO:

3510 6th Ave North
Lethbridge, AB T1H 5C3
403-328-1133
www.downtoearthlabs.com
info@downtoearthlabs.com

		Sample ID:	171116O011	171116O012	171116O013	171116O014
		Cust. Sample ID:	TP11	TP12	TP13	TP14
Analyte	**Units**	**Limit**	1.2-1.4	1.2-1.4	1.2-1.4	1.2-1.4
Sand	%	0.1	29.0	36.8	23.6	49.2
Silt	%	0.1	51.2	29.4	44.6	25.0
Clay	%	0.1	19.8	33.8	31.8	25.8
Soil Texture	-	1	Silt Loam	Clay Loam	Clay Loam	Sandy Clay Loam



Raygan Boyce - Chemist

APPENDIX B

SOIL OBSERVATION AND SOIL PROFILE DESCRIPTIONS

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP01	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	2	Cultivated

Depth of Laboratory Samples:	1.2-1.4 mbgs			
Soil Subgroup	**Parent Material**	**Drainage**	**Slope Position and Slope %**	**Site Topography**
Ca DBC	Till	Imperfect	Lower – 1% South	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.10	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.1- 0.27	Clay Loam	HT	10YR 4/3	Faint Mottling	Moderate	Fine	Blocky	Friable / firm	Moist	0
Cca	0.27-1.20	Clay Loam	HT	2.5Y 5/3	Faint Mottling	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	1.20-3.00	Clay	Lab	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
1.2 mbgs	0.1 mbgs	Seasonally saturated soils; clay with massive (Grade 0) structure.	N/A	Soil texture / grade / structure

Comments:

Faint mottling noted in B and C horizon, increased soil moisture at 1.2 m and high plastic clay inclusions.

Dugout 50 m south of test pit.

Residence 150 m West of test pit.

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP02	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	3	Cultivated

Depth of Laboratory Samples:	2.2-2.4			
Soil Subgroup	**Parent Material**	**Drainage**	**Slope Position and Slope %**	**Site Topography**
CaDBC	Till	Well	Mid – 1% South	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.10	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.11-0.24	Clay Loam	HT	10YR 4/3	Faint Mottling	Moderate	Fine	Blocky	Friable / firm	Moist	0
Cca	0.24-1.20	Clay Loam	HT	2.5Y 5/3	Faint Mottling	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	1.20-3.00	Clay	Lab	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	N/A	Seasonally saturated soils; clay with massive (Grade 0) structure.	N/A	Soil texture / grade / structure

Comments:

Adjacent property within 100 m of test pit (West)

High plastic clay inclusions from 2.2 – 3.0 m and increased soil moisture, no evidence of free water.

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP03	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	4	Cultivated

Depth of Laboratory Samples:	1.2-1.4 mbgs			
Soil Subgroup	**Parent Material**	**Drainage**	**Slope Position and Slope %**	**Site Topography**
N/A – disturbed profile	Till	Well	Mid – 1% South	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.07	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Fill	0.07-0.25	Clay Loam	HT	10YR 4/3	No	Structureless	Coarse	Massive	Firm	Moist	15
Cca	0.25-0.75	Clay Loam	HT	2.5Y 5/3	Faint Mottling	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	0.75-3.00	Clay Loam	Lab	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	0.25 to 0.75	Seasonally saturated soils; clay loam with massive (Grade 0) structure.	N/A	Soil texture / grade / structure

Comments:

Weak color change at bottom of A and B horizon, coal and oxide inclusions, and white precipitates in Ck.

1" PVC Standpipe installed to 3.0 m. Increased soil moisture at 2.1 m, no evidence of free water.

Strong eff in CCa, weak eff in Ck. Soil profile disturbed, fill material present at surface overlaying mature parent material.

Site Observations and Soil Profile

Job ID		Testpit Identification			Date	Weather Condition
ENG.LGEO03581-01		TP04			Nov. 2, 2017	Snow / windy
Site Information:						
LSD/1/4	**Sec.**	**Twp.**	**Rg.**	**Mer.**	**Proposed Lot Number**	**Vegetation**
SW	14	009	22	W4	5	Cultivated

Depth of Laboratory Samples:	1.2-1.4 mbgs			
Soil Subgroup	**Parent Material**	**Drainage**	**Slope Position and Slope %**	**Site Topography**
CaDBC	Till	Well	Mid – 1% South	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.7	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.07-0.20	Clay Loam	HT	10YR 4/3	No	Moderate	Fine	Blocky	Friable / Firm	Moist	0
Cca	0.20-1.20	Clay Loam	HT	2.5Y 5/3	Faint Mottling	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	1.20-3.00	Sandy Loam	Lab	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	0.20 to 1.20 mbgs	Seasonally saturated soils.	N/A	Soil texture / grade / structure

Comments:

Weak color change at bottom of A and B horizon, coal and oxide inclusions, and white precipitates in Ck.

1” PVC Standpipe installed to 3.0 m.

Strong eff in CCa, weak eff in Ck.

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP05	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	8	Cultivated

Depth of Laboratory Samples:	1.2-1.4 mbgs			
Soil Subgroup	**Parent Material**	**Drainage**	**Slope Position and Slope %**	**Site Topography**
O DBC	Till	Well	Mid – 1% North East	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.99	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bm	0.09-0.28	Clay Loam	HT	10YR 4/3	No	Moderate to Strong	Medium	Prismatic*	Firm	Moist	0
Ckca	0.28-0.90	Clay Loam	HT	2.5Y 5/3	No	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	0.90-3.00	Clay Loam	HT	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	N/A	Clay loam with massive (Grade 0) structure.	N/A	Soil texture / grade / structure

Comments:

No effervescence in A or B horizon. Weak color change at bottom of A and B horizon.

Coal and oxide inclusions, and white precipitates in Ck. Strong eff in CCa, weak eff in Ck.

1” PVC Standpipe installed to 3.0 m.

*Prismatic soils are not considered restrictive if they are *not* very firm or harder (while moist).

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP06	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	11	Cultivated

Depth of Laboratory Samples:	2.2 – 2.4 mbgs		

Soil Subgroup	Parent Material	Drainage	Slope Position and Slope %	Site Topography
CaDBC	Till	Well	Lower – 1% South	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.10	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.10-0.28	Clay Loam	HT	10YR 4/3	No	Moderate	Fine	Blocky	Friable / Firm	Moist	0
Cca	0.28-1.10	Clay Loam	HT	2.5Y 5/3	No	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	1.10-3.00	Clay	Lab	2.5Y 4/2	No	Structureless	Coarse	Massive	Sticky	Very Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	N/A	Clay with massive structure	N/A	Soil texture / grade / structure

Comments:

Weak color change at bottom of A and B horizon, coal and oxide inclusions, and white precipitates in Ck.

High plastic clay inclusions at 2.2 – 3.0 m, increased soil moisture. 1” PVC Standpipe installed to 3.0 m.

Strong eff in CCa, weak eff in Ck.

Dugout roughly 100 m South West of test pit,

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP07	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	6	Cultivated

Depth of Laboratory Samples:	1.2-1.4 mbgs			
Soil Subgroup	**Parent Material**	**Drainage**	**Slope Position and Slope %**	**Site Topography**
CaDBC	Till	Well	Mid – 3% South East	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.09	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.09-0.28	Clay Loam	HT	10YR 4/3	No	Moderate	Fine	Blocky	Friable / Firm	Moist	0
Cca	0.28-1.20	Silty Clay Loam	Lab	2.5Y 5/3	No	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	1.20-3.00	Clay Loam	HT	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	N/A	Clay loam with massive (Grade 0) structure.	N/A	Soil texture / grade / structure

Comments:

Weak color change at bottom of A and B horizon, coal and oxide inclusions, and white precipitates in Ck.

1” PVC Standpipe installed to 3.0 m.

Strong eff in CCa, weak eff in Ck.

Coulee break roughly 40 m South East of test pit.

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP08	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	9	Cultivated

Depth of Laboratory Samples:	1.2-1.4 mbgs			
Soil Subgroup	**Parent Material**	**Drainage**	**Slope Position and Slope %**	**Site Topography**
CaDBC	Till	Well	Mid – 2% North West	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.09	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.09-0.28	Clay Loam	HT	10YR 4/3	No	Moderate	Fine	Blocky	Friable / Firm	Moist	0
Cca	0.28-1.10	Clay Loam	HT	2.5Y 5/3	No	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	1.10-3.00	Clay	Lab	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	N/A	Clay with massive (Grade 0) structure.	N/A	Soil texture / grade / structure

Comments:

Weak color change at bottom of A and B horizon, coal and oxide inclusions, and white precipitates in Ck.

1” PVC Standpipe installed to 3.0 m.

Strong eff in CCa, weak eff in Ck.

Coulee break roughly 40 m North of test pit.

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP09	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	12	Cultivated

Depth of Laboratory Samples:	1.9-2.1 mbgs		

Soil Subgroup	Parent Material	Drainage	Slope Position and Slope %	Site Topography
CaDBC	Till	Well	Mid – 1% North West	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.12	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.12-0.24	Clay Loam	HT	10YR 4/3	No	Moderate	Fine	Blocky	Friable / Firm	Moist	0
Cca	0.24-0.90	Clay Loam	HT	2.5Y 5/3	No	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	0.90-3.00	Clay	Lab	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Very Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	N/A	Clay with massive (Grade 0) structure.	N/A	Soil texture / grade / structure

Comments:

Weak color change at bottom of A and B horizon, coal and oxide inclusions, and white precipitates in Ck.

1” PVC Standpipe installed to 3.0 m..

White precipitates in Cca, increased clay content in Ck (high plastic), increases soil moisture but no free water or mottling / gleying observed

Strong eff in CCa, weak eff in Ck.

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP10	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	10	Cultivated

Depth of Laboratory Samples:	2.7-3.0 mbgs		

Soil Subgroup	Parent Material	Drainage	Slope Position and Slope %	Site Topography
CaDBC	Till	Well	Mid – 2% South East	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.07	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.07-0.21	Clay Loam	HT	10YR 4/3	No	Moderate	Fine	Blocky	Friable / Firm	Moist	0
Cca	0.21-1.10	Clay Loam	HT	2.5Y 5/3	No	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck$_1$	1.10-2.70	Clay Loam	HT	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5
Ck $_2$	2.70-3.00	Sand	Lab	2.5 Y 5/6	No	Weak	Very Fine	Single Grained	Loose	Moist	0

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	N/A	Clay loam with massive (Grade 0) structure; sand.	Sand @ 2.7 m	Soil texture / grade / structure

Comments:

Weak color change at bottom of A and B horizon, coal and oxide inclusions, and white precipitates in Ck.

1" PVC Standpipe installed to 3.0 m. Highly permeable sand layer at 2.7 m

Strong eff in CCa, weak eff in Ck.

Coulee break within 50 m South, East, and North.

Site Observations and Soil Profile

Job ID	**Testpit Identification**	**Date**	**Weather Condition**
ENG.LGEO03581-01	TP11	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	**Sec.**	**Twp.**	**Rg.**	**Mer.**	**Proposed Lot Number**	**Vegetation**
SW	14	009	22	W4	13	Cultivated

Depth of Laboratory Samples:	1.2-1.4 mbgs			
Soil Subgroup	**Parent Material**	**Drainage**	**Slope Position and Slope %**	**Site Topography**
CaDBC	Till	Well	Mid – 2% North	Level

Profile Description

Horizon	**Depth (mbgs)**	**Texture**	**Lab/HT**	**Colour**	**Gleying/ Mottling?**	**Structure**			**Consistence**	**Moisture**	**% Coarse Fragments**
						Grade	**Class**	**Kind**			
Apk	0-0.10	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.10-0.25	Clay Loam	HT	10YR 4/3	N/A	Moderate	Fine	Blocky	Friable / Firm	Moist	0
Cca	0.25-1.10	Silty Clay Loam	HT	2.5Y 5/3	No	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	1.10-3.00	Silt Loam	Lab	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5

Depth to Groundwater	**Depth to Seasonally Saturated Soil**	**Restricting Soil Layer Characteristic**	**Depth to Highly Permeable Layer Limiting Design**	**Key Soil Characteristics Applied to System Design Effluent Loading**
N/A	N/A	Silt loam with massive (Grade 0) structure.	N/A	Soil texture / grade / structure

Comments:

Weak color change at bottom of A and B horizon, coal and oxide inclusions, and white precipitates in Ck.

1” PVC Standpipe installed to 3.0 m.

Strong eff in CCa, weak eff in Ck.

Coulee slope break roughly 60 m North of test pit.

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP12	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	7	Pasture

Depth of Laboratory Samples:	1.2-1.4 mbgs			
Soil Subgroup	**Parent Material**	**Drainage**	**Slope Position and Slope %**	**Site Topography**
CaDBC	Till	Well	Mid – 2% South	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.17	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.17-0.34	Clay Loam	HT	10YR 4/3	No	Moderate	Fine	Blocky	Friable / Firm	Moist	0
Cca	0.34-1.70	Clay Loam	Lab	2.5Y 5/3	No	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	1.70-3.00	Clay Loam	HT	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	N/A	Clay loam with massive (Grade 0) structure.	N/A	Soil texture / grade / structure

Comments:

Weak color change at bottom of A and B horizon, coal and oxide inclusions, and white precipitates in Ck.

1” PVC Standpipe installed to 3.0 m.

Strong eff in CCa, weak eff in Ck.

Coulee break roughly 35 m South of test pit

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP13	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	14	Pasture

Depth of Laboratory Samples:	1.2-1.4 mbgs			
Soil Subgroup	**Parent Material**	**Drainage**	**Slope Position and Slope %**	**Site Topography**
CaDBC	Till	Well	Mid – 2% North	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.12	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.12-0.28	Clay Loam	HT	10YR 4/3	No	Moderate	Fine	Blocky	Friable / Firm	Moist	0
Cca	0.28-1.40	Clay Loam	Lab	2.5Y 5/3	No	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	1.40-3.00	Clay Loam	HT	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	N/A	Clay loam with massive (Grade 0) structure.	N/A	Soil texture / grade / structure

Comments:

Weak color change at bottom of A and B horizon, coal and oxide inclusions, and white precipitates in Ck.

1” PVC Standpipe installed to 3.0 m.

Strong eff in CCa, weak eff in Ck.

Coulee break roughly 30 m North of test pit location.

Site Observations and Soil Profile

Job ID	Testpit Identification	Date	Weather Condition
ENG.LGEO03581-01	TP14	Nov. 2, 2017	Snow / windy

Site Information:

LSD/1/4	Sec.	Twp.	Rg.	Mer.	Proposed Lot Number	Vegetation
SW	14	009	22	W4	15	Pasture

Depth of Laboratory Samples:	1.2-1.4 mbgs		

Soil Subgroup	Parent Material	Drainage	Slope Position and Slope %	Site Topography
CaDBC	Till	Well	Mid – 1%	Level

Profile Description

Horizon	Depth (mbgs)	Texture	Lab/HT	Colour	Gleying/ Mottling?	Structure			Consistence	Moisture	% Coarse Fragments
						Grade	Class	Kind			
Apk	0-0.10	Clay Loam	HT	10YR 3/2	No	Weak	Fine	Granular	Friable	Moist	0
Bmk	0.10-0.23	Clay Loam	HT	10YR 4/3	No	Moderate	Fine	Blocky	Friable / Firm	Moist	0
Cca	0.23-1.30	Sandy Clay Loam	Lab	2.5Y 5/3	No	Moderate	Medium	Subangular Blocky	Firm	Moist	2
Ck	1.30-3.00	Sandy Clay Loam	Lab	2.5Y 4/2	No	Structureless	Coarse	Massive	Firm	Moist	5

Depth to Groundwater	Depth to Seasonally Saturated Soil	Restricting Soil Layer Characteristic	Depth to Highly Permeable Layer Limiting Design	Key Soil Characteristics Applied to System Design Effluent Loading
N/A	N/A	Sandy Clay Loam with massive (Grade 0) structure.	N/A	Soil texture / grade / structure

Comments:

Weak color change at bottom of A and B horizon, coal and oxide inclusions, and white precipitates in Ck.

1” PVC Standpipe installed to 3.0 m. Strong eff in CCa, weak eff in Ck.

APPENDIX C

LIMITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOENVIRONMENTAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the “Professional Document”).

The Professional Document is intended for the sole use of TETRA TECH’s Client (the “Client”) as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the “Contract” herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an “Authorized Party”), consideration for such authorization is the Authorized Party’s acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the “Limitations on Liability”). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party’s express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH’s professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH’s “Instruments of Professional Service”), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH’s Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH’s Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, 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. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH 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 further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document 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 conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH 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.

1.7 NOTIFICATION OF AUTHORITIES

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 TETRA TECH in its reasonably exercised discretion.

APPENDIX

APPENDIX 7 ~ STORMWATER MANAGEMENT PLAN

MARTIN
GEOMATIC CONSULTANTS LTD.

SITE DRAINANGE ANALYSIS
COULEE VIEW SUBDIVISION
S-14-9-22-W4M
LETHBRIDGE COUNTY
ALBERTA

Prepared for:	Mr. Peter Fiorino
File Number:	166729CE
Dated:	March 2018

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDIX

I. PROJECT BACKGROUND AND DRAINAGE FEATURES

The Coulee View Subdivision is a proposed group country residential subdivision located along Highway #25, roughly 1 km north of Highway#3 in Lethbridge County. The legal property description is South Half of Section 14, Township 9, Range 22 West of the 4th Meridian. The property is bound by Township Road 92 to the south, and farmland/ homesteads to the north, east and west. See Figure 1 – Project Location. This drainage report is being submitted in support of The Coulee View Area Structure Plan (ASP) and rezoning application, for consideration by the Lethbridge County. The ASP plan area is 111.54 acres (45.14 ha) which includes two legal lots. The landowner is proposing to subdivide into 15 residential lots and rezone portions of the land from Lethbridge Urban Fringe (LUF) to Group Country Residential (GCR). The proposed lot layout is shown on Figure 2 – Proposed Subdivision. The purpose of this report is to provide stormwater management strategies to guide the future development of the Coulee View Subdivision.

A. Existing Features

The site lies on the western banks of the Oldman River valley and includes two distinctly different topographical areas; an upland prairie area and a coulee area. The upland prairie area is relatively flat (slopes are in the order of 1%) and drains easterly to the coulee area. The coulee area has relatively steep banks (approaching 35% gradients) with a channel sloping down to the Oldman River. Runoff from the site presently flows eastward from cropland in the upland prairie area and enters the coulee draws which drain down to the Oldman river valley. Runoff leaving the site is mostly concentrated in a natural channel at the northeast corner of the plan area.

The site is split in to two catchment areas which define the overland drainage boundaries. The north catchment (58.3 ha) drains in to a coulee with a deep channel at the northeast corner of the plan area. This area includes mainly cropland with two homesteads, and an undisturbed coulee valley. The south catchment (2.8 ha) includes a gravel road and ditches which flows east to the west banks of the Oldman River valley.

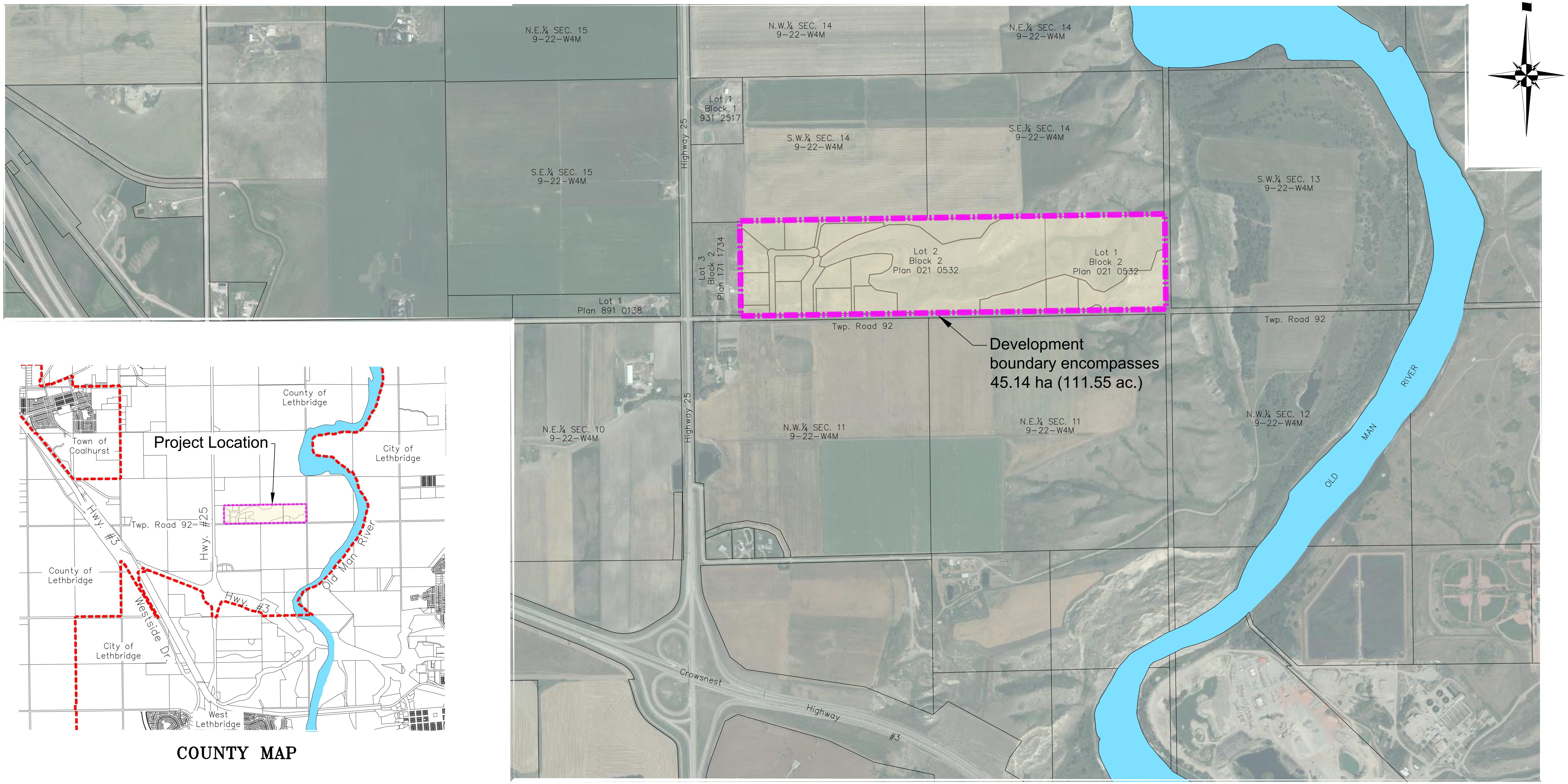
Existing soil descriptions for the area include Orthic Dark Brown Chernozem on medium textured (L, SiL) sediments deposited by wind and water (LET), Orthic Dark Brown Chernozem on medium textured (L, SiCL, CL) materials over medium (L, CL) or fine (C) textured till (WNY), miscellaneous undifferentiated mineral soils (ZUN) as defined in soil polygon 5822 and 5392[a]. Nine boreholes[b] have been completed on site to determine soil conditions for the purpose geotechnical investigations and general suitability of the proposed development. The nine boreholes were drilled to a depth of 6.6m and generally found 200mm topsoil above clay, with groundwater depths ranging from 2.5m to dry. Soil reports are included in Appendix B – Soil Information. A topographical site survey has been completed by Martin Geomatic Consultants Ltd[c] and an existing surface terrain model has been created to define drainage boundaries, storage depressions and flow conveyance routes as shown in Figure 3 – Existing Site Features.

---

[a] Alberta Soil Information Viewer, Alberta Agriculture and Forestry, http://www4.agric.gov.ab.ca/agrasidviewer

[b] Geotechnical Evaluation, Rural Country Residential Subdivision Development, Lethbridge County, Alberta" report prepared by Tetra Tech Canada Inc., December 2017.

[c] MGCL topographical site survey, May 2016.



Development boundary encompasses 45.14 ha (111.55 ac.)

LEGEND

▬·▬·▬	DEVELOPMENT BOUNDARY
- - - - -	CITY / TOWN BOUNDARY

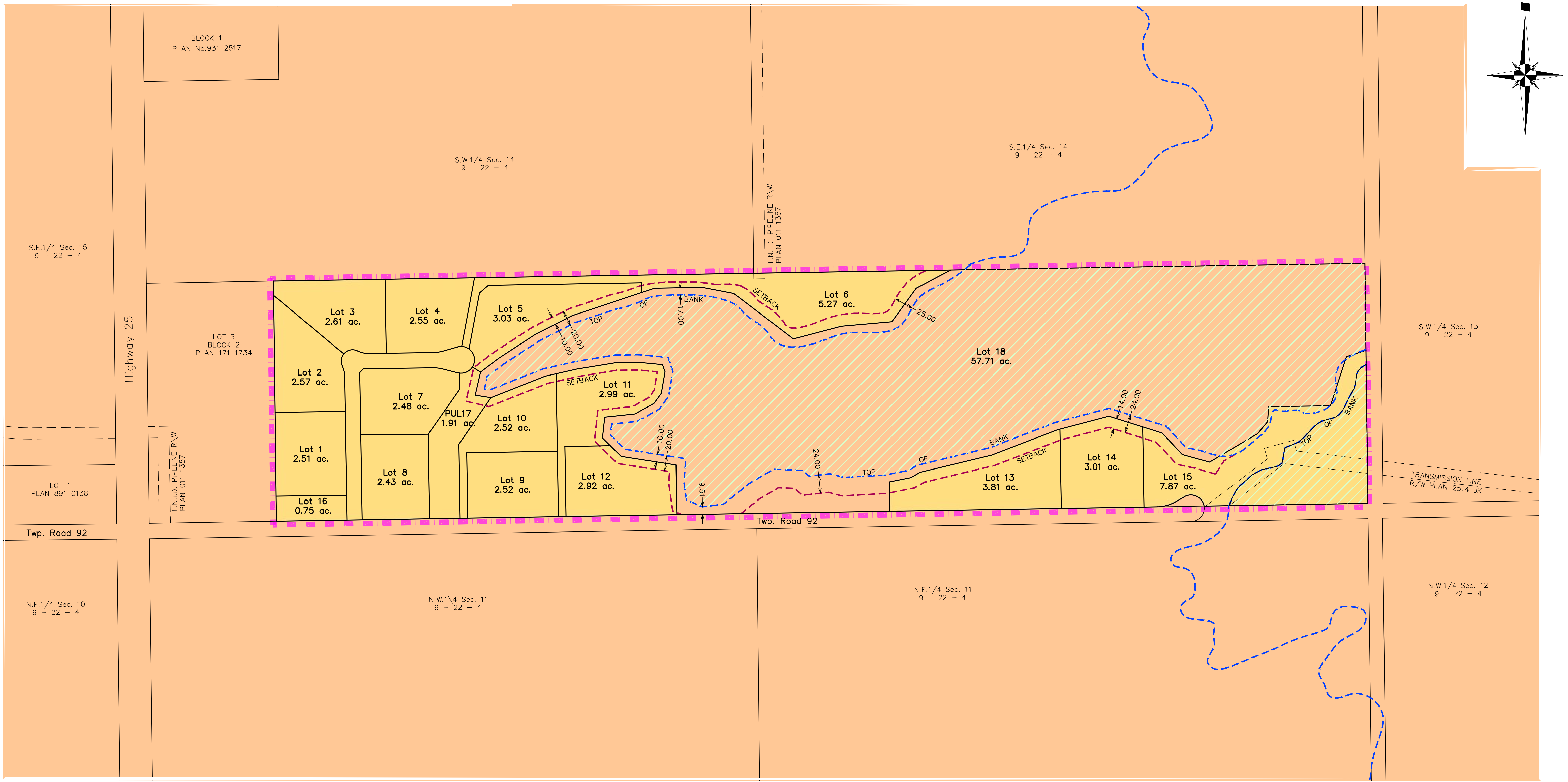
COULEE VIEW STORMWATER MANAGEMENT PLAN

PROJECT LOCATION
FIGURE 1

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE:	NOT TO SCALE
DRAWN:	RJM
DATE:	March 5, 2018
JOB #:	166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce–stormwaterreport – mar05–2018.dwg



LEGEND

AREA STRUCTURE PLAN BOUNDARY

TOP OF BANK

SETBACK - TOP OF BANK

▨ 53.72 ac. (21.74 ha.)	GROUPED COUNTRY RESIDENTIAL - GCR
▨	ENVIRONMENTAL EASEMENT
▨	LETHBRIDGE URBAN FRINGE - LUF

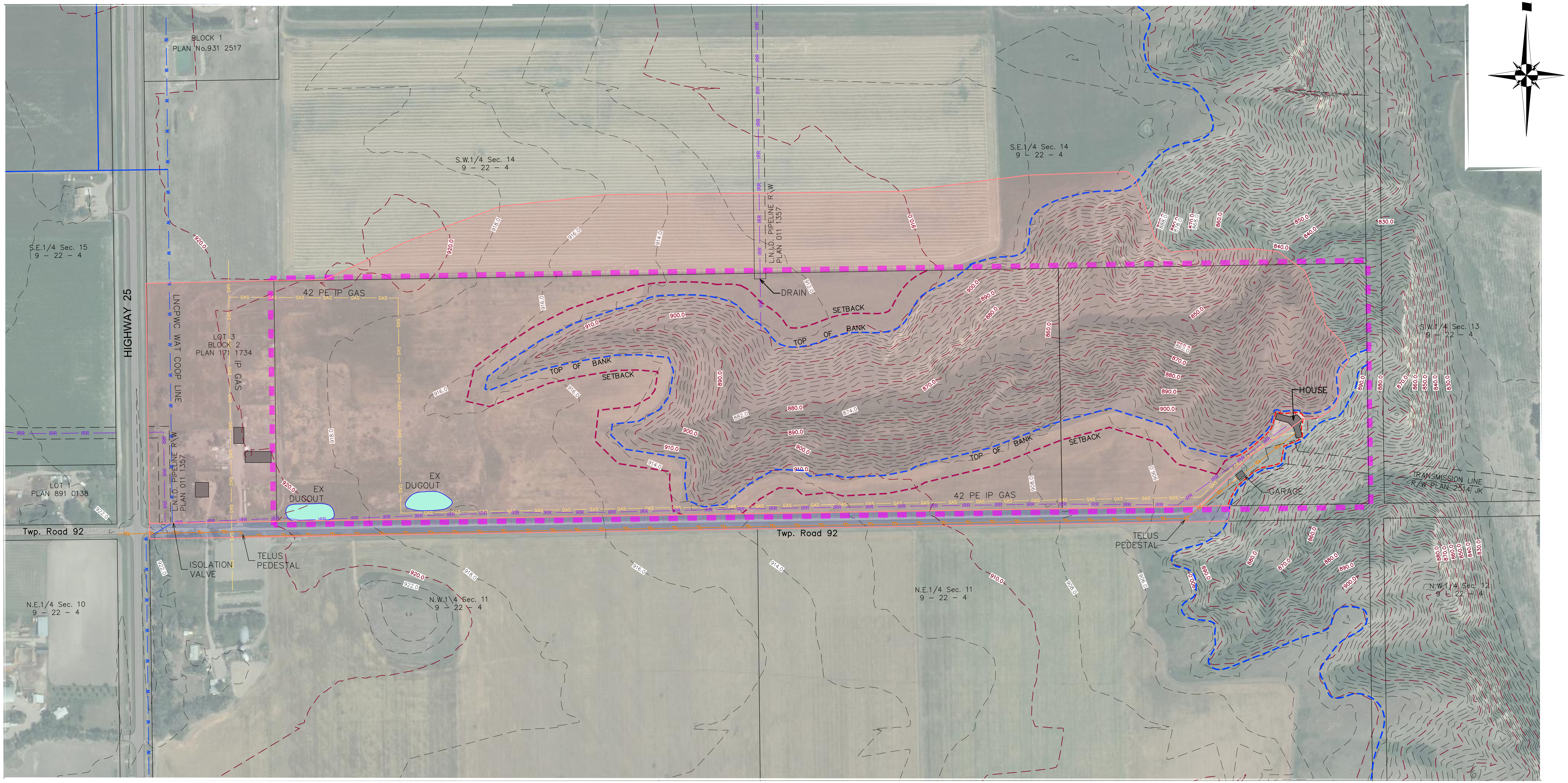
COULEE VIEW STORMWATER MANAGEMENT PLAN

PROPOSED SUBDIVISION
FIGURE 2

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE: 1:5000
DRAWN: RJM
DATE: March 5, 2018
JOB #: 166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce-stormwaterreport – mar05–2018.dwg



LEGEND

▬ ▬ ▬	DEVELOPMENT BOUNDARY
— — —	MAJOR CONTOURS (10m INT)
— — —	MINOR CONTOURS (2m INT)
— — —	TOP OF BANK
▨	EXISTING GRAVEL ROAD
▨	EXISTING PAVED ROAD
— E — E —	OVERHEAD ELECTRICAL LINE
— TEL — TEL —	BURIED TELUS CABLE
— GAS —	BURIED GAS LINE
— W — W — W —	WATER COOP LINE
— IRR — IRR — IRR —	IRRIGATION LINE
☼	EXISTING POWER POLE
🟥	SUBCATCHMENT S1 (58.42 ha)
🟦	SUBCATCHMENT S2 (2.85 ha)

COULEE VIEW
STORMWATER
MANAGEMENT PLAN

EXISTING SITE FEATURES
FIGURE 3

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE: 1:5000
DRAWN: RJM
DATE: March 5, 2018
JOB #: 166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce-stormwaterreport – mar05-2018.dwg

B. Proposed Development

The proposed development will subdivide and create 15 Group Country Residential lots ranging from 2.5 acres to 5 acres in area (about 3 acres on average). Seven of the proposed lots have frontage and direct access on to Township Road 92. An internal access road and cul-de-sac will provide access to nine lots within the development. The drainage patterns will be affected as a result of this development, as the runoff discharge rates and volumes will change with the increase in the imperviousness within the plan area from the addition of hard surfaces including building roofs and driveways. To mitigate this, the development will include detention storage on site with controlled release which is designed to not exceed the pre-development levels. The detention storage area is in a natural low area where the upland prairie meets the coulee area. The detention pond will utilize the existing topography to minimize the ground disturbance and earthwork efforts. Grass swales will be constructed to direct runoff away from the buildings and towards the designated storage areas. Figure 4 – Proposed Stormwater Upgrades shows the location of proposed detention pond.

II. METHODOLOGY

Drainage analysis of the proposed development has been completed to determine runoff, storage, and discharge rates for pre and post-development conditions. Existing site analysis (pre-development) has been analyzed to determine a benchmark for allowable release rates at the post development conditions. A stormwater management model[d] has been utilized for the analysis. The following parameters are included in the modeling:

1. Synthetic Design Storm – Chicago Method: 24-hour duration, 100-year return period, (IDF Parameters A = 1019.20, B = 0, C = 0.731)[e]
2. Rainfall time step = 5 minutes
3. Simulation duration = 24 hrs
4. Routing Method: Dynamic Wave
5. No effect of Evaporation and Groundwater
6. Total Catchment area = 61.14ha
7. Infiltration Method: Green Ampt
8. Manning's N Impervious = 0.015
9. Manning's N Pervious = 0.15 (undeveloped), 0.1 (developed)
10. Depression Storage Pervious = 5mm (undeveloped), 3.8mm (developed)
11. Depression Storage Impervious = $0.77*(S\%)^{-0.49}$

A. Sub-Catchments

The existing site (pre-development) and proposed site (post-development) models have been created to simulate drainage patterns in response to a single event 100yr synthetic design storm. The following tables show the sub catchment parameters assumed in the pre and post-development models:

---

[d] EPA Storm Water Management Model – Version 5.0 (Build 5.0.22)

[e] 2016 Design Standards, City of Lethbridge.

Table 1 – Pre Development Sub-Catchment Parameters

Name	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
S1	58.34	345.6	1,688	4.7	2	292.2	1	0.229
S2	2.79	20.25	1,380	1.3	15	292.2	1	0.229

A brief description of the existing (pre-development) sub-catchment areas follows.

S1 includes most of the land within the plan area plus additional offsite areas to the west and north of the development boundary. The land area is composed of mainly cropland and coulees and drains to the coulee channel outlet at the northeast boundary.

S2 includes the existing gravel county road along the south perimeter, which drains to the east end of Township Road 92.

Table 2 – Post Development Sub-Catchment Parameters

Name	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
hwy_comm	5.26	156.2	337	1.0	80	292.2	1	0.229
south_res	3.01	76.1	395	1.5	15	292.2	1	0.229
west-res	13.22	295.7	447	1.3	15	292.2	1	0.229
north_res	1.484	218.2	68	1.2	15	292.2	1	0.229
offsite_north	10.68	971	110	1.0	2	292.2	1	0.229
coulee	24.77	202.2	1,225	6.2	0	292.2	1	0.229
S1_1	1.60	11.6	730	1.3	40	292.2	1	0.229
S1_2	1.16	8.4	665	1.3	40	292.2	1	0.229

A brief description of the proposed site (post-development) sub-catchments is provided for reference.

hwy-comm includes the offsite area to the west which lies outside of the subdivision. This area will require on-site storage (west pond) with the site development.

south-res covers the proposed building lots which drains directly to the coulee.

west-res includes the proposed building lots which drains to the dry pond (east pond).

north-res covers the proposed building lots which drains directly to the coulee.

offsite-north encompasses those lands directly north of the Coulee View development boundary. This sub catchment drains to the coulee.

coulee is to remain undeveloped and covers the area extending up from the river valley. This sub-catchment drains to the coulee channel OF-1.

S1-1 is the west portion of Twp. Rd-92 and this drains to the coulee.

S1-2 is the east portion of Twp. Rd-92 and this drains to the east outlet OF-2.

The source information for the above Table 1 and Table 2 includes:

Area (ha) & Flow Path (m): measured

Slope (%): calculated from field survey

Soil Texture: Alberta Soil Viewer & boreholes[f]

Hydraulic Conductivity (mm/hr) & Suction Head (mm): Soil properties[g]

Initial Moisture Deficit: Typical soil characteristics[h]

Impervious areas: Estimated[i]

III. RESULTS

The model results are presented in the following tables. Details of the rainfall runoff modeling are included in Appendix B – SWMM Model Results.

A. Pre and Post Development Runoff

Table 3 presents the pre-development model results for the sub-catchment runoff generated from a 24 hour duration 100 year storm. Existing subcatchment areas are shown in the attached Appendix.

Table 3 – Pre-Development Runoff

Name	Area (ha)	Precip. (mm)	Runon (mm)	Infiltration (mm)	Runoff Depth (mm)	Runoff Vol. (ML)	Peak Runoff (m³/s)
S1	58.34	120.15	0	63.21	50.63	29.54	2.16
S2	2.79	120.15	0	54.99	57.78	1.61	0.26

Table 4 presents the sub-catchment model results for the post-development runoff generated from a 24 hour duration 100 year storm. Proposed subcatchment areas are shown in the attached Appendix.

---

[f] Geotechnical Evaluation, Rural Country Residential Subdivision Development, Lethbridge County, Alberta” report prepared by Tetra Tech Canada Inc., December 2017

[g] Rawls, W.J. et al., (1983). J. Hyd. Engr., 109:1316

[h] XP SWMM Soultions, http://help.xpsolutions.com/display/xps2015/Infiltration

[i] 2016 Design Standards, City of Lethbridge.

Table 4 – Post-Development Runoff

Name	Area (ha)	Precipitation (mm)	Runon (mm)	Infiltration (mm)	Runoff Depth (mm)	Runoff Volume (ML)	Peak Runoff (m^3/s)
hwy_comm	5.26	120.15	0	12.74	104.24	5.49	2.13
south_res	3.01	120.15	0	54.41	62.93	1.89	0.49
west-res	13.22	120.15	0	54.47	62.46	8.26	1.99
north_res	1.484	120.15	0	54.10	65.15	0.97	0.48
offsite_north	10.68	120.15	0	62.48	56.39	6.02	1.73
coulee	24.77	120.15	35.86	64.75	86.46	21.42	2.02
S1_1	1.60	120.15	0	32.18	82.81	1.33	0.26
S1_2	1.16	120.15	0	32.18	82.81	0.97	0.19

B. Proposed Storage Units

Table 5 displays the proposed storage units in response to the 100 year storm event as shown on Figure 4 – Proposed Stormwater Upgrades.

Table 5 – Proposed Storage Units

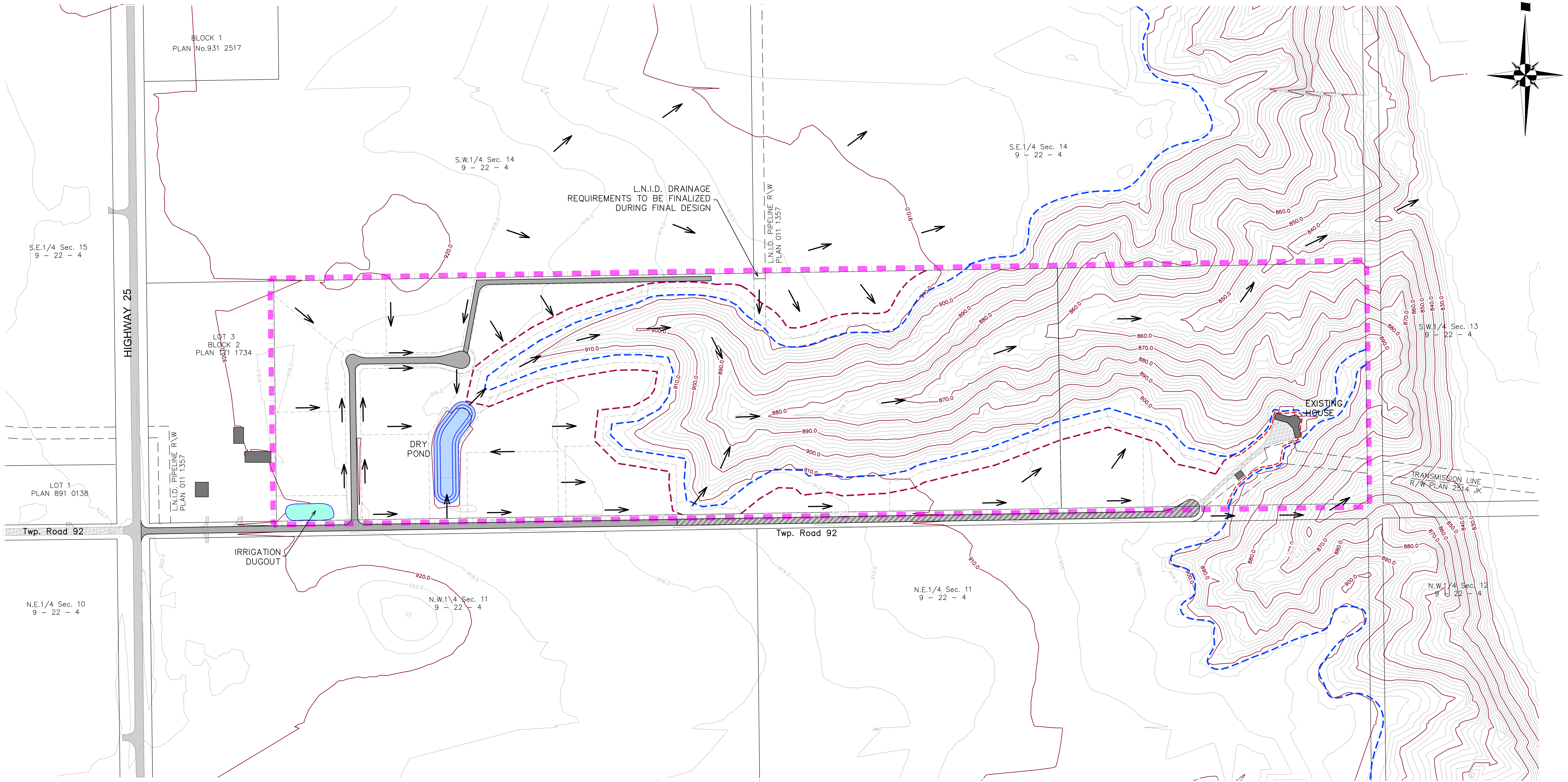
Name	Invert El. (m)	Max. Depth (m)	Max. HGL* (m)	Max. Volume (1,000 m^3)
West pond	N/A	N/A	N/A	5.61
East pond	910.0	2.07	912.1	6.28

*HGL = Hydraulic grade line

The following descriptions are provided for the proposed storage units.

West pond: the West pond represents the total volume of runoff water from the offsite area to the west (sub-catchment hwy_comm). The runoff from this area should be controlled and managed on-site and not be routed in to the Coulee View development. However, the stormwater analysis accounts for this area because the pre-development catchment extends into these lands.

East pond: the East pond is the proposed dry pond for the Coulee View development. The preliminary volume requirement is provided for planning purposes and will be confirmed with the detailed design.



LEGEND

▬ ▬ ▬ DEVELOPMENT BOUNDARY

MAJOR CONTOURS (10m INT)

MINOR CONTOURS (2m INT)

TOP OF BANK

↗ PROPOSED DRAINAGE

EXISTING GRAVEL ROAD

EXISTING PAVED ROAD

PROPOSED ASPHALT ROAD

▨ PROPOSED GRAVEL ROAD

COULEE VIEW STORMWATER MANAGEMENT PLAN

PROPOSED STORMWATER UPGRADES FIGURE 4

MARTIN
GEOMATIC CONSULTANTS LTD

SCALE: 1:5000
DRAWN: RJM
DATE: March 5, 2018
JOB #: 166729CE

z:\data\active projects\166729 fiorino land devel_asp\cadd\asp\166729ce–stormwaterreport – mar05–2018.dwg

C. Pre and Post Development Release Rates

The pre and post development discharge rates to be released from the development during the 100 year storm event are shown below.

Table 6 – Release Rates

Outlet Description	Pre-Development Qpeak (m^3/s)	Post – Development Qpeak (m^3/s)	Net Change (m^3/s)
Coulee Channel	2.158	2.146	-0.012
Twp. Rd-92	0.239	0.239	0.00

The stormwater analysis for the Coulee View development indicates that the Coulee Channel outlet located along the northeast area of the development boundary will receive a post-development peak flow rate not exceeding that of the pre-development rate. This is achieved by providing on-site storage with the construction of a dry pond to detain runoff with a controlled release. The Twp. Rd-92 outlet is designed to have a post-development peak flow rate not exceeding that of the pre-development rate. Although a portion of the road is planned to be paved, the increased runoff rate will be offset by diverting some of the ditch water into the coulee draw further upstream to the west.

IV. RECOMMENDATIONS

It is recommended that the Coulee View Development provides 6,300 m^3 of active stormwater storage on-site to detain the runoff and release at or below the pre-development rates generated from a 1 in 100 year 24 hour storm as outlined in this report. Approval drawings including the detailed designs of detention ponds, outlets, swales and grading plans are recommended prior to construction, which should generally follow the stormwater concepts outlined in this report.

It is recommended that the adjacent 13 acre highway commercial lot to the West provides on-site storage outside of the Coulee View Development. Preliminary runoff volumes are shown in this report for reference, and should be confirmed at the detailed design of the site development.

V. CLOSING

We trust that this report meets the requirements of the Area Structure Plan. Should you require any further information, please contact the undersigned.

Per:

MATTHEW REDGRAVE

MAR.05/18

Matt Redgrave, P.Eng.
Project Manager

MARTIN GEOMATIC CONSULTANTS LTD.
Association of Professional Engineers and Geoscientists of Alberta
Permit to Practice P05852

APPENDIX A

SOIL INFORMATION

SITE DRAINANGE ANALYSIS
COULEE VIEW SUBDIVISION
S. 1/2 SEC. 14-9-22-W4
LETHBRIDGE COUNTY
ALBERTA

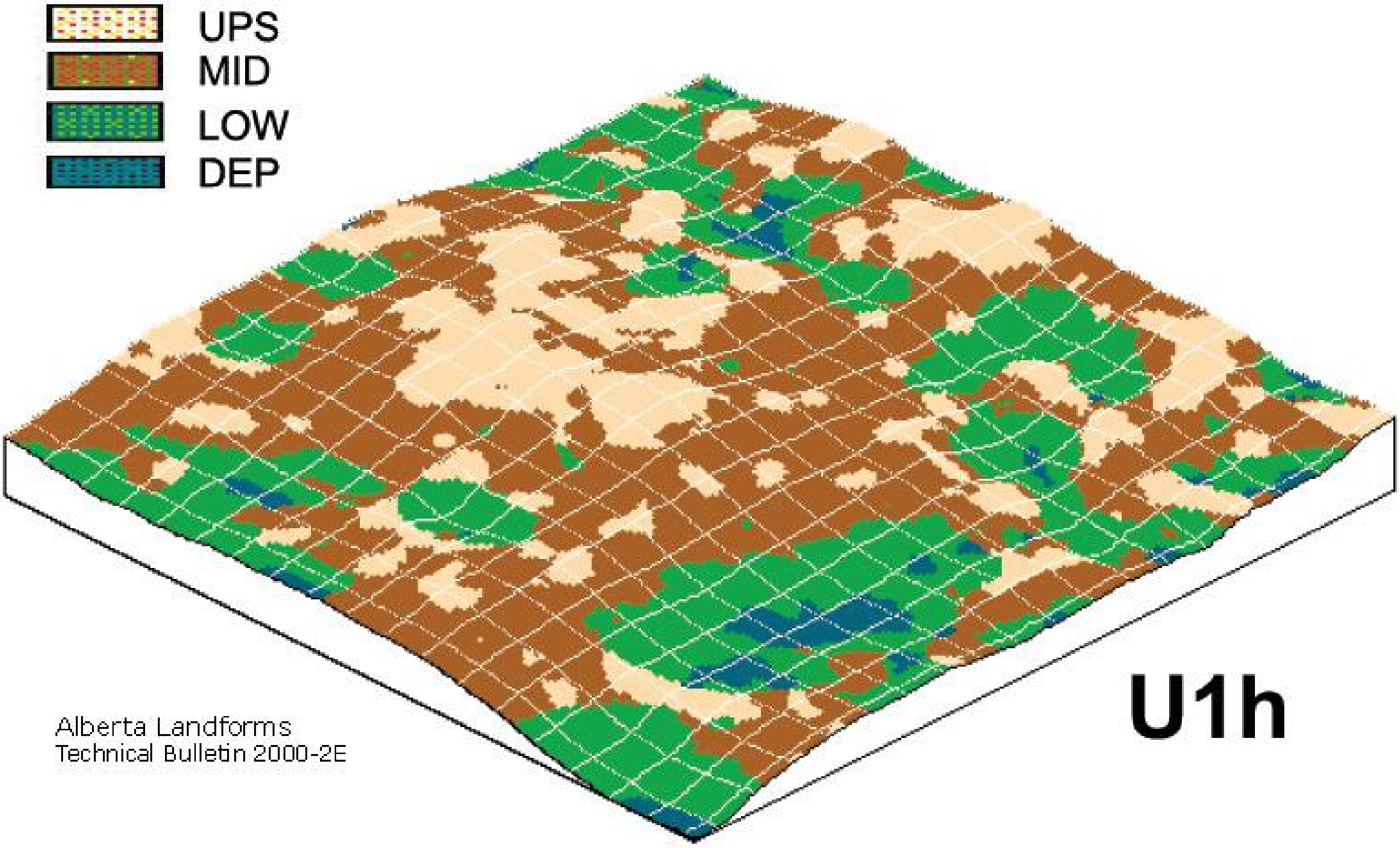
Report on Soil Polygon: 5822

Variable	Value
POLY_ID	5822
Map Unit Name	LEWN5/U1h
Landform	U1h - undulating - high relief
LSRS Rating (Spring Grains)	3M(10)

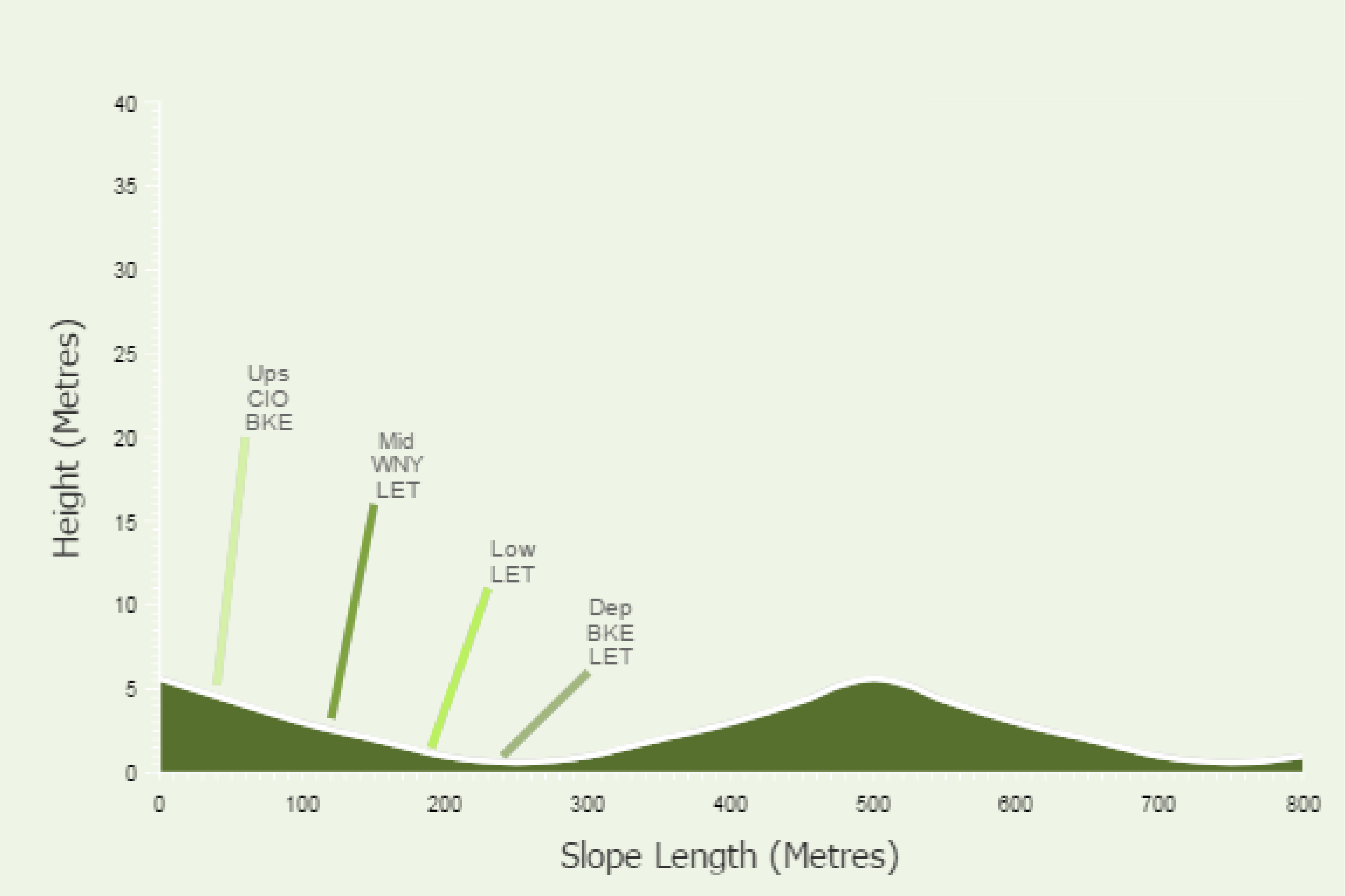
Landscape Model Descriptions:
Orthic Dark Brown Chernozem on medium textured (L, SiL) sediments deposited by wind and water (LET).
Orthic Dark Brown Chernozem on medium textured (L, SiCL, CL) materials over medium (L, CL) or fine (C) textured till (WNY).
The polygon includes soils that are finer textured than the dominant or co-dominant soils (5).
Undulating, high relief landform with a limiting slope of 4% (U1h).

Image:

Landform Model:



Landform Profile:



Report on Soil Polygon: 5392

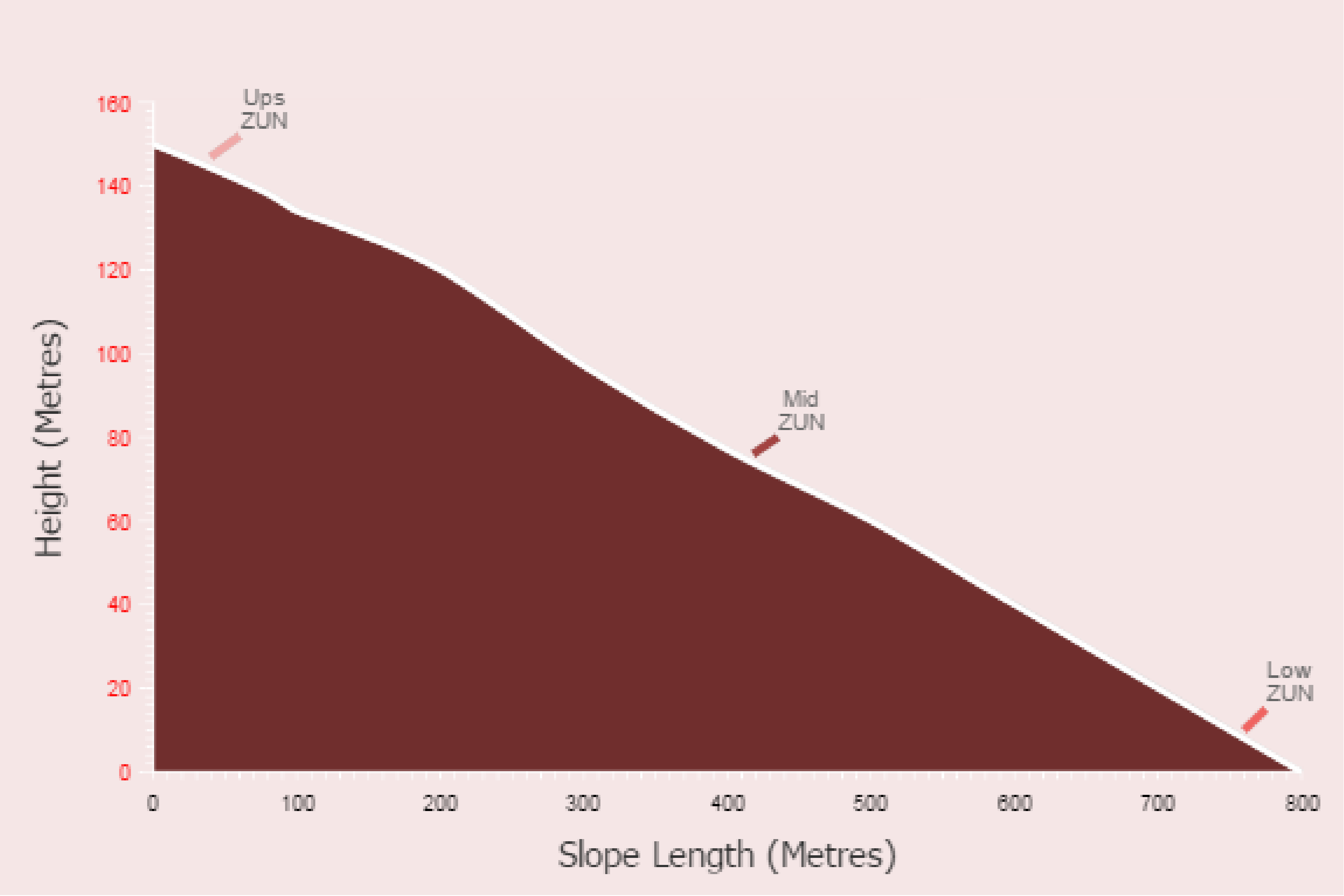
Variable	Value
POLY_ID	5392
Map Unit Name	ZUN1/I4h
Landform	I4h - inclined with BR - high relief
LSRS Rating (Spring Grains)	5TM(10)

Landscape Model Descriptions:
Miscellaneous undifferentiated mineral soils (ZUN).
The polygon may include soils that are not strongly contrasting from the dominant or co-dominant soils (1).
Inclined with bedrock, high relief landform with a limiting slope of 35% (I4h).

Image:

Landform Model:
No landform model.

Landform Profile:



APPENDIX B

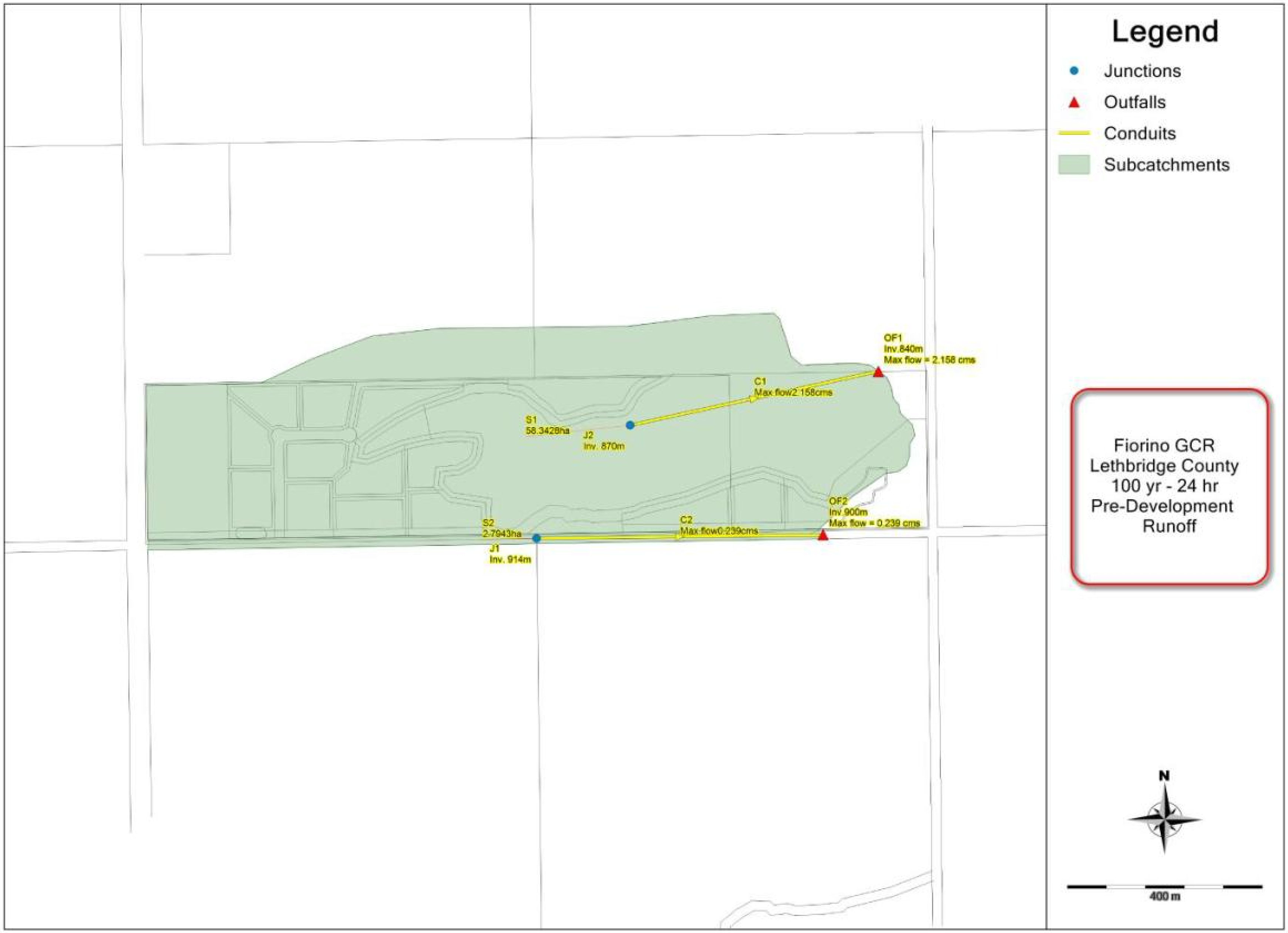
SWMM MODEL RESULTS

SITE DRAINANGE ANALYSIS
COULEE VIEW SUBDIVISION
S. 1/2 SEC. 14-9-22-W4
LETHBRIDGE COUNTY
ALBERTA

Pre-Development

Runoff Analysis

EPA SWMM 5.1



Fiorino GCR
Lethbridge County
100 yr - 24 hr
Pre-Development
Runoff

```
[TITLE]

[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           CMS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         DYNWAVE
START_DATE           06/30/2017
START_TIME           00:00:00
REPORT_START_DATE    06/30/2017
REPORT_START_TIME    00:00:00
END_DATE             07/01/2017
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:01:00
WET_STEP             00:05:00
DRY_STEP             00:05:00
ROUTING_STEP         5
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              2

[EVAPORATION]
;;Type          Parameters
;;------------- ----------
CONSTANT     0.0
DRY_ONLY     NO

[RAINGAGES]
;;                    Rain      Time   Snow   Data
```

```
;;Name                 Type      Intrvl Catch  Source
;;------------------- --------- ------ ------ ----------
Lethbridge_100yr_24hr INTENSITY 0:05   1.0    TIMESERIES Chicago_24hr

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
S1               Lethbridge_100yr_24hr J2          58.3428  2        345.633  4.7      0
S2               Lethbridge_100yr_24hr J1          2.7943   15       20.249   1.3      0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
S1               0.015      0.15       0.36       5          0          OUTLET
S2               0.015      0.15       0.67       5          0          OUTLET

[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
;;-------------- ---------- ---------- ----------
S1               292.2      1          0.229
S2               292.2      1          0.229

[JUNCTIONS]
;;               Invert     Max.       Init.      Surcharge  Ponded
;;Name           Elev.      Depth      Depth      Depth      Area
;;-------------- ---------- ---------- ---------- ---------- ----------
J1               914        2          0          0          0
J2               870        5          0          0          0

[OUTFALLS]
;;               Invert     Outfall      Stage/Table      Tide
;;Name           Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
OF1              840        FREE                          NO
OF2              900        FREE                          NO

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet      Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset     Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
C1               J2               OF1              520.72     0.013      0          0          0          0
C2               J1               OF2              587.64     0.01       0          0          0          0

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels
```

```
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
C1               TRIANGULAR   2                1          0          0          1
C2               TRIANGULAR   1                6          0          0          1

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
;Chicago design storm, a = 1019.2, b = 0, c = 0.731, Duration = 1440 minutes, r = 0.35, rain units = mm/hr.
Chicago_24hr                0:00       1.352
Chicago_24hr                0:05       1.361
Chicago_24hr                0:10       1.372
Chicago_24hr                0:15       1.382
Chicago_24hr                0:20       1.392
Chicago_24hr                0:25       1.403
Chicago_24hr                0:30       1.414
Chicago_24hr                0:35       1.425
Chicago_24hr                0:40       1.436
Chicago_24hr                0:45       1.448
Chicago_24hr                0:50       1.459
Chicago_24hr                0:55       1.471
Chicago_24hr                1:00       1.483
Chicago_24hr                1:05       1.496
Chicago_24hr                1:10       1.509
Chicago_24hr                1:15       1.521
Chicago_24hr                1:20       1.535
Chicago_24hr                1:25       1.548
Chicago_24hr                1:30       1.562
Chicago_24hr                1:35       1.576
Chicago_24hr                1:40       1.59
Chicago_24hr                1:45       1.605
Chicago_24hr                1:50       1.62
Chicago_24hr                1:55       1.635
Chicago_24hr                2:00       1.651
Chicago_24hr                2:05       1.667
Chicago_24hr                2:10       1.683
Chicago_24hr                2:15       1.7
Chicago_24hr                2:20       1.717
Chicago_24hr                2:25       1.735
Chicago_24hr                2:30       1.753
Chicago_24hr                2:35       1.771
Chicago_24hr                2:40       1.79
Chicago_24hr                2:45       1.809
```

Chicago_24hr	2:50	1.829
Chicago_24hr	2:55	1.85
Chicago_24hr	3:00	1.871
Chicago_24hr	3:05	1.892
Chicago_24hr	3:10	1.914
Chicago_24hr	3:15	1.937
Chicago_24hr	3:20	1.961
Chicago_24hr	3:25	1.985
Chicago_24hr	3:30	2.009
Chicago_24hr	3:35	2.035
Chicago_24hr	3:40	2.061
Chicago_24hr	3:45	2.089
Chicago_24hr	3:50	2.117
Chicago_24hr	3:55	2.146
Chicago_24hr	4:00	2.176
Chicago_24hr	4:05	2.206
Chicago_24hr	4:10	2.238
Chicago_24hr	4:15	2.272
Chicago_24hr	4:20	2.306
Chicago_24hr	4:25	2.341
Chicago_24hr	4:30	2.378
Chicago_24hr	4:35	2.416
Chicago_24hr	4:40	2.456
Chicago_24hr	4:45	2.498
Chicago_24hr	4:50	2.541
Chicago_24hr	4:55	2.585
Chicago_24hr	5:00	2.632
Chicago_24hr	5:05	2.681
Chicago_24hr	5:10	2.732
Chicago_24hr	5:15	2.785
Chicago_24hr	5:20	2.841
Chicago_24hr	5:25	2.9
Chicago_24hr	5:30	2.961
Chicago_24hr	5:35	3.026
Chicago_24hr	5:40	3.094
Chicago_24hr	5:45	3.166
Chicago_24hr	5:50	3.242
Chicago_24hr	5:55	3.323
Chicago_24hr	6:00	3.408
Chicago_24hr	6:05	3.499
Chicago_24hr	6:10	3.596
Chicago_24hr	6:15	3.699
Chicago_24hr	6:20	3.81
Chicago_24hr	6:25	3.929
Chicago_24hr	6:30	4.057
Chicago_24hr	6:35	4.195

Chicago_24hr	6:40	4.346
Chicago_24hr	6:45	4.509
Chicago_24hr	6:50	4.688
Chicago_24hr	6:55	4.885
Chicago_24hr	7:00	5.102
Chicago_24hr	7:05	5.344
Chicago_24hr	7:10	5.615
Chicago_24hr	7:15	5.921
Chicago_24hr	7:20	6.269
Chicago_24hr	7:25	6.67
Chicago_24hr	7:30	7.139
Chicago_24hr	7:35	7.693
Chicago_24hr	7:40	8.361
Chicago_24hr	7:45	9.186
Chicago_24hr	7:50	10.234
Chicago_24hr	7:55	11.619
Chicago_24hr	8:00	13.551
Chicago_24hr	8:05	16.477
Chicago_24hr	8:10	21.566
Chicago_24hr	8:15	33.491
Chicago_24hr	8:20	286.165
Chicago_24hr	8:25	92.134
Chicago_24hr	8:30	42.664
Chicago_24hr	8:35	30.072
Chicago_24hr	8:40	23.803
Chicago_24hr	8:45	19.955
Chicago_24hr	8:50	17.317
Chicago_24hr	8:55	15.38
Chicago_24hr	9:00	13.889
Chicago_24hr	9:05	12.7
Chicago_24hr	9:10	11.728
Chicago_24hr	9:15	10.915
Chicago_24hr	9:20	10.224
Chicago_24hr	9:25	9.629
Chicago_24hr	9:30	9.109
Chicago_24hr	9:35	8.652
Chicago_24hr	9:40	8.245
Chicago_24hr	9:45	7.881
Chicago_24hr	9:50	7.553
Chicago_24hr	9:55	7.255
Chicago_24hr	10:00	6.984
Chicago_24hr	10:05	6.736
Chicago_24hr	10:10	6.507
Chicago_24hr	10:15	6.296
Chicago_24hr	10:20	6.101
Chicago_24hr	10:25	5.919

Chicago_24hr	10:30	5.75
Chicago_24hr	10:35	5.592
Chicago_24hr	10:40	5.444
Chicago_24hr	10:45	5.304
Chicago_24hr	10:50	5.173
Chicago_24hr	10:55	5.049
Chicago_24hr	11:00	4.932
Chicago_24hr	11:05	4.822
Chicago_24hr	11:10	4.717
Chicago_24hr	11:15	4.617
Chicago_24hr	11:20	4.522
Chicago_24hr	11:25	4.431
Chicago_24hr	11:30	4.345
Chicago_24hr	11:35	4.263
Chicago_24hr	11:40	4.184
Chicago_24hr	11:45	4.109
Chicago_24hr	11:50	4.036
Chicago_24hr	11:55	3.967
Chicago_24hr	12:00	3.901
Chicago_24hr	12:05	3.837
Chicago_24hr	12:10	3.775
Chicago_24hr	12:15	3.716
Chicago_24hr	12:20	3.659
Chicago_24hr	12:25	3.604
Chicago_24hr	12:30	3.55
Chicago_24hr	12:35	3.499
Chicago_24hr	12:40	3.449
Chicago_24hr	12:45	3.401
Chicago_24hr	12:50	3.355
Chicago_24hr	12:55	3.31
Chicago_24hr	13:00	3.267
Chicago_24hr	13:05	3.224
Chicago_24hr	13:10	3.183
Chicago_24hr	13:15	3.144
Chicago_24hr	13:20	3.105
Chicago_24hr	13:25	3.068
Chicago_24hr	13:30	3.031
Chicago_24hr	13:35	2.996
Chicago_24hr	13:40	2.961
Chicago_24hr	13:45	2.928
Chicago_24hr	13:50	2.895
Chicago_24hr	13:55	2.863
Chicago_24hr	14:00	2.832
Chicago_24hr	14:05	2.802
Chicago_24hr	14:10	2.773
Chicago_24hr	14:15	2.744

Chicago_24hr	14:20	2.716
Chicago_24hr	14:25	2.689
Chicago_24hr	14:30	2.662
Chicago_24hr	14:35	2.636
Chicago_24hr	14:40	2.61
Chicago_24hr	14:45	2.585
Chicago_24hr	14:50	2.561
Chicago_24hr	14:55	2.537
Chicago_24hr	15:00	2.514
Chicago_24hr	15:05	2.491
Chicago_24hr	15:10	2.469
Chicago_24hr	15:15	2.447
Chicago_24hr	15:20	2.425
Chicago_24hr	15:25	2.404
Chicago_24hr	15:30	2.384
Chicago_24hr	15:35	2.364
Chicago_24hr	15:40	2.344
Chicago_24hr	15:45	2.325
Chicago_24hr	15:50	2.306
Chicago_24hr	15:55	2.287
Chicago_24hr	16:00	2.269
Chicago_24hr	16:05	2.251
Chicago_24hr	16:10	2.233
Chicago_24hr	16:15	2.216
Chicago_24hr	16:20	2.199
Chicago_24hr	16:25	2.183
Chicago_24hr	16:30	2.166
Chicago_24hr	16:35	2.15
Chicago_24hr	16:40	2.134
Chicago_24hr	16:45	2.119
Chicago_24hr	16:50	2.104
Chicago_24hr	16:55	2.089
Chicago_24hr	17:00	2.074
Chicago_24hr	17:05	2.059
Chicago_24hr	17:10	2.045
Chicago_24hr	17:15	2.031
Chicago_24hr	17:20	2.017
Chicago_24hr	17:25	2.004
Chicago_24hr	17:30	1.99
Chicago_24hr	17:35	1.977
Chicago_24hr	17:40	1.964
Chicago_24hr	17:45	1.951
Chicago_24hr	17:50	1.939
Chicago_24hr	17:55	1.926
Chicago_24hr	18:00	1.914
Chicago_24hr	18:05	1.902

Chicago_24hr	18:10	1.89
Chicago_24hr	18:15	1.879
Chicago_24hr	18:20	1.867
Chicago_24hr	18:25	1.856
Chicago_24hr	18:30	1.845
Chicago_24hr	18:35	1.834
Chicago_24hr	18:40	1.823
Chicago_24hr	18:45	1.812
Chicago_24hr	18:50	1.802
Chicago_24hr	18:55	1.791
Chicago_24hr	19:00	1.781
Chicago_24hr	19:05	1.771
Chicago_24hr	19:10	1.761
Chicago_24hr	19:15	1.751
Chicago_24hr	19:20	1.741
Chicago_24hr	19:25	1.732
Chicago_24hr	19:30	1.722
Chicago_24hr	19:35	1.713
Chicago_24hr	19:40	1.704
Chicago_24hr	19:45	1.695
Chicago_24hr	19:50	1.686
Chicago_24hr	19:55	1.677
Chicago_24hr	20:00	1.668
Chicago_24hr	20:05	1.659
Chicago_24hr	20:10	1.651
Chicago_24hr	20:15	1.642
Chicago_24hr	20:20	1.634
Chicago_24hr	20:25	1.626
Chicago_24hr	20:30	1.617
Chicago_24hr	20:35	1.609
Chicago_24hr	20:40	1.601
Chicago_24hr	20:45	1.593
Chicago_24hr	20:50	1.586
Chicago_24hr	20:55	1.578
Chicago_24hr	21:00	1.57
Chicago_24hr	21:05	1.563
Chicago_24hr	21:10	1.555
Chicago_24hr	21:15	1.548
Chicago_24hr	21:20	1.541
Chicago_24hr	21:25	1.534
Chicago_24hr	21:30	1.526
Chicago_24hr	21:35	1.519
Chicago_24hr	21:40	1.512
Chicago_24hr	21:45	1.506
Chicago_24hr	21:50	1.499
Chicago_24hr	21:55	1.492

```
Chicago_24hr                22:00      1.485
Chicago_24hr                22:05      1.479
Chicago_24hr                22:10      1.472
Chicago_24hr                22:15      1.466
Chicago_24hr                22:20      1.459
Chicago_24hr                22:25      1.453
Chicago_24hr                22:30      1.447
Chicago_24hr                22:35      1.441
Chicago_24hr                22:40      1.434
Chicago_24hr                22:45      1.428
Chicago_24hr                22:50      1.422
Chicago_24hr                22:55      1.416
Chicago_24hr                23:00      1.411
Chicago_24hr                23:05      1.405
Chicago_24hr                23:10      1.399
Chicago_24hr                23:15      1.393
Chicago_24hr                23:20      1.387
Chicago_24hr                23:25      1.382
Chicago_24hr                23:30      1.376
Chicago_24hr                23:35      1.371
Chicago_24hr                23:40      1.365
Chicago_24hr                23:45      1.36
Chicago_24hr                23:50      1.355
Chicago_24hr                23:55      1.349
Chicago_24hr                24:00      0

[REPORT]
INPUT      YES
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS       2888.37619743461 12556.5403090801 4622.7575707391  13086.4783992052
UNITS            Meters

[COORDINATES]
;;Node           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
J1               3768.092         12604.414
J2               3959.816         12834.577
OF1              4468.83          12944.111
OF2              4355.633         12611.476
```

```
[VERTICES]
;;Link           X-Coord          Y-Coord
;;-------------- ---------------- ----------------

[POLYGONS]
;;Subcatchment   X-Coord          Y-Coord
;;-------------- ---------------- ----------------
S1               2970.729         12600.74
S1               2967.212         12915.31
S1               3202.166         12920.389
S1               3310.43          12970.969
S1               3430.292         13016.078
S1               3565.642         13031.53
S1               3957.571         13035.387
S1               4121.132         13056.99
S1               4253.833         13062.39
S1               4265.405         13051.589
S1               4289.322         12974.438
S1               4311.696         12956.693
S1               4421.251         12960.55
S1               4452.883         12956.693
S1               4485.287         12932.004
S1               4495.317         12910.402
S1               4499.946         12888.028
S1               4510.747         12875.684
S1               4513.833         12859.482
S1               4538.521         12836.337
S1               4543.922         12813.963
S1               4532.349         12795.446
S1               4532.349         12770.758
S1               4525.406         12751.47
S1               4509.204         12739.897
S1               4482.972         12736.04
S1               4414.308         12689.749
S1               4347.602         12623.36
S1               2970.729         12600.74
S2               4347.602         12623.36
S2               4347.763         12603.288
S2               2970.83          12580.628
S2               2971.258         12601.149
S2               4347.602         12623.36

[SYMBOLS]
;;Gage           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
```

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)
--------------------------------------------------------------


*************
Element Count
*************
Number of rain gages ...... 1
Number of subcatchments ... 2
Number of nodes ........... 4
Number of links ........... 2
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                    Data       Recording
Name                 Data Source                    Type       Interval 
------------------------------------------------------------------------
Lethbridge_100yr_24hr Chicago_24hr                   INTENSITY    5 min.


********************
Subcatchment Summary
********************
Name                       Area     Width   %Imperv    %Slope Rain Gage            Outlet
-----------------------------------------------------------------------------------------------------------
S1                        58.34    345.63      2.00    4.7000 Lethbridge_100yr_24hr J2
S2                         2.79     20.25     15.00    1.3000 Lethbridge_100yr_24hr J1


************
Node Summary
************
                                         Invert      Max.    Ponded    External
Name                 Type                 Elev.     Depth      Area    Inflow  
-------------------------------------------------------------------------------
J1                   JUNCTION            914.00      2.00       0.0
J2                   JUNCTION            870.00      5.00       0.0
OF1                  OUTFALL             840.00      2.00       0.0
OF2                  OUTFALL             900.00      1.00       0.0
```

```
************
Link Summary
************
Name             From Node        To Node          Type            Length    %Slope Roughness
---------------------------------------------------------------------------------------------
C1               J2               OF1              CONDUIT          520.7    5.7708    0.0130
C2               J1               OF2              CONDUIT          587.6    2.3831    0.0100


*********************
Cross Section Summary
*********************
                                      Full     Full     Hyd.     Max.   No. of     Full
Conduit          Shape               Depth     Area     Rad.    Width  Barrels     Flow
---------------------------------------------------------------------------------------
C1               TRIANGULAR           2.00     1.00     0.24     1.00        1     7.19
C2               TRIANGULAR           1.00     3.00     0.47     6.00        1    28.17



*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... DYNWAVE
Starting Date ............ JUN-30-2017 00:00:00
Ending Date .............. JUL-01-2017 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
```

```
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         7.345       120.145
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         3.841        62.834
Surface Runoff ...........         3.120        51.037
Final Storage ............         0.388         6.350
Continuity Error (%) .....        -0.063


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         3.120        31.200
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         3.120        31.197
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.001         0.007
Continuity Error (%) .....        -0.013


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.
```

```
*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     4.50 sec
Average Time Step           :     5.00 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00


***************************
Subcatchment Runoff Summary
***************************

--------------------------------------------------------------------------------------------------------
                          Total      Total      Total      Total      Total       Total     Peak  Runoff
                         Precip      Runon       Evap      Infil     Runoff      Runoff   Runoff   Coeff
Subcatchment                 mm         mm         mm         mm         mm    10^6 ltr      CMS
--------------------------------------------------------------------------------------------------------
S1                       120.15       0.00       0.00      63.21      50.69       29.58     2.16   0.422
S2                       120.15       0.00       0.00      54.99      58.19        1.63     0.26   0.484


******************
Node Depth Summary
******************

---------------------------------------------------------------------------------
                               Average  Maximum  Maximum  Time of Max    Reported
                                 Depth    Depth      HGL   Occurrence   Max Depth
Node                 Type       Meters   Meters   Meters  days hr:min      Meters
---------------------------------------------------------------------------------
J1                   JUNCTION     0.05     0.17   914.17     0  08:26        0.05
J2                   JUNCTION     0.46     1.27   871.27     0  08:50        0.39
OF1                  OUTFALL      0.46     1.27   841.27     0  08:50        0.39
OF2                  OUTFALL      0.05     0.17   900.17     0  08:27        0.05


*******************
Node Inflow Summary
*******************

-------------------------------------------------------------------------------------------------
                                Maximum  Maximum                  Lateral       Total        Flow
```

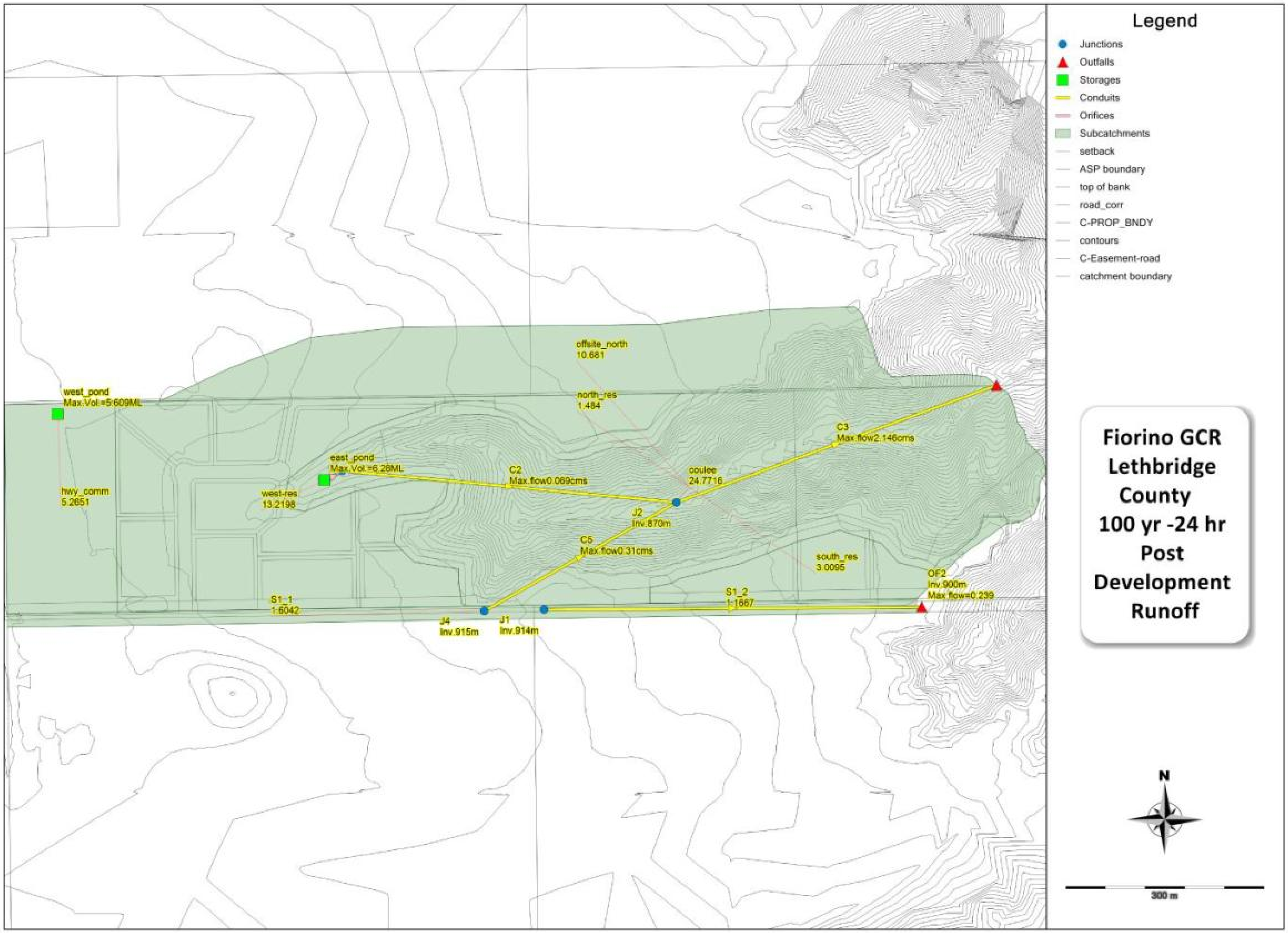
```
                                Lateral    Total  Time of Max      Inflow      Inflow     Balance
                                 Inflow   Inflow   Occurrence      Volume      Volume       Error
Node                 Type           CMS      CMS  days hr:min    10^6 ltr    10^6 ltr     Percent
-------------------------------------------------------------------------------------------------
J1                   JUNCTION     0.264    0.264     0  08:25        1.63        1.63       0.054
J2                   JUNCTION     2.159    2.159     0  08:50        29.6        29.6       0.007
OF1                  OUTFALL      0.000    2.158     0  08:50           0        29.6       0.000
OF2                  OUTFALL      0.000    0.239     0  08:27           0        1.62       0.000


**********************
Node Surcharge Summary
**********************

No nodes were surcharged.


*********************
Node Flooding Summary
*********************

No nodes were flooded.


***********************
Outfall Loading Summary
***********************

-----------------------------------------------------------
                       Flow       Avg       Max       Total
                       Freq      Flow      Flow      Volume
Outfall Node           Pcnt       CMS       CMS    10^6 ltr
-----------------------------------------------------------
OF1                   98.75     0.347     2.158      29.573
OF2                   97.23     0.019     0.239       1.625
-----------------------------------------------------------
System                97.99     0.366     2.331      31.197


********************
Link Flow Summary
********************

-----------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
```

```
Link                 Type          CMS  days hr:min     m/sec    Flow   Depth
-----------------------------------------------------------------------------
C1                   CONDUIT     2.158     0  08:50      5.32    0.30    0.64
C2                   CONDUIT     0.239     0  08:27      2.85    0.01    0.17


***************************
Flow Classification Summary
***************************

-------------------------------------------------------------------------------------
                    Adjusted    ---------- Fraction of Time in Flow Class ----------
                     /Actual         Up    Down  Sub   Sup   Up    Down  Norm  Inlet
Conduit               Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
-------------------------------------------------------------------------------------
C1                      1.00   0.01  0.00  0.00  0.00  0.99  0.00  0.00  0.00  0.00
C2                      1.00   0.02  0.00  0.00  0.01  0.97  0.00  0.00  0.55  0.00


*************************
Conduit Surcharge Summary
*************************

No conduits were surcharged.


Analysis begun on:  Tue Nov 21 16:27:50 2017
Analysis ended on:  Tue Nov 21 16:27:50 2017
Total elapsed time: < 1 sec
```

Post-Development

Runoff Analysis

EPA SWMM 5.1



Fiorino GCR
Lethbridge
County
100 yr -24 hr
Post
Development
Runoff

```
[TITLE]

[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           CMS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         DYNWAVE
START_DATE           06/30/2017
START_TIME           00:00:00
REPORT_START_DATE    06/30/2017
REPORT_START_TIME    00:00:00
END_DATE             07/01/2017
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:01:00
WET_STEP             00:05:00
DRY_STEP             00:05:00
ROUTING_STEP         5
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              2

[EVAPORATION]
;;Type          Parameters
;;------------- ----------
CONSTANT     0.0
DRY_ONLY     NO

[RAINGAGES]
;;                    Rain      Time   Snow   Data
```

```
;;Name                Type      Intrvl Catch  Source
;;------------------- --------- ------ ------ ----------
Lethbridge_100yr_24hr INTENSITY 0:05   1.0    TIMESERIES Chicago_24hr

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
coulee           Lethbridge_100yr_24hr J2          24.7716  0        202.217  6.2      0
hwy_comm         Lethbridge_100yr_24hr west_pond   5.2651   80       156.234  1        0
north_res        Lethbridge_100yr_24hr coulee      1.484    15       218.235  1.2      0
offsite_north    Lethbridge_100yr_24hr coulee      10.681   2        971      1        0
S1_1             Lethbridge_100yr_24hr J4          1.6042   40       21.975   1.3      0
S1_2             Lethbridge_100yr_24hr J1          1.1667   40       17.544   1.3      0
south_res        Lethbridge_100yr_24hr coulee      3.0095   15       76.19    1.5      0
west-res         Lethbridge_100yr_24hr east_pond   13.2198  15       295.745  1.3      0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
coulee           0.015      0.15       3.4        5          0          OUTLET
hwy_comm         0.015      0.15       0.77       3.8        0          OUTLET
north_res        0.015      0.15       0.7        3.8        0          OUTLET
offsite_north    0.015      0.15       3.4        5          0          OUTLET
S1_1             0.015      0.15       0.67       3.8        0          OUTLET
S1_2             0.015      0.15       0.67       3.8        0          OUTLET
south_res        0.015      0.15       0.63       3.8        0          OUTLET
west-res         0.015      0.15       0.68       3.8        0          OUTLET

[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
;;-------------- ---------- ---------- ----------
coulee           292.2      1          0.229
hwy_comm         292.2      1          0.229
north_res        292.2      1          0.229
offsite_north    292.2      1          0.229
S1_1             292.2      1          0.229
S1_2             292.2      1          0.229
south_res        292.2      1          0.229
west-res         292.2      1          0.229

[JUNCTIONS]
;;               Invert     Max.       Init.      Surcharge  Ponded
;;Name           Elev.      Depth      Depth      Depth      Area
;;-------------- ---------- ---------- ---------- ---------- ----------
J1               914        2          0          0          0
```

```
J2               870        5          0          0          0
J3               910        5          0          0          0
J4               915        1          0          0          0

[OUTFALLS]
;;               Invert     Outfall      Stage/Table      Tide
;;Name           Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
OF1              840        FREE                          NO
OF2              900        FREE                          NO

[STORAGE]
;;               Invert   Max.     Init.    Storage    Curve                      Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params                     Area     Frac.    Infiltration parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -------- -----------------------
east_pond        910      5        0        TABULAR    PUL                        0        0
west_pond        917      3        0        TABULAR    Hwy-Comm_pond              0        0

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet      Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset     Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
C1               J1               OF2              572.07     0.01       0          0          0          0
C2               J3               J2               508.17     0.06       0          0          0          0
C3               J2               OF1              515.8      0.06       0          0          0          0
C5               J4               J2               333.48     0.06       0          0          0          0

[ORIFICES]
;;               Inlet            Outlet           Orifice      Crest      Disch.     Flap Open/Close
;;Name           Node             Node             Type         Height     Coeff.     Gate Time
;;-------------- ---------------- ---------------- ------------ ---------- ---------- ---- ----------
C4               east_pond        J3               SIDE         0          0.65       NO   0

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
C1               TRIANGULAR   1                6          0          0          1
C2               TRIANGULAR   2                6          0          0          1
C3               TRIANGULAR   2                6          0          0          1
C5               TRIANGULAR   2                6          0          0          1
C4               CIRCULAR     0.15             0          0          0

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------
```

```
[CURVES]
;;Name           Type       X-Value    Y-Value   
;;-------------- ---------- ---------- ----------
Hwy-Comm_pond    Storage    0          2500      
Hwy-Comm_pond               2          5000      

PUL              Storage    0          2000      
PUL                         2          4000      

[TIMESERIES]
;;Name           Date       Time       Value     
;;-------------- ---------- ---------- ----------
;Chicago design storm, a = 1019.2, b = 0, c = 0.731, Duration = 1440 minutes, r = 0.35, rain units = mm/hr.
Chicago_24hr                0:00       1.352     
Chicago_24hr                0:05       1.361     
Chicago_24hr                0:10       1.372     
Chicago_24hr                0:15       1.382     
Chicago_24hr                0:20       1.392     
Chicago_24hr                0:25       1.403     
Chicago_24hr                0:30       1.414     
Chicago_24hr                0:35       1.425     
Chicago_24hr                0:40       1.436     
Chicago_24hr                0:45       1.448     
Chicago_24hr                0:50       1.459     
Chicago_24hr                0:55       1.471     
Chicago_24hr                1:00       1.483     
Chicago_24hr                1:05       1.496     
Chicago_24hr                1:10       1.509     
Chicago_24hr                1:15       1.521     
Chicago_24hr                1:20       1.535     
Chicago_24hr                1:25       1.548     
Chicago_24hr                1:30       1.562     
Chicago_24hr                1:35       1.576     
Chicago_24hr                1:40       1.59      
Chicago_24hr                1:45       1.605     
Chicago_24hr                1:50       1.62      
Chicago_24hr                1:55       1.635     
Chicago_24hr                2:00       1.651     
Chicago_24hr                2:05       1.667     
Chicago_24hr                2:10       1.683     
Chicago_24hr                2:15       1.7       
Chicago_24hr                2:20       1.717     
Chicago_24hr                2:25       1.735     
Chicago_24hr                2:30       1.753     
Chicago_24hr                2:35       1.771     
Chicago_24hr                2:40       1.79      
```

Chicago_24hr	2:45	1.809
Chicago_24hr	2:50	1.829
Chicago_24hr	2:55	1.85
Chicago_24hr	3:00	1.871
Chicago_24hr	3:05	1.892
Chicago_24hr	3:10	1.914
Chicago_24hr	3:15	1.937
Chicago_24hr	3:20	1.961
Chicago_24hr	3:25	1.985
Chicago_24hr	3:30	2.009
Chicago_24hr	3:35	2.035
Chicago_24hr	3:40	2.061
Chicago_24hr	3:45	2.089
Chicago_24hr	3:50	2.117
Chicago_24hr	3:55	2.146
Chicago_24hr	4:00	2.176
Chicago_24hr	4:05	2.206
Chicago_24hr	4:10	2.238
Chicago_24hr	4:15	2.272
Chicago_24hr	4:20	2.306
Chicago_24hr	4:25	2.341
Chicago_24hr	4:30	2.378
Chicago_24hr	4:35	2.416
Chicago_24hr	4:40	2.456
Chicago_24hr	4:45	2.498
Chicago_24hr	4:50	2.541
Chicago_24hr	4:55	2.585
Chicago_24hr	5:00	2.632
Chicago_24hr	5:05	2.681
Chicago_24hr	5:10	2.732
Chicago_24hr	5:15	2.785
Chicago_24hr	5:20	2.841
Chicago_24hr	5:25	2.9
Chicago_24hr	5:30	2.961
Chicago_24hr	5:35	3.026
Chicago_24hr	5:40	3.094
Chicago_24hr	5:45	3.166
Chicago_24hr	5:50	3.242
Chicago_24hr	5:55	3.323
Chicago_24hr	6:00	3.408
Chicago_24hr	6:05	3.499
Chicago_24hr	6:10	3.596
Chicago_24hr	6:15	3.699
Chicago_24hr	6:20	3.81
Chicago_24hr	6:25	3.929
Chicago_24hr	6:30	4.057

Chicago_24hr	6:35	4.195
Chicago_24hr	6:40	4.346
Chicago_24hr	6:45	4.509
Chicago_24hr	6:50	4.688
Chicago_24hr	6:55	4.885
Chicago_24hr	7:00	5.102
Chicago_24hr	7:05	5.344
Chicago_24hr	7:10	5.615
Chicago_24hr	7:15	5.921
Chicago_24hr	7:20	6.269
Chicago_24hr	7:25	6.67
Chicago_24hr	7:30	7.139
Chicago_24hr	7:35	7.693
Chicago_24hr	7:40	8.361
Chicago_24hr	7:45	9.186
Chicago_24hr	7:50	10.234
Chicago_24hr	7:55	11.619
Chicago_24hr	8:00	13.551
Chicago_24hr	8:05	16.477
Chicago_24hr	8:10	21.566
Chicago_24hr	8:15	33.491
Chicago_24hr	8:20	286.165
Chicago_24hr	8:25	92.134
Chicago_24hr	8:30	42.664
Chicago_24hr	8:35	30.072
Chicago_24hr	8:40	23.803
Chicago_24hr	8:45	19.955
Chicago_24hr	8:50	17.317
Chicago_24hr	8:55	15.38
Chicago_24hr	9:00	13.889
Chicago_24hr	9:05	12.7
Chicago_24hr	9:10	11.728
Chicago_24hr	9:15	10.915
Chicago_24hr	9:20	10.224
Chicago_24hr	9:25	9.629
Chicago_24hr	9:30	9.109
Chicago_24hr	9:35	8.652
Chicago_24hr	9:40	8.245
Chicago_24hr	9:45	7.881
Chicago_24hr	9:50	7.553
Chicago_24hr	9:55	7.255
Chicago_24hr	10:00	6.984
Chicago_24hr	10:05	6.736
Chicago_24hr	10:10	6.507
Chicago_24hr	10:15	6.296
Chicago_24hr	10:20	6.101

Chicago_24hr	10:25	5.919
Chicago_24hr	10:30	5.75
Chicago_24hr	10:35	5.592
Chicago_24hr	10:40	5.444
Chicago_24hr	10:45	5.304
Chicago_24hr	10:50	5.173
Chicago_24hr	10:55	5.049
Chicago_24hr	11:00	4.932
Chicago_24hr	11:05	4.822
Chicago_24hr	11:10	4.717
Chicago_24hr	11:15	4.617
Chicago_24hr	11:20	4.522
Chicago_24hr	11:25	4.431
Chicago_24hr	11:30	4.345
Chicago_24hr	11:35	4.263
Chicago_24hr	11:40	4.184
Chicago_24hr	11:45	4.109
Chicago_24hr	11:50	4.036
Chicago_24hr	11:55	3.967
Chicago_24hr	12:00	3.901
Chicago_24hr	12:05	3.837
Chicago_24hr	12:10	3.775
Chicago_24hr	12:15	3.716
Chicago_24hr	12:20	3.659
Chicago_24hr	12:25	3.604
Chicago_24hr	12:30	3.55
Chicago_24hr	12:35	3.499
Chicago_24hr	12:40	3.449
Chicago_24hr	12:45	3.401
Chicago_24hr	12:50	3.355
Chicago_24hr	12:55	3.31
Chicago_24hr	13:00	3.267
Chicago_24hr	13:05	3.224
Chicago_24hr	13:10	3.183
Chicago_24hr	13:15	3.144
Chicago_24hr	13:20	3.105
Chicago_24hr	13:25	3.068
Chicago_24hr	13:30	3.031
Chicago_24hr	13:35	2.996
Chicago_24hr	13:40	2.961
Chicago_24hr	13:45	2.928
Chicago_24hr	13:50	2.895
Chicago_24hr	13:55	2.863
Chicago_24hr	14:00	2.832
Chicago_24hr	14:05	2.802
Chicago_24hr	14:10	2.773

Chicago_24hr	14:15	2.744
Chicago_24hr	14:20	2.716
Chicago_24hr	14:25	2.689
Chicago_24hr	14:30	2.662
Chicago_24hr	14:35	2.636
Chicago_24hr	14:40	2.61
Chicago_24hr	14:45	2.585
Chicago_24hr	14:50	2.561
Chicago_24hr	14:55	2.537
Chicago_24hr	15:00	2.514
Chicago_24hr	15:05	2.491
Chicago_24hr	15:10	2.469
Chicago_24hr	15:15	2.447
Chicago_24hr	15:20	2.425
Chicago_24hr	15:25	2.404
Chicago_24hr	15:30	2.384
Chicago_24hr	15:35	2.364
Chicago_24hr	15:40	2.344
Chicago_24hr	15:45	2.325
Chicago_24hr	15:50	2.306
Chicago_24hr	15:55	2.287
Chicago_24hr	16:00	2.269
Chicago_24hr	16:05	2.251
Chicago_24hr	16:10	2.233
Chicago_24hr	16:15	2.216
Chicago_24hr	16:20	2.199
Chicago_24hr	16:25	2.183
Chicago_24hr	16:30	2.166
Chicago_24hr	16:35	2.15
Chicago_24hr	16:40	2.134
Chicago_24hr	16:45	2.119
Chicago_24hr	16:50	2.104
Chicago_24hr	16:55	2.089
Chicago_24hr	17:00	2.074
Chicago_24hr	17:05	2.059
Chicago_24hr	17:10	2.045
Chicago_24hr	17:15	2.031
Chicago_24hr	17:20	2.017
Chicago_24hr	17:25	2.004
Chicago_24hr	17:30	1.99
Chicago_24hr	17:35	1.977
Chicago_24hr	17:40	1.964
Chicago_24hr	17:45	1.951
Chicago_24hr	17:50	1.939
Chicago_24hr	17:55	1.926
Chicago_24hr	18:00	1.914

Chicago_24hr	18:05	1.902
Chicago_24hr	18:10	1.89
Chicago_24hr	18:15	1.879
Chicago_24hr	18:20	1.867
Chicago_24hr	18:25	1.856
Chicago_24hr	18:30	1.845
Chicago_24hr	18:35	1.834
Chicago_24hr	18:40	1.823
Chicago_24hr	18:45	1.812
Chicago_24hr	18:50	1.802
Chicago_24hr	18:55	1.791
Chicago_24hr	19:00	1.781
Chicago_24hr	19:05	1.771
Chicago_24hr	19:10	1.761
Chicago_24hr	19:15	1.751
Chicago_24hr	19:20	1.741
Chicago_24hr	19:25	1.732
Chicago_24hr	19:30	1.722
Chicago_24hr	19:35	1.713
Chicago_24hr	19:40	1.704
Chicago_24hr	19:45	1.695
Chicago_24hr	19:50	1.686
Chicago_24hr	19:55	1.677
Chicago_24hr	20:00	1.668
Chicago_24hr	20:05	1.659
Chicago_24hr	20:10	1.651
Chicago_24hr	20:15	1.642
Chicago_24hr	20:20	1.634
Chicago_24hr	20:25	1.626
Chicago_24hr	20:30	1.617
Chicago_24hr	20:35	1.609
Chicago_24hr	20:40	1.601
Chicago_24hr	20:45	1.593
Chicago_24hr	20:50	1.586
Chicago_24hr	20:55	1.578
Chicago_24hr	21:00	1.57
Chicago_24hr	21:05	1.563
Chicago_24hr	21:10	1.555
Chicago_24hr	21:15	1.548
Chicago_24hr	21:20	1.541
Chicago_24hr	21:25	1.534
Chicago_24hr	21:30	1.526
Chicago_24hr	21:35	1.519
Chicago_24hr	21:40	1.512
Chicago_24hr	21:45	1.506
Chicago_24hr	21:50	1.499

```
Chicago_24hr                21:55      1.492
Chicago_24hr                22:00      1.485
Chicago_24hr                22:05      1.479
Chicago_24hr                22:10      1.472
Chicago_24hr                22:15      1.466
Chicago_24hr                22:20      1.459
Chicago_24hr                22:25      1.453
Chicago_24hr                22:30      1.447
Chicago_24hr                22:35      1.441
Chicago_24hr                22:40      1.434
Chicago_24hr                22:45      1.428
Chicago_24hr                22:50      1.422
Chicago_24hr                22:55      1.416
Chicago_24hr                23:00      1.411
Chicago_24hr                23:05      1.405
Chicago_24hr                23:10      1.399
Chicago_24hr                23:15      1.393
Chicago_24hr                23:20      1.387
Chicago_24hr                23:25      1.382
Chicago_24hr                23:30      1.376
Chicago_24hr                23:35      1.371
Chicago_24hr                23:40      1.365
Chicago_24hr                23:45      1.36
Chicago_24hr                23:50      1.355
Chicago_24hr                23:55      1.349
Chicago_24hr                24:00      0

[REPORT]
INPUT      YES
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS       2888.37619743461 12556.5643474725 4622.7575707391  13086.4772545198
UNITS            Meters

[COORDINATES]
;;Node           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
J1               3783.507         12607.12
J2               3984.012         12768.191
J3               3478.129         12815.813
```

```
J4               3693.168         12605.114
OF1              4468.83          12944.111
OF2              4355.507         12611.032
east_pond        3451.045         12801.628
west_pond        3047.508         12900.208

[VERTICES]
;;Link           X-Coord          Y-Coord
;;-------------- ---------------- ----------------

[POLYGONS]
;;Subcatchment   X-Coord          Y-Coord
;;-------------- ---------------- ----------------
coulee           3989.377         12931.778
coulee           4470.036         12943.624
coulee           4485.287         12932.004
coulee           4495.317         12910.402
coulee           4499.946         12888.028
coulee           4510.747         12875.684
coulee           4513.833         12859.482
coulee           4538.521         12836.337
coulee           4543.922         12813.963
coulee           4532.349         12795.446
coulee           4532.349         12770.758
coulee           4525.406         12751.47
coulee           4509.204         12739.897
coulee           4484.19          12736.219
coulee           4484.531         12742.524
coulee           4476.617         12746.335
coulee           4449.65          12746.335
coulee           4440.27          12720.54
coulee           4403.924         12690.056
coulee           4382.526         12681.556
coulee           4371.388         12664.555
coulee           4320.093         12677.745
coulee           4294.298         12707.057
coulee           4230.985         12726.696
coulee           4166.793         12709.109
coulee           4080.323         12676.28
coulee           3988.285         12654.296
coulee           3976.853         12646.675
coulee           3943.493         12640.27
coulee           3943.557         12616.699
coulee           3664.239         12612.111
coulee           3658.924         12617.528
coulee           3653.545         12654.622
```

coulee	3654.472	12668.161
coulee	3586.591	12678.733
coulee	3555.804	12708.778
coulee	3560.626	12749.21
coulee	3584.874	12751.747
coulee	3606.622	12754.032
coulee	3627.394	12765.717
coulee	3633.885	12774.99
coulee	3638.469	12798.891
coulee	3584.874	12801.62
coulee	3493.565	12784.003
coulee	3421.113	12754.725
coulee	3387.254	12761.539
coulee	3396.881	12802.866
coulee	3408.636	12812.557
coulee	3417.114	12819.445
coulee	3425.759	12826.378
coulee	3472.231	12856.253
coulee	3523.35	12882.144
coulee	3578.452	12901.176
coulee	3599.696	12906.044
coulee	3631.784	12917.994
coulee	3708.015	12909.524
coulee	3747.225	12894.157
coulee	3810.28	12858.126
coulee	3883.933	12874.022
coulee	3940.099	12877.731
coulee	3960.234	12899.456
coulee	3973.481	12912.173
coulee	3989.377	12931.778
coulee	3943.493	12640.27
coulee	3943.493	12640.27
hwy_comm	3134.451	12918.925
hwy_comm	3137.635	12603.477
hwy_comm	2970.729	12600.74
hwy_comm	2967.212	12915.31
hwy_comm	3134.451	12918.925
north_res	3633.485	12917.805
north_res	3632.727	12928.673
north_res	3989.377	12931.778
north_res	3973.481	12912.173
north_res	3960.234	12899.456
north_res	3940.099	12877.731
north_res	3883.933	12874.022
north_res	3810.28	12858.126
north_res	3747.225	12894.157

north_res	3708.015	12909.524
north_res	3633.485	12917.805
offsite_north	4470.036	12943.624
offsite_north	3989.377	12931.778
offsite_north	3989.377	12931.778
offsite_north	3202.166	12920.389
offsite_north	3310.43	12970.969
offsite_north	3430.292	13016.078
offsite_north	3565.642	13031.53
offsite_north	3957.571	13035.387
offsite_north	4121.132	13056.99
offsite_north	4253.833	13062.39
offsite_north	4265.405	13051.589
offsite_north	4289.322	12974.438
offsite_north	4311.696	12956.693
offsite_north	4421.251	12960.55
offsite_north	4452.883	12956.693
offsite_north	4470.036	12943.624
S1_1	3768.351	12613.822
S1_1	3768.72	12593.707
S1_1	2970.963	12580.651
S1_1	2970.729	12600.74
S1_1	3768.351	12613.822
S1_2	3768.72	12593.707
S1_2	3768.351	12613.822
S1_2	4347.783	12623.325
S1_2	4348.183	12603.19
S1_2	3768.72	12593.707
south_res	4484.531	12742.524
south_res	4484.19	12736.219
south_res	4482.972	12736.04
south_res	4414.986	12688.722
south_res	4348.244	12623.7
south_res	3943.557	12616.699
south_res	3943.493	12640.27
south_res	3976.853	12646.675
south_res	3988.285	12654.296
south_res	4080.323	12676.28
south_res	4166.793	12709.109
south_res	4230.985	12726.696
south_res	4294.298	12707.057
south_res	4320.093	12677.745
south_res	4371.388	12664.555
south_res	4382.526	12681.556
south_res	4403.924	12690.056
south_res	4440.27	12720.54

```
south_res        4449.65          12746.335
south_res        4476.617         12746.335
south_res        4484.531         12742.524
west-res         3632.727         12928.673
west-res         3633.485         12917.805
west-res         3631.784         12917.994
west-res         3599.696         12906.044
west-res         3578.452         12901.176
west-res         3523.35          12882.144
west-res         3472.231         12856.253
west-res         3425.759         12826.378
west-res         3417.114         12819.445
west-res         3408.636         12812.557
west-res         3396.881         12802.866
west-res         3387.254         12761.539
west-res         3421.113         12754.725
west-res         3493.565         12784.003
west-res         3584.874         12801.62
west-res         3638.469         12798.891
west-res         3633.885         12774.99
west-res         3627.394         12765.717
west-res         3606.622         12754.032
west-res         3584.874         12751.747
west-res         3560.626         12749.21
west-res         3555.804         12708.778
west-res         3586.591         12678.733
west-res         3654.472         12668.161
west-res         3653.545         12654.622
west-res         3658.924         12617.528
west-res         3664.239         12612.111
west-res         3137.635         12603.477
west-res         3134.451         12918.925
west-res         3202.166         12920.389
west-res         3632.727         12928.673

[SYMBOLS]
;;Gage           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
```

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)
--------------------------------------------------------------

WARNING 02: maximum depth increased for Node J4

*************
Element Count
*************
Number of rain gages ...... 1
Number of subcatchments ... 8
Number of nodes ........... 8
Number of links ........... 5
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                    Data       Recording
Name                 Data Source                    Type       Interval
------------------------------------------------------------------------
Lethbridge_100yr_24hr Chicago_24hr                   INTENSITY    5 min.


********************
Subcatchment Summary
********************
Name                       Area     Width   %Imperv    %Slope Rain Gage            Outlet
-----------------------------------------------------------------------------------------------------------
coulee                    24.77    202.22      0.00    6.2000 Lethbridge_100yr_24hr J2
hwy_comm                   5.27    156.23     80.00    1.0000 Lethbridge_100yr_24hr west_pond
north_res                  1.48    218.24     15.00    1.2000 Lethbridge_100yr_24hr coulee
offsite_north             10.68    971.00      2.00    1.0000 Lethbridge_100yr_24hr coulee
S1_1                       1.60     21.98     40.00    1.3000 Lethbridge_100yr_24hr J4
S1_2                       1.17     17.54     40.00    1.3000 Lethbridge_100yr_24hr J1
south_res                  3.01     76.19     15.00    1.5000 Lethbridge_100yr_24hr coulee
west-res                  13.22    295.75     15.00    1.3000 Lethbridge_100yr_24hr east_pond


************
Node Summary
************
                                         Invert      Max.    Ponded    External
Name                 Type                 Elev.     Depth      Area    Inflow
```

```
-------------------------------------------------------------------------------
J1                   JUNCTION            914.00      2.00       0.0
J2                   JUNCTION            870.00      5.00       0.0
J3                   JUNCTION            910.00      5.00       0.0
J4                   JUNCTION            915.00      2.00       0.0
OF1                  OUTFALL             840.00      2.00       0.0
OF2                  OUTFALL             900.00      1.00       0.0
east_pond            STORAGE             910.00      5.00       0.0
west_pond            STORAGE             917.00      3.00       0.0


************
Link Summary
************
Name             From Node        To Node          Type            Length    %Slope Roughness
---------------------------------------------------------------------------------------------
C1               J1               OF2              CONDUIT          572.1    2.4480    0.0100
C2               J3               J2               CONDUIT          508.2    7.8959    0.0600
C3               J2               OF1              CONDUIT          515.8    5.8261    0.0600
C5               J4               J2               CONDUIT          333.5   13.6186    0.0600
C4               east_pond        J3               ORIFICE


*********************
Cross Section Summary
*********************
                                      Full     Full     Hyd.     Max.   No. of     Full
Conduit          Shape               Depth     Area     Rad.    Width  Barrels     Flow
---------------------------------------------------------------------------------------
C1               TRIANGULAR           1.00     3.00     0.47     6.00        1    28.55
C2               TRIANGULAR           2.00     6.00     0.83     6.00        1    24.86
C3               TRIANGULAR           2.00     6.00     0.83     6.00        1    21.36
C5               TRIANGULAR           2.00     6.00     0.83     6.00        1    32.65


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
```

```
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... DYNWAVE
Starting Date ............ JUN-30-2017 00:00:00
Ending Date .............. JUL-01-2017 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         7.353       120.145
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         3.407        55.668
Surface Runoff ...........         3.759        61.424
Final Storage ............         0.205         3.346
Continuity Error (%) .....        -0.243


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         3.759        37.588
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         2.719        27.189
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
```

```
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         1.042        10.419
Continuity Error (%) .....        -0.052


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     4.50 sec
Average Time Step           :     5.00 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00


***************************
Subcatchment Runoff Summary
***************************

--------------------------------------------------------------------------------------------------------
                          Total      Total      Total      Total      Total       Total     Peak  Runoff
                         Precip      Runon       Evap      Infil     Runoff      Runoff   Runoff   Coeff
Subcatchment                 mm         mm         mm         mm         mm    10^6 ltr      CMS
--------------------------------------------------------------------------------------------------------
coulee                   120.15      36.12       0.00      64.72      86.05       21.32     2.00   0.551
hwy_comm                 120.15       0.00       0.00      12.72     106.59        5.61     2.14   0.887
north_res                120.15       0.00       0.00      54.01      66.59        0.99     0.50   0.554
offsite_north            120.15       0.00       0.00      62.48      56.39        6.02     1.73   0.469
S1_1                     120.15       0.00       0.00      38.44      79.78        1.28     0.34   0.664
S1_2                     120.15       0.00       0.00      38.42      80.01        0.93     0.26   0.666
south_res                120.15       0.00       0.00      54.34      64.40        1.94     0.50   0.536
west-res                 120.15       0.00       0.00      54.41      63.92        8.45     2.02   0.532
```

```
******************
Node Depth Summary
******************

  ---------------------------------------------------------------------------------
                                 Average  Maximum  Maximum  Time of Max    Reported
                                   Depth    Depth      HGL   Occurrence   Max Depth
  Node                 Type       Meters   Meters   Meters  days hr:min      Meters
  ---------------------------------------------------------------------------------
  J1                   JUNCTION     0.04     0.17   914.17     0  08:27        0.05
  J2                   JUNCTION     0.30     0.85   870.85     0  09:00        0.26
  J3                   JUNCTION     0.16     0.22   910.22     0  14:05        0.07
  J4                   JUNCTION     0.09     0.35   915.35     0  08:27        0.11
  OF1                  OUTFALL      0.28     0.84   840.84     0  09:00        0.26
  OF2                  OUTFALL      0.04     0.17   900.17     0  08:27        0.05
  east_pond            STORAGE      1.23     2.07   912.07     0  14:01        0.63
  west_pond            STORAGE      0.96     1.60   918.60     1  00:00        0.49


*******************
Node Inflow Summary
*******************

  -------------------------------------------------------------------------------------------------
                                  Maximum  Maximum                  Lateral       Total        Flow
                                  Lateral    Total  Time of Max      Inflow      Inflow     Balance
                                   Inflow   Inflow   Occurrence      Volume      Volume       Error
  Node                 Type           CMS      CMS  days hr:min    10^6 ltr    10^6 ltr     Percent
  -------------------------------------------------------------------------------------------------
  J1                   JUNCTION     0.261    0.261     0  08:25       0.933       0.933       0.068
  J2                   JUNCTION     2.002    2.156     0  08:55        21.3        26.3       0.223
  J3                   JUNCTION     0.000    0.069     0  14:01           0        3.73       0.766
  J4                   JUNCTION     0.341    0.341     0  08:25        1.28        1.28      -1.103
  OF1                  OUTFALL      0.000    2.146     0  09:00           0        26.3       0.000
  OF2                  OUTFALL      0.000    0.239     0  08:27           0       0.933       0.000
  east_pond            STORAGE      2.023    2.023     0  08:25        8.45        8.45       0.006
  west_pond            STORAGE      2.137    2.137     0  08:25        5.61        5.61     -49.997


**********************
Node Surcharge Summary
**********************

  Surcharging occurs when water rises above the top of the highest conduit.
  ---------------------------------------------------------------------
```

```
                                             Max. Height   Min. Depth
                                 Hours       Above Crown    Below Rim
Node                 Type      Surcharged         Meters       Meters
---------------------------------------------------------------------
east_pond            STORAGE        16.24          1.919        2.931
west_pond            STORAGE        24.00          1.602        1.398


*********************
Node Flooding Summary
*********************

No nodes were flooded.


**********************
Storage Volume Summary
**********************

--------------------------------------------------------------------------------------------------
                       Average     Avg  Evap Exfil       Maximum     Max    Time of Max    Maximum
                        Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outflow
Storage Unit           1000 m3    Full  Loss  Loss       1000 m3    Full    days hr:min        CMS
--------------------------------------------------------------------------------------------------
east_pond                3.588      16     0     0         6.280      28       0  14:01      0.069
west_pond                3.230      25     0     0         5.609      43       1  00:00      0.000


***********************
Outfall Loading Summary
***********************

-----------------------------------------------------------
                       Flow       Avg       Max       Total
                       Freq      Flow      Flow      Volume
Outfall Node           Pcnt       CMS       CMS    10^6 ltr
-----------------------------------------------------------
OF1                   95.83     0.317     2.146      26.256
OF2                   97.20     0.011     0.239       0.933
-----------------------------------------------------------
System                96.51     0.328     2.220      27.188


********************
Link Flow Summary
********************
```

```
-----------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
Link                 Type          CMS  days hr:min     m/sec    Flow   Depth
-----------------------------------------------------------------------------
C1                   CONDUIT     0.239     0  08:27      2.88    0.01    0.17
C2                   CONDUIT     0.069     0  14:05      0.82    0.00    0.26
C3                   CONDUIT     2.146     0  09:00      2.01    0.10    0.42
C5                   CONDUIT     0.310     0  08:27      1.21    0.01    0.27
C4                   ORIFICE     0.069     0  14:01                      1.00


***************************
Flow Classification Summary
***************************

-------------------------------------------------------------------------------------
                    Adjusted    ---------- Fraction of Time in Flow Class ----------
                     /Actual         Up    Down  Sub   Sup   Up    Down  Norm  Inlet
Conduit               Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
-------------------------------------------------------------------------------------
C1                      1.00   0.02  0.00  0.00  0.01  0.97  0.00  0.00  0.32  0.00
C2                      1.00   0.02  0.00  0.00  0.97  0.00  0.00  0.00  0.97  0.00
C3                      1.00   0.02  0.00  0.00  0.98  0.00  0.00  0.00  0.00  0.00
C5                      1.00   0.02  0.00  0.00  0.94  0.04  0.00  0.00  0.93  0.00


*************************
Conduit Surcharge Summary
*************************

No conduits were surcharged.


Analysis begun on:  Tue Nov 21 16:25:55 2017
Analysis ended on:  Tue Nov 21 16:25:56 2017
Total elapsed time: 00:00:01
```

APPENDIX

APPENDIX 8 ~ ADJACENT LANDOWNER CONSULTATION

Martin Geomatic Consultants Ltd.
255 – 31 Street North
Lethbridge, Alberta, T1H 3Z4
(403) 329-0050

Meeting Notes

Date

March 20, 2018

Location

MGCL board room

Attending

Peter Zmurchyk
Ray Martin

Regarding

Coulee View Area Structure Plan

Discussion

Ray provided a copy of the ASP maps to Peter and provided an overview of the development proposed. Peter liked the concept and layout and has no issues or concerns from a development point of view. Peter offered concerns to future home owners living next to a farmer’s field which may include: dust, noise and odors from farming operations. Canola crop is planted and work starts early in the mornings.

End

March 21, 2018

I, Joe Fekete of Box 702, Lethbridge met with Ray Martin of Martin Geomatic Consultanting Ltd. with regards to the Area Structure Plan for Coulee View Country Residential Subdivision (Pete Fiorino) in the County of Lethbridge.

I have reviewed the concept plans and have no concerns with regards to the proposed development.

Regards, Joseph Fekete

Martin Geomatic Consultants Ltd.
255 – 31 Street North
Lethbridge, Alberta, T1H 3Z4
(403) 329-0050

Meeting Notes

Date

March 22, 2018

Location

MGCL board room

Attending

Garry Boychuk
Larry Boychuk
Ray Martin

Regarding

Coulee View Area Structure Plan

Discussion

Ray provided a copy of the ASP maps to Larry and Garry and provided an overview of the development proposed. Garry and Larry have some concerns over garbage blowing down onto their property to the east. Temporary construction fences were discussed as a means to mitigate the garbage. Permanent chain link fences and runoff was also questioned. At the conclusion of the meeting, both Garry and Larry were okay with the layout and development of the subdivision. They will fill out a form and return within a week.

End

March 22, 2018

I, Gary Boychuk on behalf of Pauline Boychuk of 221036 Twp. Road 91A, in the Lethbridge County met with Ray Martin of Martin Geomatic Consultants Ltd. with regards to the Area Structure Plan for Coulee View Country Residential Subdivision (Pete Fiorino)located in the County of Lethbridge.

I have reviewed the concept plans prepared for the ASP and have no concerns with regards to the proposed development.

Regards,

March 28/18

Questions of above proposed By Garry A. Boychuk/Pauline Boychuk

1. proper drainage for entire development through out the construction stage and final completion. This takes into account when massive rain & snow storms occur that there will not be a river coming down the valley into Mrs. Pauline Boychuks' lands. Were does the L.N.I.D. water drain into?

2. Fire control from development which may East onto Mrs. Pauline Boychuks' lands? People walk around and use matches for an array of uses. Smoking is a strong concern. Will there be a sufficient supply of water on site?

3 On the run-off concern especially with pavement the use of chemicals for weed control could run down hill. Washing of vehicles, driveways has run off water going somewhere

4. Will there be individual septic fields or one large collection site? Possible odour.

5. Scattered garbage (bags, boxes, etc) blown onto others' property.

6. The annoying of people trespassing. Will "NO TRESPASSING SIGNS" be provided, installed for adjacent land owners? Again possible garbage left behind. Fires started with matches?

From:	Raymond Martin
Sent:	Friday, April 13, 2018 3:22 PM
To:	Matt Redgrave
Cc:	Ed Martin
Subject:	FW: FW: Coulee View Area Structure Plan (ASP) drawings - Pete Fiorino

Ray Martin, P.Eng., P.E.

Ray Martin | V.P. Engineering | Martin Geomatic Consultants Ltd. | 255 -31st. Street No., Lethbridge, Alberta, T1H 3Z4 | Office: (403) 329-0050 | Fax: (403) 329-6594 | Cell: (403) 382-9985

From: Allan Chell [mailto:allan@cdemo.com]
Sent: April-13-18 1:14 PM
To: Raymond Martin
Subject: Re: FW: Coulee View Area Structure Plan (ASP) drawings - Pete Fiorino

I really don't have any feedback other than if this sub-division does get approved by the county then it does set a precedent for neighboring properties to do the same.

Regards
Allan Chell

On Fri, Apr 13, 2018 at 12:27 PM, Raymond Martin <raym@mgcl.ca> wrote:

Hi Allan,

We are finalizing our Area Structure Plan submittal today and was wondering if you have any comments or concerns?

After we submit this there will still be a public hearing to discuss any issues but it would be nice to know in advance if you have any concerns.

Thanks,

Ray Martin, P.Eng., P.E.