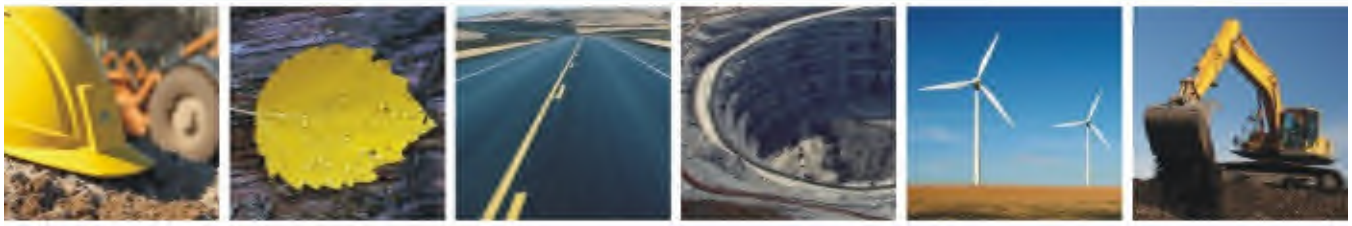
CITY OF MEDICINE HAT

CITY OF MEDICINE HAT
SLOPE SETBACK ASSESSMENT



REPORT

APRIL 2014
ISSUED FOR USE
EBA FILE: C12101372

creating & delivering | BETTER SOLUTIONS

A TETRA TECH COMPANY

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the City of Medicine Hat and their agents. EBA Engineering Consultants Ltd. operating as EBA, A Tetra Tech Company, 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 City of Medicine Hat, 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 EBA's Services Agreement. .

.

EBA Engineering Consultants Ltd. operating as EBA, A Tetra Tech Company
Riverbend Atrium One, 115, 200 Rivercrest Drive SE
Calgary, AB T2C 2X5 CANADA
p. 403.203.3355 f. 403.203.3301

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 SCOPE 1

3.0 PROJECT TEAM 2

4.0 METHODS 2

4.1 Review Existing Guidelines and Available Reports 2
4.2 Desktop Study 3
4.3 Site Reconnaissance 3
4.4 Drilling and Laboratory Program 4
4.5 Hazard and Risk Assessment 4
4.6 Analyses 5
4.7 Project Deliverables 5

5.0 BACKGROUND 5

5.1 Hardy Report 5
5.1.1 Sectors 6
5.1.2 Setback Policy 6
5.1.3 Medicine Hat Open Space Policy 8
5.2 Existing Setback Criteria 8
5.3 Development Controls in Other Jurisdictions 8
5.3.1 Calgary 8
5.3.2 Edmonton 8
5.3.3 Lethbridge 9
5.4 Sources of Information 9

6.0 STUDY AREA 11

6.1 Topography 11
6.2 Climate 11
6.3 Bedrock Geology 12
6.4 Surficial Geology and Glacial History 13
6.5 Surface Drainage and Groundwater 14
6.6 Coal and Clay Mining 14

7.0 INVESTIGATIVE PROGRAM 15

7.1 General 15
7.2 Borehole Database 16
7.3 Drilling and Sampling Methods 16
7.4 Borehole Results 16
7.4.1 Soil Conditions 16
7.5 Groundwater 19
7.6 Laboratory Program 19

8.0 TERRAIN HAZARD AND LANDSLIDE MAPPING 19
8.1 General Approach 19
8.1.1 Air Photo Interpretation 21
8.1.2 Fieldwork 21
8.1.3 Digital Capture 22
8.2 Slope Gradient Mapping and Top/Toe of Escarpment 22
8.3 Landslide Mapping 23
8.4 Terrain Hazard Mapping 24
8.5 Reliability and Limitations 26

9.0 SLOPE STABILITY IN THE MEDICINE HAT AREA 27
9.1 Introduction 27
9.2 Landslide Types and Failure Mechanisms 27
9.2.1 Bedrock Walled Valley 27
9.2.2 Preglacial Medicine Hat Valley 28
9.2.3 Tributary Valleys 29
9.2.3.1 General 29
9.2.3.2 Seven Persons Creek 30
9.2.3.3 Ross Creek 30
9.2.4 Interior Slopes 30
9.3 Effects of Mining 30

10.0 CASE STUDIES 31
10.1 Introduction 31
10.2 ADM Slide 31
10.2.1 EBA, A Tetra Tech Company, 2011 Report 31
10.3 Eagleview Slide 32
10.3.1 EnviroGeoTesting Sabatini 1999 Report 32
10.4 Canyon Creek Slide 33
10.4.1 EnviroGeo Testing 2002 Report 33
10.4.2 EBA, A Tetra Tech Company, 2007 Report 34
10.5 Cypress County TWP Road 130 Slide 34

11.0 SLOPE DATABASE AND SLOPE STABILITY ANALYSIS 36
11.1 Introduction 36
11.2 Slope Stability Analyses 37
11.2.1 General 37
11.2.2 Approach 38
11.2.3 Results 38
11.2.4 Discussion 39
11.3 Lateral Migration 39
11.3.1 Approach 39
11.3.2 Assessment and Results 40
11.4 Discussion 41

12.0 REVISED DEVELOPMENT SETBACK GUIDELINES 42
12.1 Approach, Geological Sectors, and Definitions 42
12.2 Revised Setback Policy 43
12.2.1 Top of the Escarpment Setback 43
12.2.2 Toe of the Escarpment Setback 44
12.2.3 Site-Specific Geotechnical Assessments 45

13.0 PARTIAL RISK ASSESSMENT 45
13.1 Overview of Risk 45
13.2 Definition of Partial Risk 46
13.3 Hazard Likelihood 46
13.4 Spatial Probability 47
13.5 Partial Risk 47
13.6 Results 49

14.0 CLOSURE 50

REFERENCES 51

TABLES

Table 1 Previous Reports Reviewed
Table 2 Sectors in Hardy (1978) (included within the body of the report)
Table 3 Groundwater Depths for Additional Boreholes (included within the body of the report)
Table 4 Qualitative Landslide Susceptibility Criteria for Potentially Hazardous Slopes (included within the body of the report)
Table 5 Qualitative Terrain Hazard Classifications (included within the body of the report)
Table 6 Comparison of Case Studies
Table 7 ADM Mill's Soil Strength and Groundwater Parameters (EBA 2011 Report) (included within the body of the report)
Table 8 Factor of Safety Results (EnviroGeo 1999 Report) (included within the body of the report)
Table 9 Factor of Safety Results (EnviroGeo 2002 Report) (included within the body of the report)
Table 10 Slope Database
Table 11 Soil Parameters Used in Stability Analysis (included within the body of the report)
Table 12 Comparison of Soil Parameters
Table 13 Summary of Slope Stability Results
Table 14 Summary of Measurements for Lateral Migration
Table 15 Summary of Lateral Migration Results
Table 16 Slope Database Summary
Table 17 Required Geotechnical Setbacks from Top of Escarpment for Slopes >33%
Table 18 Qualitative Spatial Probability (Consequence) for Upslope Elements (included within the body of the report)
Table 19 Qualitative Spatial Probability (Consequence) for Downslope Elements (included within the body of the report)
Table 20a Partial Risk (included within the body of the report)

Table 20b Risk Evaluation and Response (included in the body of the report)
Table 21 Properties at Risk – Top and Toe of Escarpment

FIGURES

Figure 1 Site Location Plan
Figure 2 Detailed Site Location Plan
Figure 3 Elevation Map
Figure 4 Bedrock Geology
Figure 5 Surficial Geology
Figure 6 Bedrock Topography
Figure 7 Mine Workings in the Medicine Hat Area
Figure 8 Previous Borehole Location Plan
Figure 9 2011 Borehole Location Plan
Figure 10 Slope Gradient and Top/Toe of Escarpment Map
Figure 11 Ancient, Historic, and Recent Landslide Locations
Figure 12 Areas of Landslide Activity
Figure 13 Areas with Active Landslide Activity
Figure 14 Landslide Size and Type
Figure 15 Terrain Hazard Map
Figure 16 Areas with Class 3 and 4 Terrain Hazards
Figure 17 Case Study Location Plan
Figure 18 Landslide Regression Plan – Cypress County TWP Rd 130 Slide
Figure 19 Cross-Section Location Plan
Figure 20 Lateral Migration and Stream Reaches
Figure 21 Geological Sectors
Figure 22 Geotechnical Setback Sectors for Interior Slopes
Figure 23 Geotechnical Setback Sectors for the South Saskatchewan River
Figure 24 Geotechnical Setback Sectors for Seven Persons Creek
Figure 25 Geotechnical Setback Sectors for Ross Creek
Figure 26 Setback Lines for Top/Toe of Escarpment
Figure 27 Properties at Risk – Top and Toe of Escarpment

APPENDICES

Appendix A Project Team
Appendix B Glossary
Appendix C Exerpt from City of Medicine Hat's Land Use Bylaw
Appendix D Borehole Logs
Appendix E Laboratory Data
Appendix F Definitions and Classification Tables
Appendix G Landslide Database
Appendix H Air Photo Inventory
Appendix I Traverse Map and Field Check Map
Appendix J Selected Photographs of Areas Represented by Cross-Sections

Appendix K Cross-Sections
Appendix L How to Use This Report
Appendix M DVD Pocket

1.0 INTRODUCTION

EBA Engineering Consultants Ltd. operating as EBA, A Tetra Tech Company (EBA), was retained by the City of Medicine Hat (the City) to review and update the City's existing development setback report and create a detailed Geographic Information System (GIS) plan along all the slopes located within the City's limits.

In recent years, the City has had high seasonal precipitation and experienced a number of slope instability issues. The slope instability has presented a low risk to human health and the City's infrastructure; however, there is now increased public awareness of these issues. The existing report providing recommendations for the guidelines was prepared 27 years ago in 1984 by Hardy Associates (1978) Ltd. (Hardy). The purpose of this project is to review and update the City's information such that a specific policy dealing with existing and future development above, on, or below the slopes and coulee system may be created.

The City is located in southeastern Alberta (Figure 1). The Medicine Hat area consists of two narrow valleys formed by Seven Persons Creek (SPC) and Ross Creek (RC) that discharge to the South Saskatchewan River (SSR), which forms the third and main broad valley (Figure 2). RC flows north and bounds the City to the east, along its southeast quadrant. SPC flows northeast across the southern quadrants of the City and converges with RC just before the confluence with the SSR. The SSR flows from west to east and essentially bisects the City north and south. Near the confluence with RC, the SSR turns north and defines the northeastern boundary of the City. These three valleys comprise an area of about 3,100 ha, which is about 25% of the total area (12,000 ha) contained within the City's boundaries (the study area). The geology of Medicine Hat has been described by MacKay and Thomson (1980) as "*not difficult in broad outline, is complex in detail.*"

2.0 SCOPE

The following report provides the City with a report that has reviewed and updated their existing guidelines for setback requirements around slopes and a GIS plan that outlines recommended setbacks around the slopes of Medicine Hat. The scope of work for this study, as outlined in EBA's proposal dated May 19, 2011, included the following:

- Review of the City's existing guidelines for setback requirements to evaluate the suitability of the guidelines based on known slope failures and applicability compared to currently accepted practice standards for slope stability;
- Review of existing geotechnical and slope stability reports within the City's report library to identify where detailed information is available for slope assessments and where additional geotechnical profiling may be required to complete the project;
- Review of available aerial photographs, supplied topographic survey data, available climatic data, and published reports on the geology of Medicine Hat;

- Determination and execution of a field program based on the outcome of the review of existing information. EBA completed a site reconnaissance across the entire City to inventory the current condition of all significant slopes and coulee systems;
- Reconnaissance level terrain hazard mapping based on the results of the air photo and imagery interpretation, and support with field observations at a minimum 1:20,000 scale;
- Slope stability analyses to provide setbacks for developments above, on, and below the City's slopes and coulee systems. The analysis included back analysis of slopes that have failed, recent and historic, to ensure suitable soil parameters are used. Analyses of typical slope sections around the City were undertaken such that the setback lines are determined; and
- Creation of a GIS plan showing the recommended setbacks from the top of escarpments and, where applicable, toes of slopes were created using the information from the slope stability analyses and slope inspections. The GIS plan will be compatible with the City's platform and technical requirements.

Our scope of work does not include any assessment, analysis, comments, or recommendations concerning appropriate setbacks for flood events or design flood levels.

3.0 PROJECT TEAM

To accomplish the tasks presented above, EBA's project team consisted of the following professionals:

- Slope Stability Analyses/Project Manager – Mr. Michael George, B.E. (Project Engineer/Project Director – EBA Calgary);
- Terrain Analysis/Hazard and Risk Assessment – Ms. Shelley Higman, M.Sc., P.Eng./P.Geo. (Senior Geotechnical Engineer);
- GIS – Mr. Mathew Stephenson, B.A., M.GIS (GIS Applications Specialist);
- Senior Reviewers – Mr. Tony Ruban, M.Eng., P.Eng. (Principal Consultant) and Mr. Bob Patrick, M.Sc., P.Eng. (Principal Engineer – Geotechnical); and
- Corporate Sponsor – Mr. Marc Sabourin, P.Eng. (Senior Project Director, Prairie Region).

Brief descriptions of the qualifications of each of the team members are provided in Appendix A.

4.0 METHODS

The methodology that EBA has followed for this study is described in the sections below. A glossary of terms used in this report is provided in Appendix B.

4.1 Review Existing Guidelines and Available Reports

The beginning of the project comprised a review of the existing guidelines by Hardy and available geotechnical reports. As mentioned above, the review of the guidelines included examination of the suitability of the guidelines based on known slope failures and applicability compared to currently

accepted practice standards for slope stability. The review of existing geotechnical reports facilitated the identification of where detailed information was available for slope assessments and where additional geotechnical profiling would be required to complete the project.

4.2 Desktop Study

The desktop study included a review of existing information from the City, aerial photograph interpretation (API), supplied topographic survey data, available climatic data, and published reports on the geology and slope stability of Medicine Hat.

The API used current and historic aerial photographs in connection with available orthophotos and satellite imagery. Stereo pairs of photos were viewed with a stereoscope to assess a three-dimensional image for more accurate identification of geohazards.

The geology and slope stability of Medicine Hat has been the subject of numerous reports. These reports were reviewed for consistency and to confirm EBA's understanding of the geology.

4.3 Site Reconnaissance

EBA's site reconnaissance involved nine field days and was carried out from August 2, 2011, to August 10, 2011, by Ms. Shelley Higman, M.Sc., P.Eng./P.Geo., Mr. Kevin Lee, E.I.T., and Mr. Jiujun Zhao, E.I.T., all of EBA. The site reconnaissance included:

- Detailed foot reconnaissance of the valley slopes along about 15.3 km of SPC, within the City limits;
- Detailed foot reconnaissance of the valley slopes along approximately 12.5 km of RC, within the City limits;
- Detailed foot reconnaissance of the valley slopes along approximately 12.1 km of the SSR, within the City limits, and about 0.8 km within Cypress County directly west of the City boundary;
- Detailed foot reconnaissance along interior slopes (IS):
  - Along about 2.7 km of the IS north of 5 Street NW; and
  - Along about 1.2 km of the IS west of Kingsway Avenue SE.
- Detailed truck traverses with short foot traverses:
  - Along the IS north of Kipling and Spenser Streets SE;
  - At the Fertilizer Plant slide; and
  - Within the Ranchlands subdivision.
- Two overview, low level reconnaissance flights by fixed-wing aircraft of all three valleys.

The above areas are identified on Figure 2. Field traverses and observation points, as well as flight paths, are provided in Appendix I. The site reconnaissance was undertaken across the City to inventory the current condition of all significant slopes and coulee systems. The site reconnaissance included identification of the current form of landslides that have occurred, geologic mapping of exposed soil and

rock, and noting of any seepage zones. The low level flight with a fixed-wing plane was conducted to document additional landslides that have occurred since the time the last imagery was acquired. The flights were recorded using digital video recorders, as well as still camera digital photography. These videos and photos, including all site photos, are provided in Appendix M.

4.4 Drilling and Laboratory Program

EBA's review of the existing data determined that additional geotechnical and soil profiling investigations were required. A subsequent proposal for this additional scope of work was submitted and approved by the City. The drilling program was conducted November 8, 2011, to November 10, 2011, where six boreholes were completed using a solid-stem auger. Depths of these boreholes ranged from 16.8 m to 54.9 m. This program and results are described in detail in Section 7.0.

4.5 Hazard and Risk Assessment

The methodology that EBA has followed for this study is based on those used in other jurisdictions and described in *Risk Management: Guidelines for Decision Makers*, by the Canadian Standards Association (CSA) (1997). Terms and definitions used in this study are consistent with those in:

- "*A Framework for Landslide Risk Assessment and Management,*" by Fell, R., Ho, K.K.S., Lacasse, S., and Leroi, E. in Landslide Risk Management. Proceedings of the International Conference on Landslide Risk Management, Vancouver, Canada, May 31-June 3, 2005, by Hungr, O., Fell, R., Couture, R., and Eberhardt E. (editors); and
- "*Landslide Risk Case Studies in Forest Development Planning and Operations,*" by Wise, M., Moore, G., and VanDine, D. (editors), Land Management Handbook 56, BC Ministry of Forests, 2004.

Based on the results of the air photo and imagery interpretations, and supported with field observations, EBA has mapped the study area at a detailed level at a 1:10,000 scale. Polygons have been defined on all slope sections exceeding 15% slope gradient, and delineate areas using a 4-Class system where low is a Terrain Hazard 1, moderate is a Terrain Hazard 2, high is a Terrain Hazard 3, and a very high potential for landslide occurrence is a Terrain Hazard 4, such that areas having a probability of landslide occurrence of greater than 10% in 50 years are identified for damaging events. This is the level of landslide safety used in many jurisdictions and is the level acceptable to the City. In connection with these hazard ratings, EBA has developed qualitative susceptibility criteria and has developed a simple landslide database. The database indicates the location, type of landslide (e.g., rotational or translational), degree of activity (e.g., historic, inactive, active), and magnitude of the landslide.

EBA has estimated the magnitude, return frequency, and probable spatial extent of future landslide events. These assessments have been based on the occurrence of past landslide events supported by our interpretation of historical aerial photographs and the results of our field reconnaissance.

EBA used the concept of qualitative partial risk analysis to evaluate the likelihood of a specific adverse effect arising from the identified hazards within a period of development that we assume to be 100 years. This approach has been used since this study is intended to prioritize areas for subsequent action that may include follow-up monitoring, detailed investigations, or mitigation. Partial risk analysis incorporates hazard likelihood and spatial probability only – that is, the probability of occurrence of a specific hazardous

landslide and the probability of it reaching, or otherwise affecting, the site occupied by a specific element – in this case, properties.

In this study, EBA has considered an adverse effect as meaning loss of infrastructure or property or damage to infrastructure or property. Qualitative risk classification system has been developed using a letter system, where very low is Risk Class E, low is Risk Class D, moderate is Risk Class C, high is Risk Class B, and very high is Risk Class A for the various areas comprising the study area. These areas are delineated graphically such that the study area is spatially differentiated into zones of higher and lower risk.

4.6 Analyses

Detailed slope stability analyses have been undertaken to provide setbacks above and below the slopes and natural coulee systems. Stability analyses have been undertaken using the computer program Slope/W. Input parameters for the program were determined from the desktop study and site reconnaissance. Typical profiles for the slopes have been determined using the City's existing topographic information. The analysis includes back analysis of slopes that have failed, recent and historic, to ensure suitable soil parameters are used. Analyses of typical slope sections around the City have been undertaken such that the setback lines could be determined.

4.7 Project Deliverables

A GIS plan of Medicine Hat showing the relevant setbacks from the top of escarpments and, where applicable, toes of slopes has been created using the information from the slope stability analyses and slope inspections. The mapping product has been provided in ArcGIS format compatible with the City's mapping systems, as well as in pdf format.

This report has been prepared that provides detailed hazard and risk assessment for all existing slopes within Medicine Hat.

5.0 BACKGROUND

5.1 Hardy Report

Hardy (1978) prepared a report to the City Community Services Division in October of 1984 entitled "Geotechnical Study Relative to Slope Stability Aspects, City of Medicine Hat Open Space Policy." The purpose of the report was to provide geotechnical background information in conjunction with the "Open Space Policy" in order to establish criteria for urban development adjacent to slopes.

The study area is defined by the 1984 City limits of the City that we understand was smaller than the current study area, but we are unaware of the actual size. Air photo coverage was reviewed to confirm existing surficial geology mapping to identify and categorize areas of instability. Where geological and geotechnical data was available, cross-sections were developed for stability analysis. The stability analysis, supplemented by field reconnaissance, was used to develop setback criteria with respect to the top of escarpment and bottom of escarpment. A review of Alberta and Medicine Hat slope stability-related development guidelines, previous investigations, and studies were conducted as part of this study.

5.1.1 Sectors

Four design sectors were defined in the study area including sub-sectors to reflect minor variations in geologic profile or slope morphology. These sectors included the following.

Sector A

Sector A is defined by the SSR valley where the river has actively eroded along the outside meanders causing large-scale retrogressive landsliding. Slope heights in this sector ranged between 60 m to 90 m with typical soil stratigraphy consisting of glaciolacustrine sediments overlying interbedded tills, inter-tills and preglacial sand and gravel, underlain by bedrock.

Sector B

Sector B is defined by where the bedrock surface approaches close to ground surface located on the western part of the study area along the SSR. Slope heights in this sector were in the vicinity of 80 m and comprised almost entirely of bedrock capped off by till.

Sector C

Sector C is defined by the tributary valleys of SPC and RC. Sector C also includes a north facing wall of the SSR located between the City centre and the Power Plant. Slope heights in this sector ranged between 30 m to 50 m. Soil stratigraphy typically consisted of glaciolacustrine deposits interbedded with till.

Sector D

Sector D is defined along the north wall of the SSR valley between Crescent Heights and Riverside subdivisions. Slope heights in this sector ranged between 20 m to 35 m, with exception of specific areas where slope heights reached up to 50 m. Soil stratigraphy typical consisted of glaciolacustrine sand and gravel overlying till.

5.1.2 Setback Policy

The setback policy was established using the Bishop Simplified method of analysis for deep seated rotational instabilities and infinite slope method of analysis for surficial instabilities. The setback defined a zone between the setback line and the top of escarpment. The setback policy would ensure that development located outside of the setback zone would have a factor of safety greater than 1.5 against potential deep-seated instabilities. If a development were to encroach within the setback zone, a detailed slope stability analysis should be undertaken before proceeding with development.

Two setback policies were developed to ensure that development within proximity of slopes provided adequate safety and access for remedial works, if necessary. One policy pertaining to the top of escarpment and one policy pertaining to the bottom of escarpment.

"Top of Escarpment" Setback

The top of escarpment setback policy is used to prevent development on unstable or potentially unstable terrain located within the setback zone of the slope at the top of escarpment. The top of escarpment is

defined at the point at which the slope changes from a slope angle greater than 15% to less than 15%. The top of escarpment policy is divided into three scenarios for application.

The first scenario – when the overall slope is less than or equal to 15%, the setback policy dictates that no restriction on development is required.

The second scenario – when the overall slope exceeds 15% but not greater than 33%, the setback policy dictates that a minimum setback distance of 6 m is required. In cases where parties involved feel that 6 m is unsatisfactory, a site-specific investigation to determine setback distance should be undertaken by a qualified geotechnical engineer.

The third scenario – where the overall slope exceeds 33%, a site-specific investigation is recommended. In the absence of an investigation, the following table can be used in relation to the corresponding sector using the height of slope.

Table 2: Sectors in Hardy (1978)

Sector	Subsector	Setback from Top of Escarpment (x slope height)
A		1.25
	A1	1.5
B		1.5
	B1	1.25
C		1.0
	C1	1.0
	C2	*
	C3	*
	C4	1
D		1.0
	D1	1.25

* Average slope angle less than 18 degrees, for appropriate setback see first and second scenario.

"Bottom of Escarpment" Setback

The bottom of escarpment setback policy is used to provide passive protection to facilities from the base of valley walls. The bottom of escarpment policy is divided into three scenarios for application.

The first scenario – where the overall slope is less than or equal to 15%, the setback policies dictate that no setback is required.

The second scenario – where the overall slope exceeds 15% but not greater than 33%, the policy dictates that a setback equal to the larger value of either 50% of the "top of escarpment" setback or a minimum setback of 4 m.

The third scenario – where the overall slope exceeds 33%, the setback policy dictates that the "bottom of escarpment" setback will be equal to the "top of escarpment" setback.

In any situation where evidence of slope stability exists, a site-specific investigation should be undertaken to determine the setback.

5.1.3 Medicine Hat Open Space Policy

The following guidelines are provided with the proposed Open Space Policy relative to review and processing of geotechnical reports. If the report indicates that no corrective engineering work is required, then the site may be considered to conform to the Medicine Hat Open Space Policy. If the report indicates corrective engineering work is required, then work may proceed subject to the following:

- "During development of the site, all recommendations of the geotechnical engineering report must be adhered to;"
- "Upon completion, the geotechnical engineer shall certify to the City of Medicine Hat that all report recommendations have been adhered to;"
- "The City will consider means of saving harmless any claims related to soils movement or erosion damage, such as a caveat to restrict land use and terrain modifications conflicting with the recommendations of the geotechnical engineering report;" and
- "The City shall be saved harmless from any claims related to soils movement or erosion damage."

5.2 Existing Setback Criteria

Medicine Hat's current setback criteria are based on the policies set out in Hardy's (1978) "Geotechnical Study Relative to Slope Stability Aspects, City of Medicine Hat Open Space Policy" summarized above, and summarized in an excerpt from the City's Land Use Bylaw 3181 in Appendix C.

5.3 Development Controls in Other Jurisdictions

5.3.1 Calgary

The City of Calgary's slope development policy is outlined in the "Policy Regarding Slope Stability Reports prior to the Issuance of Development and/or Building Permits" and must adhere to the City of Calgary standards "Land Use Bylaw 1P2007". The policy states that a slope stability report is required prior to issuing a development permit and/or a building permit where:

- Any slope across the property is 15^0 or greater; and/or
- Any slope across the property where an imaginary line drawn from the toe to the top of an embankment exceeds a slope of 1 in 3.

The City of Calgary's slope development policy is supplemented by the "City of Calgary Slope Adaptive Development Policy and Guidelines and Conservation." The document's application pertains to any residential, industrial, commercial, or recreational development on lands with a slope of 20% or greater in developing and developed areas. The slope adaptive guideline does not regulate slope stability or safety.

5.3.2 Edmonton

The City of Edmonton's slope development policy is outlined in the "Top of Bank Policy – Approved February 2010." The policy states that the recommended setback lines for development and structures

shall be determined by the Geotechnical Engineer and shall be in accordance with the concept of an Estimated Long-Term Line of Stability.

The Estimated Long-Term Line of Stability is obtained through analysis and assessment and is defined for the following situations. Where there is a top of bank roadway, a minimum estimated long term factor of safety of 1.3 taking account for future instability factors, shall determine the Urban Development Line. Where no roadway exists at the top of bank, a minimum estimated long term factor of safety of 1.3 taking account for future instability factors, shall determine the rear property line for development. Additionally, where no roadway exists, a minimum estimated long-term factor of safety of 1.5 is used to establish the rear foundation of any primary dwelling or structure.

The policy has defined any major slope as any slope with inclination greater than 15^0 and a height greater than 10 m. A minor slope is any slope with inclination less than 15^0 and a height no more than 10 m. Moderate slopes are defined as any slope with inclination greater than 15^0 and have a height less than 10 m.

5.3.3 Lethbridge

The City of Lethbridge's slope development policy is outlined in the "River Valley Area Redevelopment Plan" (RVARP). A summary of the recommended development setback distance measured from top of escarpment is outlined as follows:

- Where slopes are shallower than 15% (8.5^0), no development setback distance is required from top of escarpment;
- Where slopes exceed 33% (18^0), the setback distance will be equal to 1.25 x the height of slope; and
- Where slopes exceed 15% but are shallower than 33%, the setback distance will vary linearly from 0 to 1.25 x the height of slope, but will be a minimum of 6 m.

Revisions to the RVARP are provided in the "City of Lethbridge Phase II Development Setback Assessment Oldman River Valley Slopes" addressing altered slopes, coulee slopes without bedrock failure risk, and valley slopes exposed to bedrock failure risk.

5.4 Sources of Information

A number of geotechnical reports and published papers have been reviewed prior the completion of this report and are referenced below, and are contained in Table 1.

- AGRA Earth & Environmental, "Geotechnical Assessment Altawana Back Slope Slumping Medicine Hat, Alberta," dated April 2005.
- AGRA Earth & Environmental, "Geotechnical Report Seepage and Slope Assessment South of Rideau Manor," dated October 1997.
- AGRA Earth & Environmental, "Slope Stability Setback Assessment 351 and 363 13 Street S.W. Medicine Hat, Alberta," dated August 1999.

- EBA, A Tetra Tech Company, "Geotechnical Evaluation Slope Stability Assessment Study No. 5, Southeast Hill Medicine Hat, Alberta," dated October 2005.
- EnviroGeo Testing Sabatini, "Geotechnical Slope Stabilization Study 32 Street S.W. and 10 Avenue S.W., Medicine Hat," dated November 1998.
- EnviroGeo Testing, "Slope Stability Analysis/Geotechnical Investigation River Ridge Estates Medicine Hat, Alberta," dated April 2001.
- EnviroGeo Testing, "Geotechnical Investigation and Slope Stability Report SE 15-12-6-W4M Medicine Hat, Alberta," dated June 2002.
- EnviroGeo Testing, "Slope Stability Review, Saamis Heights Subdivision – Phase 3, Medicine Hat, AB," dated July 2003.
- EnviroGeo Testing "Saamis Heights Subdivision Lot 6, Block 28, Plan 0312828, Medicine Hat, AB," dated June 2005.
- EnviroGeo Testing, "Slope Stability Analysis Proposed Ranchlands Residential Subdivision Phase 2F and G, and Phase 3 Medicine Hat, AB," dated November 2005.
- Focus Corporation Ltd., "Phase 4 Ranchlands Subdivision Environmental Reserve Delineation Medicine Hat, Alberta," dated November 2007.
- Geo-Engineering Ltd., "Saamis Memorial Funeral Chapel & Crematorium, Medicine Hat," dated December 2003.
- Golder Associates, "A Report to the City of Medicine Hat Providing an Assessment of the Stability of Slopes in the Crestwood Drive Area," dated September 1976.
- Hardy Associates Ltd., "Report on Geotechnical Study Relative to Slope Stability Aspects City of Medicine Hat Open Space Policy," dated October 1984.
- HBT AGRA Limited, "Slope Stability investigation Fairway Manor Apartments Medicine Hat, Alberta," dated October 1992.
- Pennell Geotechnical Engineering Ltd., "Report on Subsoil Conditions and Slope Stability Conditions at Proposed Subdivision S & T Ranch Property Medicine Hat, Alberta," dated March 1980.
- Pennell Geotechnical Engineering Ltd., "Report on Subsoil and Slope Stability Conditions at South Saskatchewan River Medicine Hat Golf Course Subdivision," dated February 1981.
- Pennell Geotechnical Engineering Ltd., "Report on Slope Stability for Ross Glen Extension Lecuyer Cattle Co. Medicine Hat, Alberta," dated July 1982.
- Stantec Consulting Ltd., "Southeast Hill Drainage Improvements and Slope Stability Study," dated November 2006.
- Thurber Engineering Ltd., "Saamis Heights Subdivision Medicine Hat, Alberta Slope Setback Study," dated November 2000.

- Thurber Engineering Ltd., "Scholen Hill Slope Stabilization Preliminary Geotechnical Investigation and Recommendations," dated August 2001.
- Thurber Engineering Ltd., "Scholten Hill Slope Stabilization Supplementary Drilling and Instrumentation Program Medicine Hat, Alberta," dated October 2003.
- Underwood McLellan Ltd., "Report on Subsoil Conditions and Slope Stability at Ross Glen Subdivision Medicine Hat, Alberta," dated October 1976.
- Underwood McLellan Ltd., "Report on Subsoil Conditions and Slope Stability at Proposed Subdivision Medicine Hat, Alberta," dated March 1976.
- Underwood McLellan Ltd., "Report on Subsurface Investigation and Slope Stability at the Proposed Golf and Country Club Medicine Hat, Alberta," dated July, 1980.
- University of Alberta, "A Report on Slope Stability along the South Saskatchewan River and tributaries in the Vicinity of Medicine Hat, Alberta," dated October 1980.

6.0 STUDY AREA

6.1 Topography

The Medicine Hat area is characterized by the three river valleys flowing through the City, with the largest being the SSR. The majority of the City is located within Prairie uplands where the topography is undulating as shown on Figure 3, where elevations range from about 700 m to 765 m and averages about 715 m. Elevations along the valley floor of the SSR range from 650 m to 665 m, indicating the river has a very gentle stream gradient (<1%) as it falls only 15 m over the 30 km distance that it flows through the study area. Valley heights along this section are as high as 100 m.

RC meanders over a broad valley bottom that ranges in elevation from about 700 m to 655 m at its confluence with the SSR. It also has a low stream gradient (<1%) where it falls 45 m over its more than 7 km distance that it flows within and adjacent to the study area.

SPC also meanders over a wide valley bottom over a similar elevation range as RC. It converges with RC about 58 m upstream of the confluence of RC and the SSR. SPC falls about 40 m over the greater than 9 km that it flows through the study area, indicating that the stream gradients along SPC are also very low at less than 1%.

6.2 Climate

Historical climate information was obtained from Environment Canada for the Medicine Hat Weather Station located at the Medicine Hat Airport at an elevation of 717 m.

Climate normals were available for the period between 1971 and 2000 and are as follows:

- Daily Average Temperature: 5.7°C;
- Daily Minimum Temperature: -1.0°C;
- Daily Maximum Temperature: 12.3°C;

- Standard Deviation: 1.4;
- Annual Rainfall: 249.6 mm;
- Highest Monthly Rainfall: 62.6 mm (June);
- Extreme Daily Rainfall: 121.9 mm (August 14, 1927);
- Annual Precipitation: 333.8 mm;
- Highest Monthly Precipitation: 62.6 mm (June);
- Extreme Daily Precipitation: 121.9 mm (August 14, 1927);
- Annual Snowfall: 95.2 cm;
- Highest Monthly Snowfall: 16.6 cm (December); and
- Extreme Daily Snowfall: 33.8 cm (March 11, 1954).

Annual precipitation for the last five years was available from The Weather Network and is summarized as follows:

- 2011: 231.2 mm, which is 31% lower than the annual average of 333.8 mm;
- 2010: 410.2 mm, which is 23% higher than the annual average;
- 2009: 373.4 mm, which is 12% higher than the annual average;
- 2008: 322.3 mm, which is 3% lower than the annual average; and
- 2007: 238.9 mm, which is 28% lower than the annual average.

6.3 Bedrock Geology

Bedrock is exposed along the SSR west of Medicine Hat and consists of Upper Cretaceous sedimentary rocks of the Foremost and Oldman Formations (Irish 1968). Reportedly, remnants of the Bearpaw Formation are found east and northeast but are not found adjacent to the river valley of the study area (Mckay and Thomson 1980). Their distribution is shown on Figure 4.

These deposits originated as detrital sediments that transported eastwards by rivers flowing off the highlands of the central Cordillera to the west, and deposited in fresh water, brackish, and marine environments (McCrossan and Glaister 1966). McCrossan and Glaister (1966) further report that these deposits infrequently contain coal and bentonite seams and fossil-rich beds, where the bentonite beds formed from volcanic ash ejected from Cordilleran volcanoes.

No major faults have been mapped in the area, but structurally, the geology of the southern Alberta plains is controlled by the Sweet Grass Arch that is a broadly plunging anticline formed by deep igneous intrusions, resulting in the bedrock in the study area having a gentle dip to the northeast and east (Irish 1968). This was confirmed during EBA's site reconnaissance where the strike and dip were measured at 308^0 and 8^0 (northeast), respectively.

The oldest stratigraphic unit in the succession is the Foremost Formation that is exposed at the river level and part way up the valley slopes. It consists of a mixture of brackish water and fresh water deposits that are described as a sequence of pale grey sandstone, siltstone, and shale. Coal seams occurring in the upper part of the Foremost Formation have been mined along the south and north slopes of the river valley below Redcliff (see Section 6.6).

The Oldman Formation overlies the Foremost Formation. Irish (1967) reports that the contact between the two units is gradational and that the two units are differentiated mainly by the lighter colour of the Oldman Formation. This formation consists of cross-bedded sandstone, siltstone, and shale. According to Hardy (1984), the Lethbridge Coal Member, located near the top of the unit, may or may not be present. Where the Oldman Formation is exposed along the river valley, it erodes into a "badlands" type of topography, likely due to the high bentonite content within the strata (Mckay and Thomson 1980). EBA observed this type of topography along the north valley slopes of the SSR below Redcliff, and to a lesser extent near: 1) the City limits along the north valley slopes across from the Echodale Regional Park (Figure 2) where a bentonite seam was observed; and 2) the slopes to the west of the City boundary, west of the Redcliff Pumphouse Slide (Figure 2).

Near Medicine Hat and to the north, bedrock is less prominent. Bedrock of the Foremost Formation is exposed at or near the river level, generally under a thick succession of surficial materials.

6.4 Surficial Geology and Glacial History

The surficial geology of the Medicine Hat area has been described by a number of authors (for example, Westgate 1968; Carlson 1970; Stalker 1969; Berg and McPherson 1972; Stalker and Wyder 1983). These authors describe the upland area as being underlain by glaciolacustrine sediments and glacial and preglacial deposits. The valley slopes are comprised of similar materials but contain discontinuous veneers of colluvium. The valley bottoms are infilled by alluvial silt, sand, and gravel. The spatial distribution of these deposits is shown on Figure 5.

The glacial deposits comprise a complex sequence of interbedded tills and inter-till deposits (silt, sand, and gravel) that are underlain by fluvial sand and gravel deposits called the Saskatchewan Gravels (Westgate 1968). In the Medicine Hat area, three till sheets have been identified, corresponding to three separate glacial advances. The interglacial periods between these advances were characterized by deposition of proglacial lake sediments and granular outwash and fluvial deposits. However, the lateral continuity between these sediments is poor due to rapid changes in the depositional environment and/or subsequent erosion. The youngest till sheet is overlain by deposits of clay, silt, sand, and gravel, indicating that the postglacial depositional environment in the Medicine Hat area, prior to the development of the SSR valley, included a proglacial lake and a slow moving, meandering river.

The thickness of this stratigraphic sequence is variable in the Medicine Hat area, varying from about 5 m thick near Redcliff to more than 65 m in the eastern portion of Medicine Hat. The reason for the variability is due to the bedrock topography in the area. The bedrock topography, mapped by Carlson (1970), reveals a large north-south trending buried valley, referred to as the Medicine Hat Valley, beneath the eastern portion of the study area and approximately in line with the present SSR (Figure 6).

6.5 Surface Drainage and Groundwater

Hardy (1984) reports that surficially, the study area is well drained, and that surface water runoff is generally directed into the SSR and its tributaries (SPC and RC). Where surface water drainage is less well developed, the surface water seeps into the ground and recharges the groundwater system.

A previous hydrogeological study by Stevenson and Borneuf (1977) that is summarized by both Mckay and Thomson (1980) and Hardy (1984) indicates that there are two distinct groundwater systems that may or may not be connected in the Medicine Hat area:

- Deep regional groundwater flows within the bedrock that locally discharge to the SSR; and
- Shallow, localized groundwater flows, that are associated with the upper glaciolacustrine and glaciofluvial deposits, as well as the permeable inter-till deposits. These flows are relatively small and seasonal, but often these perched water tables discharge into the river valley.

It is these shallow, localized flows, that are of the most importance to slope stability since recharge to these shallow aquifers can be natural or anthropogenic. Anthropogenic effects such as storage of water in reservoirs, septic fields, collection or concentration of storm runoff, leaking sewer or storm drains, watering of lawns, golf courses, farm or recreational fields can add additional recharge to these shallow aquifers. An increase in the height of the water table or discharge rate in these aquifers adjacent to a slope can decrease the stability of the slope, resulting in a new failure or reactivation of an old failure.

6.6 Coal and Clay Mining

According to historical records, coal mining within the Medicine Hat city limits occurred, where shown on Figure 7, in the area of Echodale Regional Park. EBA obtained this information from the Esplanade Museum at the time of our August 2011 site reconnaissance. Available archival material indicates that mining in the area started in 1888 and ceased operations in 1964. EBA was unable to confirm the methods of mining, but historic photographs suggest the underground mines were mined by room and pillar methods. Extensive coal exploitation has also been documented along the north slopes of the SSR, below the community of Redcliff, but outside the City limits of Medicine Hat. Anecdotally, we understand that the red appearance of the bedrock in this area is from coal that burned within the mine.

Available historic aerial photographs of the Medicine Hat area prior to closure of the mines do not extend this far west, so EBA cannot comment on the nature of the slopes in the area at the time the mine was operational. During our field review, EBA noted sinkholes at the locations shown on Figure 7, which may be indicative of coal mining activities extending further to the west. However, this could not be confirmed by our review of the available mine plans.

EBA notes that the mine area shown on Figure 7 identifies the broad area that contained underground coal mining. The exact documented layout of the mine and extensions is not included, nor does EBA know the full extent of the mining operations in the area.

Unlike coal mining, clay mining is still active within the City, and the single operating mine is currently owned by IXL Industries. The location of the open pit mine is shown on Figure 7. EBA understands, however, that this mine is nearing completion and that the land may be used for other purposes in the near

future. Like coal mining, EBA understands that clay mining and the manufacturing of bricks and other clay products initiated in the area in the late 1800s to early 1900s.

7.0 INVESTIGATIVE PROGRAM

7.1 General

The investigative program was conducted to provide suitable subsurface (soil and groundwater) information to assist in slope stability and slope setback development for the Medicine Hat Slope Setback Report. Across Medicine Hat, a total of 29 locations had been selected for evaluation. Of the 29 locations, a total of 6 locations have been identified, in consultation with the City, as requiring additional subsurface soil stratigraphy information. The investigative program consisted of an exploratory borehole at each identified location to determine subsurface soil stratigraphy. Locations are referenced by cross-section number with background information presented below. The naming convention of the cross-sections is explained in Section 11.1.

Cross-Section IS-6

Cross-Section IS-6 is located south of Saamis Drive NW on 20 Street SE at the southernmost end of 20 Street SE. Immediately northeast of the cross-section is Burnside Heights. The slope in question could impact any potential future development in the area including potential future Burnside Heights residential development.

Cross-Section SSR-3

Cross-Section SSR-3 is located approximately 500 m northeast of the IXL facility, located at Porcelain Avenue SE. The slope is located on the south bank of the SSR. The area is currently privately owned but is of interest to Municipal Development. Cross-Section SSR-3 has experienced an ancient slope failure.

Cross-Section SSR-7

Cross-Section SSR-7 is located approximately 450 m northwest of 11 Avenue SW, bordering the south side of the SSR. Potential future development and a potential campground expansion have been proposed for the area.

Cross-Section SSR-5

Cross-Section SSR-5 is located north of 4 Avenue SW and 2 Street SW. This is a residential area that Municipal Works has requested be further assessed.

Cross-Section IS-3

Cross-Section IS-3 is located immediately south of 2 Avenue SE and 13 Street SE. The area is currently in a residentially developed area and infringes on existing Land Use Bylaw setback. The slope will affect the current developments in the area.

Cross-Section SPC-4

Cross-Section SPC-4 is located approximately 230 m west of College Avenue SE and 140 m north of College Drive SE, north of the Medicine Hat College Main Building 1. The slope in question is north of an outdoor soccer field located on Campus grounds. Slope failures have become a concern with planning, building, and development services as slope failures will begin to impact college property for future development.

7.2 Borehole Database

Details of the soil and groundwater conditions encountered at each borehole location (Boreholes BH IS-6, BH SPC-4, BH IS-3, BH SSR-3, BH SSR-5, and BH SSR-7) and are presented on the borehole logs in Appendix D. The summary of the soil conditions encountered in the boreholes are presented in Section 7.4.1.

7.3 Drilling and Sampling Methods

A total of six boreholes, designated in Section 7.2, were drilled to depths ranging between 16.7 m to 55 m below the existing ground surface. Following clearance from underground utilities using Alberta One-Call and private locators, fieldwork was carried out between November 7, 2011, and November 10, 2011, utilizing a truck-mounted drill rig contracted from Chilako Drilling Services Ltd. (Chilako), of Coaldale, Alberta. The drill rig was equipped with solid-stem augers.

Disturbed grab samples and split-spoon samples were recovered at regular intervals. Standard Penetration Tests (SPTs) and Shelby Tubes were performed at selected depths in each borehole. All samples were examined visually and classified in the field. Soil stratigraphy was logged noting the depths of stratigraphic boundaries, water-bearing layers, and other significant features. Borehole logs are included in Appendix D.

Hand slotted 25 mm polyvinyl chloride (PVC) standpipes were installed in all boreholes to allow for monitoring of groundwater. The backfilling details are provided on the borehole logs.

7.4 Borehole Results

It should be noted that geological conditions are innately variable. Glacial deposits, in particular, are seldom spatially uniform. At the time of preparation of this report, information on the subsurface stratigraphy is available only at discrete borehole locations.

7.4.1 Soil Conditions

The depths of the different soil layers in the following summary are referenced from the ground surface elevation, which existed in November 2011, and may be different from the current/future ground surface elevations. Borehole logs are provided in Appendix D.

Cross-Section IS-6

Borehole BH IS-6 was drilled south of Saamis Drive NW on 20 Street SE at the southernmost end of 20 Street SE on November 10, 2011. Borehole BH IS-6 was drilled to a total depth of 16.7 m below existing ground surface.

Clay fill was found to a depth of approximately 1.5 m before native clay till material was encountered. The clay till was silty, varied in sand content (from some sand to sandy), and contained trace amounts of gravel. The clay till was low plastic, damp to moist, and brown.

A silt layer, approximately 0.6 m in thickness, was encountered at a depth of 4.5 m below existing ground surface followed by a sand layer approximately 1.3 m in thickness. The silt comprised some sand and some clay. Silt was damp in moisture and brown. Sand was medium grained, poorly graded, damp, brown, and compact.

Clay till of similar composition to the clay till found at a depth of 1.5 m was encountered at depths of 6.4 m, 10.6 m, 14.0 m, and 16.1 m below existing ground surface. The clay till was separated by sand layers encountered at depths of 9.1 m, 12.5 m, and 15.5 m below ground surface. Sand layers were medium grained, poorly graded, dense, moist, and brown.

Auger refusal was met at a depth of 16.7 m below ground surface upon contact with a possible cobble or boulder.

Cross-Section SSR-3

Borehole BH SSR-3 was drilled approximately 500 m northeast of the IXL facility, located at Porcelain Avenue SE, on November 8, 2011. Borehole BH SSR-3 was drilled to a total depth of 55 m below existing ground surface.

Glaciolacustrine clay was encountered at the surface continuing to a depth of 5.2 m below existing ground surface. The clay till was silty, trace amounts of sand, damp, and light brown. Glaciolacustrine clay was encountered again at a depth ranging from 6.0 m to 8.2 m.

Clay till was encountered at a depth of 5.2 m below existing ground surface and transitioned into Glaciolacustrine clay till, of similar composition to that encountered at surface, at a depth ranging from 6.0 m to 8.2 m before returning to clay till. The clay till was silty, sandy, with trace amounts of gravel, low plastic, hard, damp, and brown.

At a depth of approximately 39.6 m, clay till changed composition containing reduced amounts of both silt and sand, increased plasticity, and a colour change from brown to grey. The grey clay till continued to the end of hole at a depth of 55 m.

Cross-Section SSR-7

Borehole BH SSR-7 was drilled approximately 450 m northwest of 11 Avenue SW, bordering the south side of the SSR. Borehole BH SSR-7 was drilled to a total depth of 26.4 m below existing ground surface.

Clay till was encountered at the surface and continued to a depth of 26.2 m with intermittent sand layers. Surface clay till was silty, varied in sand content (from some sand to sandy), trace amount of gravel, low plastic, stiff, damp, and brown. Clay till changed composition at a depth of 15.2 m containing reduced amounts of both silt and sand, increased plasticity, and a colour change from brown to grey.

Intermittent sand layers were encountered at depths of 17.3 m and 23.1 m below existing ground surface with corresponding sand layer thicknesses of 1.2 m and 0.3 m, respectively. The sand was

medium-grained, poorly graded, varied in moisture content (from moist to wet), and brown. The sand was also encountered at a depth ranging from 26.2 m to the end of the hole (26.4 m).

Cross-Section SSR-5

Borehole BH SSR-5 was drilled north of 4 Avenue SW and 2 Street SW. Borehole BH SSR-5 was drilled to a total depth of 25.9 m below existing ground surface.

Sand and gravel were encountered at the surface and continued to a depth of 3.7 m below existing ground surface overlying a clay fill layer of an approximate thickness of 2.7 m. The clay fill was silty, sandy, trace amounts of gravel, low plastic, firm, varied in moisture content (moist to wet), and brown.

Clay till was encountered at a depth of 6.7 m below existing ground surface and continued to a depth of 18.3 m below existing ground surface. The clay till was silty, varied in sand content (some sand to sandy), trace amounts of gravel, varied in plasticity (low to medium plasticity), moist, and brown.

Sand was encountered at a depth of 18.3 m below existing surface and continued to the end of hole (25.9 m). The sand was medium grained, poorly graded, varied in moisture content (damp to moist), and brown.

Cross-Section IS-3

Borehole BH IS-3 was drilled immediately south of 2 Avenue SE and 13 Street SE. Borehole BH IS-3 was drilled to a total depth of 20.3 m below existing ground surface.

Silt was encountered at the surface and continued to a depth of 7.0 m below existing ground surface. The silt contained some sand, trace amount of clay, varied in moisture content (damp to dry), and was light brown.

Clay till was encountered at a depth of 7.0 m below existing ground surface and continued to the end of hole (20.3 m). The clay till was silty, varied in sand content (some sand to sandy), low plastic, firm, moist, and brown. At a depth of 9.8 m the clay till changed colour from brown to grey and increased in plasticity at a depth of 12.8 m.

Cross-Section SPC-4

Borehole BH SPC-4 was drilled located approximately 230 m west of College Avenue SE and 140 m north of College Drive SE, north of the Medicine Hat College Main Building 1. Borehole SPC-4 was drilled to a total depth of 26.4 m below existing ground surface.

Clay fill was encountered at the surface and continued to a depth of 3.0 m with an intermittent sand layer from 1.2 m to 2.1 m. The clay fill was silty, varied in sand content (some sand to sandy), low plastic, firm, varied in moisture content (damp to moist), and was brown. The sand was medium-grained, poorly graded, compact, varied in moisture content (damp to moist), and was brown.

Glaciolacustrine clay was encountered at a depth of 3.0 m and continued to a depth of 12.5 m with an intermittent sand seam at a depth of 9.1 m. Glaciolacustrine clay till was silty, some sand, trace amounts of gravel, stiff, low plastic, moist, and was brown

Sand was encountered intermittently at depths of 12.5 m, 16.2 m, and 18.6 m below existing ground surface with corresponding sand layer thicknesses of 0.6 m, 0.6 m, and 3.7 m, respectively. The sand was medium-grained, poorly graded, wet, and varied in colour (brown and grey).

Clay till was encountered at a depth of 13.1 m below existing ground surface and continued to end of hole (26.4m) with intermittent sand layers mention above. The clay till was silty, varied in sand content (some sand to sandy), trace amounts of gravel, low plastic, very stiff, moist, and was brown. At a depth of 13.7 m, the clay till changed colour from brown to grey.

7.5 Groundwater

At the time of drilling and upon completion of drilling, all boreholes were found to be dry. Groundwater levels were measured again on November 19, 2011. The following table summarizes the depths to groundwater recorded in the boreholes.

Table 3: Groundwater Depths for Additional Boreholes

Borehole No.	Standpipe Depth (m)	Depth of Groundwater below Existing Grade (m)	
		Upon Completion of Drilling	November 19, 2011
BH IS-3	20.3	Dry	5.5
BH IS-6	13.0	Dry	12.9
BH SSR-3	54.9	Dry	Dry
BH SSR-5	25.9	Dry	24.6
BH SSR-7	26.4	Dry	26.0
BH SPC-4	18.3	Dry	5.9

7.6 Laboratory Program

Classification and index tests were subsequently performed in EBA's Calgary and Edmonton laboratories on selected samples from boreholes to aid in evaluation of their engineering properties. Laboratory tests included the following:

- Natural moisture contents;
- Atterberg limits;
- Grain size analysis; and
- Direct shear test, consolidated drained with residual strength.

Laboratory results are summarized on the borehole logs (Appendix D) and are fully presented in Appendix E.

8.0 TERRAIN HAZARD AND LANDSLIDE MAPPING

8.1 General Approach

EBA carried out terrain hazard and landslide mapping for slope sections over the study area that exceed 15% in slope gradient using air photo interpretation supported with field observation. Terrain polygons

were delineated based on common terrain attributes (such as slope, aspect, geology, drainage, landform, and geomorphic process) and assigned a unique number. A terrain database was compiled that is provided in the data DVD contained in the DVD Pocket in Appendix M. The terrain database contains the following information that is briefly described below. Complete definitions and classification tables regarding these attributes are provided in Appendix F. Many of these definitions are used in the legends of the figures included in this report:

- Polygon number;
- UTM coordinates of the centroid of the polygon (determined by GIS);
- Associated air photo number;
- Land use in the area enclosed by polygon, as per the City's land use definitions (provided in Appendix F);
- Area (in m^2) of the polygon (determined by GIS);
- Overall slope height (in m) of the polygon (determined by GIS at the centroid of the polygon, indicating the elevation difference between the top of the polygon and the toe of the polygon);
- Overall length of slope (in m, measured along the slope) of the polygon (determined by GIS through the centroid of the polygon, indicating the length of slope from the top of the polygon and the toe of the polygon);
- Overall slope gradient (in percent and degrees) of the polygon (determined by GIS at the centroid of the polygon, indicating the slope gradient from the top of the polygon to the toe of the polygon);
- Whether the polygon contains a watercourse (i.e., yes or no);
- Representative cross-section (see Section 11.0);
- Stability rating of the polygon as low, moderate, high, or very high potential for landslide occurrence. This is discussed in detail below and definitions provided in Appendix F;
- The land use (as per the City's definitions provided in Appendix F) where a potential landslide may deposit;
- Comments pertaining to the general character of the polygon as observed from the air photo interpretation, available topography, and field review;
- Type of field check carried out on the polygon (detailed, foot reconnaissance, truck reconnaissance, visual or not checked – definitions are provided in Appendix F);
- If the polygon defined a landslide, then a unique landslide number was assigned in addition to the unique polygon number, and attributes associated with landslides (determined from air photo interpretation) were populated in the terrain database as outlined below and detailed in Appendix F. A derivative landslide database was subsequently developed that is provided in Appendix G:
  - Landslide age (ancient, historic, or recent);
  - Landslide type (earth/rock slump, earth/rock slide, or compound);

  - Landslide depth (shallow, intermediate, or deep);
  - Degree of landslide activity (active, suspended, reactivated, or inactive);
  - Landslide size class (very small, small, moderately small, moderate, moderately large, large, very large, and extremely large); and
- If the polygon contained numerous landslides, then they were not identified as individual landslides, but the relevant landslide attributes were populated in the terrain database.

EBA based the terrain mapping on 1:8,000 scale, colour, aerial photographs that were acquired by the City in 2006. This was the last year that stereo-pairs for the entire study area were available. The subsequent 2010 imagery was acquired as digital orthophotos and cannot be viewed in three-dimensions as stereo-pairs. Terrain polygons were drawn on clear acetate film affixed to the air photo with masking tape in order to preserve the integrity of the original air photo. In total, 510 terrain polygons were defined, corresponding to an area of 1,262 ha. The average polygon size is 2.4 ha. Terrain polygons were digitally captured as described in Section 8.1.3 to form a digital GIS layer that was mapped at a 1:10,000 scale.

Results of the terrain hazard and landslide mapping are described in subsequent subsections.

8.1.1 Air Photo Interpretation

All air photo interpretation was carried out by Shelley Higman, M.Sc., P.Eng./P.Geo., of EBA. As mentioned above, all typing of the identified terrain polygons was completed on the 2006 1:8,000 scale, colour air photos. Information interpreted for the terrain polygons was determined from the 2006 air photos, as well as review of other available air photos and imagery. Specifically, EBA reviewed six decades of air photos from 1955 to 2006, as well as 1999 and 2010 orthophoto and 2010 GoogleEarth Pro imagery. A list of the air photos reviewed is provided in Appendix H. Additionally, 1-m contour information (provided by the City) was utilized in the air photo interpretation.

8.1.2 Fieldwork

Fieldwork was carried out on nine traverse days between August 2, 2011, and August 10, 2011. Ms. Shelley Higman, M.Sc., P.Eng./P.Geo., and Mr. Jiejun Zhao, E.I.T., of EBA, carried out fieldwork between August 2, 2011, and August 6, 2011. Between August 7, 2011, and August 10, 2011, the fieldwork was performed by Ms. Higman and Mr. Kevin Lee, E.I.T., of EBA. Mr. Matt Hopkins, an engineering summer student with the City of Medicine Hat, accompanied the field crews on many of the traverse days, and Mr. Ian Hakes, P.Eng., of the City of Medicine Hat, accompanied the crews on two field days. Mr. Tony Ruban, M.Eng., P.Eng., Mr. Marc Sabourin, P.Eng., and Mr. Michael George, B.E., all senior geotechnical engineers with EBA, each spent separate days in the field with the field crew.

Fieldwork was carried out using a combination of foot traverses and vehicle traverses. Two low-level fixed-wing flights were also completed. All traverses and points of specific observation were collected by a hand-held global positioning system (GPS). Approximate traverse routes, flight paths, and points of specific observation are provided in Appendix I. While mapping was continuous over the study area, the field checking was concentrated within areas of known landslide occurrences, and representative areas of steep terrain, generally outside of private land. Field sites have been identified as either detailed,

reconnaissance, or visual: detailed sites were based on detailed ground inspection, data collection, and measurement of features using hand equipment; reconnaissance sites were also ground inspected by either foot or truck, but did not involve detailed data collection and measurement; and visual sites included observations made from a distance (e.g., from a fixed wing plane or from a viewpoint, etc.)

A total of 350 field sites were recorded (92 detailed ground sites, 141 reconnaissance ground sites, and 117 visual sites) within 510 polygons defined throughout the study area. This represents a check of 69% of the polygons in the study area. Based on the total sloped area (1,262 ha) mapped within the study boundaries, this corresponds to a field check density of about 28 field sites per 100 ha.

Additionally, as discussed in Section 7.0, EBA completed six additional boreholes in areas of existing data gaps to better understand the subsurface stratigraphy and groundwater conditions. Selected site photographs are presented in Appendix J.

8.1.3 Digital Capture

The finalized line work on the air photos was transferred to digital format by digitizing the line work onto the City's 2010 orthophotos using the contour lines provided by the City to ensure the digitized lines followed ridge tops and valley bottoms, as closely as possible.

All polygon attribute data was input digitally, concurrent with the air photo interpretation, eliminating the need for the transferring and checking of attribute data, which is commonly done.

Quality assurance (QA) methods were incorporated throughout the digital capture process to ensure accurate line work. These methods included an independent cross-check of work, as well as colour editing of hard copy draft maps, cross-referencing of the terrain database with the maps and the original air photos, as well as sorting and running attribute checks through the database to search for any discrepancies.

8.2 Slope Gradient Mapping and Top/Toe of Escarpment

EBA generated a slope gradient map based on the following slope classes from a slope gradient raster that was created by EBA from digital elevation data provided by the City of Medicine Hat:

- 0% to 14% (0° to 8°);
- 15% to 32% (8.5° to 17.7°);
- 33% to 44% (18.3° to 23.8°);
- 45% to 59% (24.2° to 30.5°);
- 60% to 69% (31.0° to 34.6°);
- 70% to 79% (35.0° to 38.3°);
- 80% to 99% (38.7° to 44.7°); and
- >100% (> 45°).

This slope gradient map is a useful tool for assisting in the delineation of problematic and potentially problematic slopes. The raster was developed from City of Medicine Hat's Hypsographic Contours. We are told that the contour data was derived from photogrammetrically collected mass points and breaklines, and has a horizontal and vertical accuracy of +/- 0.5 m. However, we are not aware of the year of photography on which the contours are based. The features were subsequently used to generate a TIN (Triangulated Irregular Network), from which a 0.5-m raster was generated using the Natural Neighbours algorithm. EBA notes that a TIN draws straight lines between points to create a surface of triangles where the three corner vertices have elevation attributes and the three edges have slope and direction attributes. A TIN does not interpolate between points so in areas where the contours are not as detailed, the surface will not be as accurate. Overall, the surfaces created are limited by the accuracy and detail of the dataset supplied by the City.

Following creation of the slope gradient map, EBA defined the top and toe of the escarpment features as follows:

- Top of Escarpment – is defined where the slope increases from less than or equal to 15% to greater than 15% (i.e., >15%) in the direction of increasing slope gradient.
- Toe of Escarpment – we have developed two lines to delineate the toe of the escarpment in the direction of decreasing slope gradient:
  - Where the slope breaks to <33% for establishment of the setback from the top of the escarpment as measured from this toe of slope; and
  - Where the slope breaks to <15% for establishment of the setback from the toe of the escarpment as measured from this toe of slope.

The top and toe of escarpment are overlain on the slope gradient map shown on Figure 10.

8.3 Landslide Mapping

EBA mapped 46 landslides within the Medicine Hat area. For each of these landslides, EBA identified which are Ancient, Historic, or Recent. Definitions for each of these are found in Appendix B. The distribution of these landslides is shown spatially on Figure 11. Further to this, EBA identified an additional 139 polygons with small landslide occurrences (too numerous to map on an individual basis), indicating, in total, 185 areas contain landslides. These 185 areas are shown on Figure 12. Of the 185 areas containing landslides, 54 are currently active; the locations of which are shown on Figure 13.

For the 46 landslides, EBA classified them according to size class, with the following results that are also shown graphically on Figure 14:

- Very small (≤ 500 m^2): 1;
- Small (>500 m^2 to 1,000 m^2): 0;
- Moderately small (>1,000 m^2 to 2,500 m^2): 2;
- Moderate (>2,500 m^2 to 5,000 m^2): 8;
- Moderately large (>5,000 m^2 to 10,000 m^2 (1ha)): 5;

- Large (>1 ha to 10 ha): 26;
- Very large (>10 ha to 100 ha): 4; and
- Extremely large (>100 ha): 0.

EBA notes that the size distribution is biased by the fact that the 46 landslides were large enough to define them as separate polygons, and that the numerous landslides within the remaining 139 polygons are typically in the very small to moderately small size classes. Additionally, the size of the landslide is limited by the height of the slope on which it originates. Since the valley slopes have the greatest slope heights, it is not surprising that most, if not all, of the large and very large landslides occur along the SSR as shown on Figure 14. This figure also indicates that the majority of these landslides are of the compound type, meaning that they show characteristics associated with both rotational and translational failure modes (see Appendices B and F for more detailed descriptions).

Four of these landslides occur outside the City limits to the west, in Cypress County. However, EBA has included them in this analysis since the conditions giving rise to their occurrence are not unlike the terrain characteristics documented within the City limits. Most notably, a recent slide that has occurred in the vicinity of TWP Road 130 in Cypress County is uniquely a translational failure involving a considerable portion of the area at the top of the escarpment. Possible causal mechanisms and their bearing on our setback analysis for the City are discussed in Section 10.5.

8.4 Terrain Hazard Mapping

EBA completed terrain hazard mapping in the Medicine Hat area using qualitative hazard probability estimates. These were approximated based initially on evidence of past failures and adverse slope conditions as observed during the site reconnaissance, from aerial photographs, or documented in other reports.

The terrain hazard mapping was then refined based on the hazard susceptibility ratings and criteria shown in Table 4 and landslide probability criteria shown in Table 5 according to the level of acceptable landslide safety outlined in Section 4.5 (i.e., 10% chance of occurring in 50 years). Note that Table 4 pertains to "Potentially Hazardous Slopes". In terms of slope gradient, such slopes generally, but not always, exceed 33% (18°).

Table 4: Qualitative Landslide Susceptibility Criteria for Potentially Hazardous Slopes

Hazard Rating	Criteria
Very High	Evidence of active landslides[1] or slope deformation, regardless of slope gradient or height, showing: ▪ Landslide scarps and/or tracks with exposed mineral soil; or ▪ Active tension cracks at the crest of the slope.
High	Evidence of previous landslides[1] or slope deformation, regardless of slope gradient or height, showing: ▪ Landslide scarps and/or tracks that are re-vegetated; or ▪ Visible settlement in fills, retaining walls; or ▪ Historic tension cracks at the crest of the slope; or ▪ Indicators of instability (e.g. bulging toe, significant, active erosion).

Table 4: Qualitative Landslide Susceptibility Criteria for Potentially Hazardous Slopes (Continued)

Hazard Rating	Criteria
Moderate	Adverse slope conditions, but no evidence of previous landslides[1] or slope deformation, where: slope gradients are steeper than 33% (or 19°) or less than 60% in soft soils with high clay content. Additionally, there may be: ▪ Presence of random fills or yard waste; or ▪ Presence of non-engineered retaining walls; or ▪ Active seepage or surface erosion.
Low	Favourable slope conditions and no evidence of previous landslides[1] or slope deformation, where: ▪ Slope gradients are steeper than 33% (or 19°).

[1] The presence of previous landslides (ancient or historical), as used in this report, indicates either a potential for recurrence or the potential for an event of similar magnitude to occur on adjacent slopes that have similar slope and soil conditions.

Table 5: Qualitative Terrain Hazard Classifications

Terrain Hazard Class	Hazard Rating	Return Period[1]	Probability of at Least One Occurrence in 100 Years[2]	Probable Size	Qualitative Description of Site Conditions
4	Very High	Less than ten years	More than 99%	Depends on slope height, gradient, geomorphic process, and slope composition.	Event is highly probable based on existing/assumed site conditions.
3	High	Ten to 100 years	63% to 99%	Depends on slope height, gradient, geomorphic process, and slope composition.	Event is probable unless the site conditions are significantly better than existing/assumed.
2	Moderate	100 to 500 years	18% to 63%	Depends on slope height, gradient, geomorphic process, and slope composition.	Event is not likely, but possible if there was a significant change to one or more of the existing/assumed site conditions.
1	Low	More than 500 years	Less than 18%	Depends on slope height, gradient, geomorphic process, and slope composition.	Likelihood of an event is remote, although it is possible, given site-specific combinations of site conditions.

[1] Based on adopting a 10% in 50 years as the accepted level of landslide safety (i.e., annual probability of 1/475), as approved by the CoMH (on September 12, 2011) since the project addresses damaging events (to property) and not life-threatening events.

[2] Based on a general person life expectancy of 100 years.

Based on the above criteria, the terrain hazard (i.e., potential for landslide occurrence) associated with the 510 mapped polygons is summarized below and shown on Figure 15. The associated risk to properties is discussed in Section 13.

- Class 1 Terrain Hazard (Low Hazard Terrain): 160 polygons (31% of the polygons), corresponding to an area of 400 ha (32% of the mapped area);
- Class 2 Terrain Hazard (Moderate Hazard Terrain): 117 polygons (23% of the polygons), corresponding to an area of 207 ha (16% of the mapped area);
- Class 3 Terrain Hazard (High Hazard Terrain): 139 polygons (27% of the polygons), corresponding to an area of 331 ha (26% of the mapped area); and
- Class 4 Terrain Hazard (Very High Hazard Terrain): 94 polygons (18% of the polygons), corresponding to an area of 324 ha (26% of the mapped area).

The areas of Class 3 and Class 4 terrain hazards are shown on Figure 16.

8.5 Reliability and Limitations

The accuracy of terrain mapping, and hence the reliability of terrain hazard interpretations depends on numerous factors, such as the skill and experience of the mapper, scale and quality of the air photos, type and density of vegetation, field access, length of time spent in the field, and type and complexity of terrain and surficial materials. For this project, accuracy of terrain mapping is considered to be relatively high because the work was carried out by an experienced mapper and air photo quality is good. Mapping is expected to be less reliable in areas where much of the terrain consisted of steep, rocky, till-covered terrain that made safe access difficult. The chief factor detracting from the accuracy of the mapping is the difficulty in interpretation of seepage zones from air photo interpretation.

As such, the terrain hazard map may not capture all areas of potential concern. There may be other, smaller areas and features that are not characterized as potentially unstable.

The air photos and digital imagery used to review the project area spanned 55 years (1955 to 2010), with coverage available for each decade, including flood coverage from 1995. Coverage that was available for the project area varied in age and scale but was generally consistent in flight direction. Most of the air photos for the entire project were at a good scale ranging from 1:6,000 to 1:24,000.

Field sampling was completed over a nine-day period to confirm interpretations made from the review of available geological information, air photo review, and topographic mapping. The site reconnaissance was conducted during a period of good weather from August 2, 2011, to August 10, 2011. Access to private property was the primary limitation to sampling; however, the City assisted in obtaining approvals for access from most property owners in areas of interest. In total, 92 detailed site observations were recorded. In addition to the site-specific observations, exposures of soil and rock in road cuts were utilized along the road and extensive trail network in Medicine Hat.

The information and analyses contained in this report are based on observations of land-surface conditions and our current understanding of terrain features and slope processes. However, because slope stability is strongly influenced by subsurface conditions that are not apparent from surface observations or from air photo interpretation (e.g., characteristics of subsurface materials, subsurface hydrologic conditions), by events whose time of occurrence cannot be predicted (e.g., extreme storms), and by land management practices, the results and recommendations provided in this report cannot guarantee that no landslides

will occur in areas affected by development activities. Appropriate use of terrain information will, however, reduce the risk of landslides and other geomorphic events.

9.0 SLOPE STABILITY IN THE MEDICINE HAT AREA

9.1 Introduction

The slope stability conditions in the Medicine Hat area have been comprehensively studied by Mckay and Thomson (1980) and Hardy (1984), as well as more broadly by Thomson and Morgenstern (1977). The Mckay and Thomson (1980) report identified 16 landslides within the City limits. The same 16 were commented on by Hardy (1984) but not added to. Many of these landslides are labelled on Figure 2, notably:

- Fertilizer Plant Slide;
- Evilsmelling Bluffs;
- Rattlesnake Slide;
- Police Point Slide;
- Powerhouse Slide;
- Surprise Bluffs; and
- Redcliff Pumphouse Slide.

As described earlier, EBA identified 46 landslides, and numerous smaller landslides, such that there are over 185 documented occurrences of landslides in the Medicine Hat area. Our inventory does not include some of the landslides documented by Mckay and Thomson (1980) because several of these fall outside of the City limits to the north, and similar such landslides occur within the City limits that are considered representative of this type of failure mechanism. EBA's inventory does, however, include landslides outside of the City limits to the west that have failure mechanisms not observed within the City limits, but similar such occurrences are considered to be possible within the City limits under the right set of circumstances.

These previous authors subdivided the study area into distinct valley types, which EBA has adopted in this current study. Associated with each distinct valley type are characteristic landslide activity and failure modes, valley profiles, and upland drainage that are described below.

9.2 Landslide Types and Failure Mechanisms

9.2.1 Bedrock Walled Valley

This valley section extends along the SSR from the western extent of the study area to about 3 km west (upstream) of the Trans-Canada Highway bridge near the east end of Echodale Regional Park labelled on Figure 2. Over the Bedrock Walled Valley, the valley is typically 1 km to 1.3 km wide and 70 m to 90 m deep, and is characterized by steep slope gradients with the steepest sections near the crest of the slope.

The Upper Cretaceous bedrock of the Oldman and Foremost Formations is overlain by generally a veneer of till, which can be up to 15 m thick.

Mckay and Thomson (1980) describe the landslides in this area as having two modes of failure:

- Rockfall failure near the base of the valley slopes where bedrock blocks fail along weak discontinuities in a falling or toppling mode on the steep undercut banks that are more prominent at the outside of meanders. The occurrence of such failures has reportedly been linked to freeze-thaw cycles due to water infilling near-vertical joints in the bedrock; and
- Large-scale compound failure in the bedrock where the failure is characterized by a steep curved back scarp that forms the upper failure surface and extends downwards to the nearly horizontal lower slide surface. This results in the inner slide block(s) moving downward and rotating backward as the failure surface curves and the lower slide mass translating horizontally outward towards the river.

The presence of bentonite in the Upper Cretaceous bedrock makes the bedrock more susceptible to failure. The bentonite occurs as pure beds or as a constituent component of the bedrock and as described by Mckay and Thomson (1980), "increases the swelling which occurs when seepage migrates through the slope along permeable beds such as sandstone or coal seams and along open joints. Associated with the swelling, is an increase in moisture content and a resultant decrease in the available shear strength".

Additionally, Mckay and Thomson (1980) emphasize the role of toe erosion by the river that undercuts and oversteepens the valley slopes.

A key example of this type of failure is the Redcliff Pumphouse Slide (Figure 2) that occurred across from the old Redcliff pumphouse. Although the Powerhouse Slide (Figure 2) occurs within the Preglacial Medicine Hat Valley (Section 9.2.2), it also occurred in this fashion (in 1980). Of the 46 landslides identified by EBA, 9 occur within this area.

9.2.2 Preglacial Medicine Hat Valley

This area starts about 3 km west (upstream) of the Trans-Canada Highway bridge and extends downstream along the SSR to the east and then north, coinciding with the Preglacial Medicine Hat Valley shown on Figure 6. This area also includes tributary valleys of RC and SPC, but for the purposes of this report, these tributary valleys are described separately in Section 9.2.3. This section of the report will focus on the current SSR portion of the Preglacial Medicine Hat Valley.

Along this section of the SSR, the valley is 1.6 km to 2 km wide, generally characterized by a tightly meandering channel cutting through surficial deposits, typically 50 m to 60 m deep, and formed by a dominantly laterally migrating, degrading river. The surficial deposits consist of interbedded till at the western and northern extents of this section (i.e., near the Surprise Bluffs and Rattlesnake and Fertilizer Plant Slides, respectively [Figure 2]). However, near the Ranchlands (Figure 2), the surficial material consists of alluvium. The presence of the tight meanders indicates the absence of bedrock control in this area. However, Mckay and Thomson (1980) report that the present river thalweg is approximately at the bedrock-surficial sediment contact.

The dominant characteristic in this area is the large landslides that are present on the outside of almost every meander. This same observation led Mckay and Thomson (1980) to suggest that the major process

responsible for widening along this section of the valley was the formation of landslides along undercut meander banks and the subsequent erosion of the landslide debris.

Mckay and Thomson (1980) indicate there are two types of landslides present over this section of the SSR within the Preglacial Medicine Hat Valley:

- Deep-seated landslides with a near-horizontal lower failure surface, at or below the bedrock contact. These landslides have a compound failure mode with the rotational movement occurring along the steep curved upper failure surface and translational movement on the lower failure surface. These deeper failures appear to have been initially triggered by lateral river migration and have failed in a retrogressive fashion.
- Shallow landslides that are commonly recorded as creep movement on steep slope sections with seepage zones, and also as shallow, planar slides within the deep-seated landslides. These types of landslides are triggered by natural and artificially induced seepage.

In addition to undercutting from toe erosion by the river, Mckay and Thomson (1980) emphasize the importance of groundwater conditions within the slope sections in the overall stability of slopes within the Medicine Hat Preglacial Valley. A good example of this is the Fertilizer Plant Slide (Figure 2) that has been undercut by the SSR and also contains sag ponds indicating saturated zones and the role that groundwater is playing in its ongoing regression.

The Surprise Bluffs landslide and the Powerhouse Slide are included in the Preglacial Medicine Hat Valley; although both differ from the type of failure exemplified by the Fertilizer Plant Slide: the Powerhouse Slide is more closely associated with the type of landslide occurring in the Bedrock Walled Valley due to the degree of bedrock control, and the failures comprising the Surprise Bluffs are higher than those occurring further to the north. The Surprise Bluffs failures likely occurred on or below the bedrock contact. EBA notes that an underground reservoir structure is located a short distance upslope of these landslides. This reservoir could lead to subsequent movement should it leak and/or be subject to deformation should the failures regress.

The different character of the Surprise Bluffs Slide and the Powerhouse Slide is likely due to their occurrence at the transition from the Bedrock Walled Valley and the Preglacial Medicine Hat Valley as inferred by Figure 6. Of the 46 landslides identified by EBA, 12 occur within this area.

9.2.3 Tributary Valleys

9.2.3.1 General

The tributary valleys of RC and SPC also occur within the Preglacial Medicine Hat Valley as inferred by Figure 6. These tributary valleys have cut down about 30 m to 40 m through surficial deposits, and the tight, meandering streams occupy broad, low-gradient valley floors. The width of these valleys ranges from about 140 m to 490 m wide, which is considerably wider than the hydraulics of the present-day streams. Bedrock does not appear to be involved in any of the instabilities.

9.2.3.2 Seven Persons Creek

EBA documented numerous areas of instability along the valley walls of SPC. These instabilities are similar in nature, but much smaller in scale and magnitude, to those on the SSR within the Preglacial Medicine Hat Valley. They tend to occur due to seepage pressures behind the valley walls and from toe erosion by the creek. These landslides are primarily of a compound, regressive nature where they occur in connection with toe erosion by the creek, and are typically shallow to intermediate in depth. Where they occur in connection with seepage, they tend to be translational in nature and of relatively shallow depth. Key examples are the ADM Slide, the Eagleview Slide, and the Canyon Creek Slide that are shown on Figure 17 and described in detail in Section 10.0. Of the 46 landslides identified by EBA, 18 occur within SPC.

9.2.3.3 Ross Creek

RC defines the southeast boundary of Medicine Hat, such that, generally, only its west valley slope falls within the City limits. An active rail line separates the creek from most of the west valley slope: the creek only coincides with the toe of the west slope in four locations. As such, toe erosion by the creek is not a common source of instability along RC within the study area. The occurrence of instability is less frequent than that in SPC and the SSR. Where instability occurs, it is generally due to seepage pressures in the valley slopes, resulting in relatively shallow, translational failures. Of the 46 landslides identified by EBA, only 2 were documented within the RC tributary valley.

9.2.4 Interior Slopes

The Medicine Hat area consists of several slope sections that are not associated with the current streams and river flowing through the City. They are likely remnants of streams associated with the Preglacial Medicine Hat Valley. One slope section in the northeast corner of the study area is included in this category even though the coulee system contains a creek system. EBA documented several slope sections with instability along these IS sections, but only documented three landslides, all of which occur in the northeast corner of the study area within the coulee system with the active stream channel. Generally, however, instability along the IS is due to seepage pressures that result in relatively shallow slumps and compound failures. Translational failures are more common on the drier slope sections.

9.3 Effects of Mining

The distribution of areas with documented coal mining activity and areas of known clay mining were discussed in Section 6.6 and the distribution of the areas is shown on Figure 7. Mining activity can influence the local stability of an area. In the case of underground mines, collapse of the mine shafts can lead to collapse features, such as sinkholes appearing at the ground surface and can also lead to localized increases in slope gradient. Depending on the nature of the ground surface where these appear, a landslide could potentially be initiated. With respect to open pit mining, the active pit walls are typically marginally stable, such that oversteepening of the slope by excavation can lead to the occurrence of landslides. Mine tailings from either underground or open pits can lead to slope stability issues, depending on how the tailings were placed.

In consideration of the landslides that have occurred in the areas of known mining, there are four: the Redcliff Pumphouse Slide plus two other events and the Police Point Slide (Figure 14). The Redcliff

Pumphouse Slide has occurred on the south valley slope of the SSR, across the river from the former Redcliff Pumphouse at the western extent of the City limits. Its location is at the western end of the documented coal mine workings in this area. This landslide is described by Mckay and Thomson (1980). These researchers have defined toe erosion by the SSR as the triggering mechanism such that this event was not associated with the nearby coal workings. The other two landslides in this area appear to be ancient, translational events that likely pre-date the mining activities. They also appear to also be due to erosion at the toe from the SSR.

Mine tailings are evident in the area of the underground mine, but no evidence of slope instability associated with these tailings was noted.

The Police Point Slide has occurred at the northeast end of the open pit clay mine. This landslide is also described in detail by Mckay and Thomson (1980). They indicate that the landslide occurred pre-1938, and that the triggering mechanism was toe erosion and not mining activity.

EBA notes that the density of landslides is relatively high in areas with documented mining activity. However, these landslides appear to have occurred primarily from toe erosion, as the areas are all located along the outer bend of the SSR, and do not appear to be associated with mining activity. These facts suggest that coal and clay mining in the area have likely not created a significant negative influence on slope stability.

10.0 CASE STUDIES

10.1 Introduction

The information presented in the previous sections shows that both active and past landslide activity is prevalent along the SSR and the SPC and to a lesser extent along the RC coulee systems. The City asked EBA to consider the following recent areas of landslide activity as case studies for understanding the geology and factors contributing to their occurrence. Based on this information, these key sites represent the base studies on which EBA's setback analysis for the entire City is established. Three of the studies are along SPC, and one is on the SSR in Cypress County, west of the City. The locations of these areas are shown on Figure 17. Key attributes for each are summarized in Table 6.

10.2 ADM Slide

The ADM Mills Slide is a well-known, recent slide in Medicine Hat. It is discussed in detail below to provide a 'benchmark' to readers of this report.

10.2.1 EBA, A Tetra Tech Company, 2011 Report

EBA prepared a report entitled "Slope Stability Assessment ADM Mills Slide – SPC Medicine Hat, Alberta," in June 2011. The report provided a slope stability assessment on a section of valley located along SPC, near the Saamis Memorial Funeral Chapel in the City, Alberta.

The scope of work for this report included review of historical data relative to site, site reconnaissance, a one borehole drilling program, and slope stability analysis.

The slope stability analysis was performed along three cross-sections located along the slope using the General Limit Equilibrium method (GLE) with the aid of computer software program Slope/W. Geometries of slope sections were obtained from site contour drawings and verified by field survey. Analysis utilized porewater pressure as a means to represent groundwater levels to account for any perched water tables that may exist in sand and or silt seams present in the till. Soil strength parameters utilized in analysis was established based on triaxial testing coupled with EBA's experience in materials in this area.

Soil strength and groundwater parameters selected for analysis of the slopes are provided in Table 7.

Table 7: ADM Mill's Soil Strength and Groundwater Parameters (EBA 2011 Report)

Material	Unit Weight (kN/m^3)	Cohesion c' (kPa) *	Friction Angle ϕ' (˚)	Porewater Pressure r_u
Glaciolacustrine Clays	18	2	30	0.2
Upper High Plastic Clay Till	17	0	20	0.3
Upper Medium Plastic Clay Till	18	10	30	0.1
Lower Clay Till	18	10	30	0.1

*It should be noted that the Medicine Hat Slope Setback Report stability analysis uses different values for soil parameters. Site-specific testing has been carried out to establish soil parameters for this location and may not be representative of the soil parameters for areas reviewed in the Medicine Hat Slope Setback Report.

Results of the analysis displayed signs of surficial instability with translational and rotational failure in the upper portion of the slope and shallow rotational failure along the overall slope. Analysis revealed Factor of Safety values were approximately 1.0 when using the above parameters.

The remediation recommendation as a result of this study included flattening the slope to a 3H:1V configuration from the existing toe of slope to the crest elevation. Stability analysis revealed that this change in slope angle would yield a Factor of Safety of 1.5 and prevent deep seated instability at the new proposed crest level. Consideration could be given to reconfigure the slope to a 2.5H:1V to reduce the volume of earth work but this would reduce the overall Factor of Safety to 1.2. To mitigate the risk of erosion, slope protection and additional benching should be considered in this case.

10.3 Eagleview Slide

10.3.1 EnviroGeoTesting Sabatini 1999 Report

EnviroGeoTesting Sabatini prepared a report entitled "Report on the Bank Stabilization Study" in May 1999 for the City regarding the slope stability located on a portion of the SPC bank. The slope exists south of 32 Street SW extending from 10 Avenue SW, approximately 150 m west in Medicine Hat, Alberta.

The objective of this report was to identify significant features of the environment to determine the cause of the observed instability, provide remedial measures, and cost estimates for remedial measures. Surface runoff analysis and bank erosion analysis were carried out by a hydro-consultant followed by a slope stability analysis.

The slope stability analysis was performed along two cross-sections of the slope using the Bishsop-Morgenstern method. Three different groundwater levels were analyzed for each cross-section. The first case analyzed was the present case for the existing groundwater condition and toe conditions. The second case was analyzed for a rise in groundwater level with no changes to toe conditions. The third

case was analyzed for a rise in groundwater level and possible toe erosion. Table 8 presents a summary of the factor of safety results obtained from analysis.

Table 8: Factor of Safety Results (EnviroGeo 1999 Report)

Section	Condition	Factor of Safety
A-A	Present Condition	0.77
A-A	Groundwater Rise	0.76
A-A	Groundwater Rise and Toe Erosion	0.55
B-B	Present Condition	0.73
B-B	Groundwater Rise	0.72
B-B	Groundwater Rise and Toe Erosion	0.51

The findings of the stability analysis indicated that the slope in its condition (1999) is unstable. The apparent cohesion allows the slope to remain stable; however, is compromised by wetting from rainfall, seepage, or any other sources of external water imposed on the slope. There is evident seepage along the slope face and coupled with toe erosion a loss of cohesion is apparent, which will lead to slope failure at this site.

The remedial measures put forward for recommendation included earth reinforcement of the bank with erosion control, slope flattening with channel diversion, and slope flattening with erosion control and acquisition of property. After selection of the remedial method(s), a re-evaluation was recommended to be carried out.

10.4 Canyon Creek Slide

10.4.1 EnviroGeo Testing 2002 Report

EnviroGeo Testing prepared a report entitled "Geotechnical Investigation and Slope Stability Report" in June 2002 regarding the proposed residential subdivision located within a portion of the S.E. ¼, Sec. 15, Twp. 12, Rge. 6, W4M, within the southwest section of Medicine Hat, Alberta. A slope exists on the north bank of Canyon Creek passing through the study area.

The objective of the investigation was to evaluate the slope, determine subsurface soil conditions, and to determine ground water conditions. The information was then used to evaluate the feasibility of proposed development in the area and complete a slope stability analysis.

The slope stability analysis was performed along three cross-sections along the slope using computer software GSLOPE. The result of the analysis revealed a slope factor of safety ranging between 0.874 and 1.171 and does not meet the minimum required factor of safety of 1.5. The following table provides a summary of the factors of safety determined from the analysis and required setbacks to acquire a factor of safety of 1.5.

Table 9: Factor of Safety Results (EnviroGeo 2002 Report)

	Section AA	Section BB	Section CC
Existing Slope	46% (24.7 ˚)	45% (24.2˚)	60% (31.0 ˚)
Existing Factor of Safety	1.134	1.171	0.874
Factor of Safety with Setback (Setback)	1.587 (15 m)	1.523 (17 m)	1.548 (30 m)

A building setback of 22 m to 37 m from the top of escarpment or 7 m from rear of property line was recommended.

10.4.2 EBA, A Tetra Tech Company, 2007 Report

EBA prepared a report entitled "Canyon Meadows Subdivision Review of Geotechnical Reports" in January 2007 in regards to review of geotechnical reports with a specific focus on slope stability. The following reports were provided for review:

- June 2002, "Geotechnical/Investigation and Slope Stability Report, SE15-12-6 W4M Medicine Hat, Alberta," for Kingsland Developments Inc., prepared by EnviroGeo Testing;
- November 2005, "Geotechnical/Investigation Report Canyon Creek Meadows, Medicine Hat, Alberta," for Kingsland Developments Inc., c/o Focus Intec, prepared by EnviroGeo Testing;
- January 13, 2006, "Deep Fills Report, Canyon Creek Meadows, Medicine Hat, Alberta," for Focus Intec, prepared by EnviroGeo Testing;
- April 2006, "Additional Stability Analysis, Canyon Creek, SE15-12-6-W4M, Medicine Hat, Alberta," for Kingsland Developments Inc., c/o Focus Intec, prepared by EnviroGeo Testing; May 1, 2006, "Additional Comments and Recommendations, Canyon Creek Meadows, Medicine Hat, Alberta," for Kingsland Developments Inc., prepared by EnviroGeo Testing; and
- August 11, 2006, "Slope Erosion Protection Canyon Creek Meadows, Medicine Hat, Alberta," for Kingsland Development Inc., prepared by EnviroGeo Testing.

Review of the reports above covered toe erosion, fill placement of the slope, clay deposits, and slope stability analysis. Recommendations upon completion of review included justification for the strength parameters used in the slope stability analysis and reconsiderations of the use of the swale at the top of the slope.

10.5 Cypress County TWP Road 130 Slide

Although this landslide has occurred outside the City limits, EBA has included this recent landslide in this analysis since the slope and soil conditions giving rise to its occurrence are similar to terrain characteristics documented within the City limits. As mentioned above, most of the landslides occurring along the SSR west of the City limits are generally rotational, or relatively shallow, planar (translational) failures, but most are a compound landslide involving elements of both translational and rotational failure mechanisms. The TWP Road 130 in Cypress County is uniquely, a block (translational) failure involving a considerable portion of the area at the top of the escarpment. No other landslides in the area are similar to this occurrence. Additionally, aside from the subdivision (that we are told was established in the 1970s) located directly above this landslide, there is little development along the SSR in the vicinity of Medicine Hat on which to base inferences on the effects that development has had on slope stability. EBA's site observations indicate:

- The slide measures about 110 m to 125 m wide across the top and is about 10 m to 12 m deep; it extends down to the river over a distance of about 255 m, of which 55 m of this has formed a depositional fan within the SSR.

- It appears that roughly 80,000 m^3 of material was mobilized from the initiation zone; the depositional area roughly equals the size of the initiation area.
- A series of tension cracks were observed upslope of the crest of the failure, suggesting that the landslide continues to regress.
- Air photos indicate that this is a site of an ancient, compound failure, of intermediate depth, whose occurrence was likely related to toe erosion by the SSR.
- Discussions with one of the property owners directly upslope of the initiation zone indicates that slope movements in this area originated in 2005. Observation of available imagery does show the development of scarp-like features on the 2006 air photos. The 2010 orthophotos show the failure. The property owner indicated that substantial movement occurred in 2008 (Figure 18).
- The property boundary was originally set back about 50 m to 80 m from the top of the escarpment and is now about 33 m from the crest of the initiation zone.
- The property above the landslide is on three septic fields; adjacent home owners are also on septic fields.
- The above property owner has a 580 m^2 dug-out on his property; adjacent home owners also have similar sized dug-outs.
- Groundwater seepage was observed within the landslide track.
- A distinct white layer is apparent near the base of the failure, possibly bentonite.

EBA completed a back-analysis of this landslide, and could only achieve failure by adding a weak layer (such as bentonite). The analysis indicates a Factor of Safety of 0.22 for the critical failure surface and a setback of 80 m from the top of the escarpment to achieve a Factor of Safety of 1.5 (see discussion in Section 11.0). The cross-section and results of the analysis are shown in Appendix K (Figure K-37A and K-37B). The stratigraphy used in this model was based on field observations and available water well information. The failure mode is a translational block failure, which is unique in this area, based on the types of landslides observed in adjacent areas.

To our knowledge, this landslide has not been investigated. In absence of a detailed analysis, our preliminary observations suggest that the 30-year old subdivision may have played a role in the occurrence of the landslide on what is generally marginally stable to unstable terrain in this area. Potential contributing factors could be the water storage dug-outs, lawn irrigation, or perhaps failure of one or more septic systems. Further investigation is required in order to determine probable cause. However, terrain conditions are similar within the Medicine Hat area, and therefore, approvals of future developments within such areas should take the occurrence of this type of landslide into account.

11.0 SLOPE DATABASE AND SLOPE STABILITY ANALYSIS

11.1 Introduction

The previous sections demonstrate that historical and active landslides are extensive in the Medicine Hat area. The objective of this section is to describe our approach for developing guidelines for safe, long-term setbacks for development. To achieve this, EBA considered:

- The stability of representative slopes over the study area; and
- The long-term lateral migration of the streams and the river flowing through the study area since toe erosion is a significant trigging mechanism for the observed slope instability.

To accomplish this, EBA examined the slope stability of representative areas within the study area based on the results of the landslide and terrain mapping, as well as our understanding of the various landslide failure modes and triggering mechanisms. The representative areas were assembled into a slope database based on the failure modes, degree of landslide/slope activity (including shallow slope sections that are believed to represent the ultimate, long-term stable slope angle [Cruden et al 1989]), slope height, slope gradient, geology, and groundwater conditions.

In total, 37 cross-sections were generated based on the high quality, hypsographic contours available from the City. These cross-sections have been named according to the following four geological sections of the study area that have been defined based on the discussion in Section 9.0:

- SSR;
- SPC;
- RC; and
- IS.

The cross-sections are then numbered sequentially from downstream to upstream, or from east to west, specifically:

- SSR cross-sections are identified as SSR-1A/1B/1C to SRR-11, with a total of fifteen slope sections;
- SPC cross-sections are identified as SPC-1 to SPC-7A/7B, with a total of nine slope sections;
- RC cross-sections are identified as RC-1 to RC-4A/4B, with a total of five slope sections; and
- IS cross-sections are identified as IS-1 to IS-7, with a total of eight slope sections.

The locations of these cross-sections are shown on Figure 19. A summary of key attributes of each of the slope sections is provided in Table 10. A detailed presentation of the slope cross-sections is provided in Appendix K.

Our methods for determining the stability of each of the slope sections and lateral stream migration are described in the sub-sections that follow, along with the results of our analyses.

11.2 Slope Stability Analyses

11.2.1 General

The main objective of the slope stability analysis was to determine potential failure planes, potential failure mechanisms, and resistance of slopes from failure by sliding or collapsing. The analysis results were used to develop the appropriate setback which is being (or will be) used for slopes across the study area.

A total of 29 locations were selected and evaluated across Medicine Hat. Ground elevations for each location were gathered using the computer software program Arc GIS and were used to developed slope profiles for the analyses.

Soil stratigraphy and soil properties (unit weight, cohesion, and internal friction angle) were referenced from previous reports, previous borehole drilling programs, back-analyses from case studies (Section 10.0), and supplemented by the investigative program (Section 6.0) to develop the models used for analysis. A list of referenced material is available in Table 1.

It should be noted that geological conditions are innately variable. Glacial deposits, in particular, are seldom spatially uniform. At the time of preparation of this report, information on the subsurface stratigraphy is available only at discrete borehole locations. In order to develop cross-section models from this information, it has been necessary to make some assumptions concerning conditions other than those at the borehole locations.

The following soil parameters were used for the slope stability analysis.

Table 11: Soil Parameters Used in Stability Analysis

Soil Type	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (Degrees)	Porewater Pressure (Ru)
Clay Till	20	5	30	0.2 – 0.3
Clay High Plastic	18	1	18	0.3
Glaciolacustrine Clay	18	2	26	0.2 – 0.3
Upper Silt	18	0	30	0.2 – 0.3
Silt	18	0	32	0.2 – 0.3
Upper Sand	19	0	30	0.2 – 0.3
Sand	19	0	32	0.2 – 0.3
Sandy Gravel	20	0	33	0
Gravel	20	0	34	0
Bedrock	22	15	28	0
Bentonite	19	0	7	0.3
Silty Clay Sand*	18	0	28	0.2

*Cross-section 17B also known as Evilsmelling band.

It should be noted that the porewater pressure (Ru) parameter was only utilized in soil layers above the ground water table.

A comparison chart of soil parameters used in the referenced material is available in Table 12.

The following sections present a summary of the results and methodology used in the slope stability analysis and development of slope setback distances.

11.2.2 Approach

All slope models were analyzed using the Morgenstern-Price limit equilibrium method, while soil properties followed the Mohr-Coulomb model. The Morgenstern-Price method is a method of analyzing both shear and normal interslice forces to satisfy both moment and force equilibrium in a given slope. Mohr-Coulomb is a mathematical model used to describe and define shear strength of different soil types.

Global stability analysis of slopes was carried out using computer software program GeoStudio 2007 (Version 7.17 Build 4921). Using Slope/W, a component of GeoStudio, cross-sectional slope profiles were modelled and analyzed to obtain a factor of safety.

The factor of safety is the numerical ratio of the resisting forces to the driving forces causing movement in a slope. A factor of safety equivalent to 1.0 would represent an equilibrium of driving and resisting forces and indicate incipient failure of the slope. A common factor of safety used in slope setback development is 1.5, a safety margin of 50%, and is intended to help mitigate uncertainties in soil stratigraphy, soil properties, pore pressure, and modelling, and is considered a reasonable measure of safety.

A total of 37 cross-sections were modelled and analyzed following the methods mentioned above. Upon completion of analysis, the top of escarpment and toe of slope were identified to determine an appropriate setback. The top of escarpment was identified where grade percentage of slopes transitioned from slopes less than 15% to slopes greater than 15%. The toe was identified where grade percentage of slopes transitioned from slopes greater than 33% to slopes less than 33%, if the slope was less than 33% then 15% was used. The gradient of 33% was selected as the toe of slope from the analysis since: 1) most, if not all, of the landslides inventoried initiated at a slope gradient greater than 33% and generally started depositing at a slope gradient less than 33%; and 2) the toe of the critical slip surface from the stability analysis typically emerged on the slope at slope gradients less than 33%.

Using the Safety Map feature in GeoStudio, failure planes with factors of safety less than 1.5 were identified. Examining each cross-section's Safety Map, it is possible to determine where the critical failure plane that will have the most impact, in regards to horizontal setback from top of escarpment, on the slope would occur.

Appropriate setback was determined as a horizontal distance back from crest of slope where potential failure planes, identified by the model, presented a factor of safety equal to or greater than 1.5. In cases where slope models presented no failure planes with factors of safety less than 1.5, a minimum 6 m setback from top of escarpment is recommended to account for any shallow surficial movement.

11.2.3 Results

Two cases were taken as critical slope failure planes during the analysis. The first was the failure plane that exhibited the lowest factor of safety that intersected or encroached the top of escarpment. The second was the failure plane that exhibited the largest setback distance from top of escarpment still maintaining a minimum factor of safety of 1.5. Results of each failure plane for the cross-sections analyzed are presented in Appendix K.

The setback distance, slope height, slope inclination, and critical factor of safety is presented in Table 13 appended to this report.

The setback distance for the cross-sections ranged between 6 m and 56 m for interior slopes, between 6 m and 62 m for slopes located along RC, between 6 m and 80 m for slopes along SPC, and between 6 m and 97 m for slopes along the SSR.

Slope height and slope angle were calculated using slope topography based on contour lines using GIS.

11.2.4 Discussion

Slope height can provide a good indication whether or not a slope is at risk of failure; however, it can be a poor indicator of the slope setback required to provide a reasonable measure of safety. Caution needs to be taken when developing slope setback solely based on slope height. The recommended slope setbacks discussed in this section refer to slope setbacks calculated from Slope/W models.

Slope setback based solely on slope height may lead to overly conservative slope setbacks or inversely unsafe slope setbacks, as seen in Interior Slopes IS-1 and IS-3A for example. IS-1 has a slope height of approximately 25 m and IS-3A has a slope height of approximately 22 m. A difference in slope height of 3 m, yet the recommended slope setback distances are 34 m and 56 m for IS-1 and IS-3A, respectively. In this situation, given only one data set, i.e., IS-1, and evaluating IS-3A as another Interior Slope, IS-3A may have been given a setback less than what was recommended and pose a potential safety risk.

Utilizing only slope angle in slope setback distance provides a better indication of the slope setback requirement as seen in the sample data set for IS and RC slopes. IS and RC slopes that were equivalent or exceeded a slope angle of 3H:1V, all exhibited factors of safety greater than 1.5 that extended to the top of the escarpment. In cases where the factor of safety were equivalent or greater than 1.5 while encroaching the top of escarpment, a minimum setback distance of 6 m was determined to be a reasonable setback distance from top of escarpment.

11.3 Lateral Migration

11.3.1 Approach

Lateral stream migration is an important consideration in the long-term slope stability of valley slopes that are in contact, or are in close proximity, to flowing water. As discussed in previous sections, toe erosion is one of the main landslide triggering mechanisms along the valleys within the Medicine Hat area. It is difficult to model the effects of lateral migration on slope stability since it causes a progressive change in the morphology of the slope. We have assumed that a horizontal loss of material at the toe of the slope due to lateral migration of the channel will result in an equal loss in horizontal distance at the top of the slope. We would have been able to verify this assumption if we could have measured the corresponding changes to the top of the escarpment if topographic information was available for the period of record. Unfortunately, the City only had one year of topographic information available. Our assumption of the lateral change at the toe effecting an equal change to the top of the slope is likely over-simplified, but is likely conservative. Lateral migration is considered an important factor in determining safe setbacks for development, especially in light of climate change.

As such, the approach EBA took was to measure the horizontal change in stream width over a period of record from 1955 to 2010. In doing so, we also defined stream reaches for each of the SSR, SPC, and RC according to common stream characteristics. For the SSR, 4 reaches were defined; for SPC, 52 reaches were defined, and for RC, 12 reaches were defined. These are labelled on Figure 20 as follows:

- SSR: SSR-R1 to SSR-R4;
- SPC: SPC-R1 to SPC-R52; and
- RC: RC-R1 to RC-R12.

Because RC flows in and out of the City limits, the sections that fall outside of the City limits were assigned a single stream reach number (e.g., RC-R4 and RC-R6 fall outside the City limits). If these reaches were within the study area, they may be divided into additional reaches based on stream characteristics.

Available aerial photographs from 1955 represent the oldest available air photos of record. These were scanned and geo-referenced from known geographic features and digitally input into the GIS platform Arc Map. Stream edges from this 1955 coverage where digitized and compared to the stream edges mapped on the 2010 orthophotos. Figure 20 shows the stream edges for the two imagery years.

EBA then considered which stream reaches were in contact with, or in close proximity to, the existing valley slopes, and which reaches were covered by both the 1955 and 2010 imagery. Table 14 summarizes the results of this review. Where imagery was available for both years (representing a time span of 55 years), and where valley slopes could be affected by hydrological processes, EBA measured the change in stream width between the two image sets. Measurements were determined for the left bank (defined as when facing downstream) and the right bank. Where the stream increased in width (i.e., moved into the bank), measurements were recorded as positive; where the stream decreased in width, measurements were recorded as negative. To ensure the measurements were representative, several measurements were completed on longer stream reaches and fewer on shorter stream reaches, and an average determined for each reach. Table 14 indicates which reaches were measured, and the number of measurements completed for each stream reach.

11.3.2 Assessment and Results

The measured changes in stream width over the period of record from 1955 to 2010, representing a period of 55 years, are summarized in Table 15. The rate of change per year was also calculated and is also shown on Table 15. Small changes in stream morphology occur on a yearly basis, primarily due to annual aggradation and degradation processes. Channel forming events, however, occur on an infrequent basis, and usually occur in connection with a hydroclimatic event (generally in the summer months). These types of events can significantly alter the fluvial geomorphology of the stream, and are typically events that would cause an abrupt increase in channel width that could initiate instability on an affected, adjacent slope.

In consideration of this, EBA reviewed available hydrometric information from the Water Survey of Canada from the following hydrometric stations:

- SSR at Medicine Hat (05AJ001) – period of record 1911 to 2010; regulated flow;

- SPC at Medicine Hat (05AH005) – period of record: 1910 to 2010; regulated flow since 1955; data absent between 1957 and 1972; and
- RC at Highway 41 (05AH052) – period of record 2000 to 2010; regulated flow.

Over the period of interest, from 1955 to 2010, several significant flow events have occurred that judging from the data from the SSR are larger, or as large, as events prior to 1955, indicating that the period of interest is representative of the type of flow events that have occurred over the hydrometric station's period of record. The greatest peak flow recorded on the SSR was in 1995 and second highest was 2010. For both SPC and RC, 2010 was the highest peak flow recorded. In total, over the period of interest, there appears to be about four significant flow events (1975, 1995, 2005, and 2010) that could affect channel change.

For the setback analysis, EBA considers the period of interest for the lateral migration analysis to be representative of long-term channel migration effects. As such, we multiplied the annual rate of change by a representative timeframe of 50 years to arrive at the expected long-term channel migration values:

- SSR:
  - R1: 27.1 m;
  - R2: 11.2 m;
  - R3: 18.1 m; and
  - R4: 18.2 m.
- SPC: 8.2 m (that applies to Reaches: R2, R3, R5, R7, R9, R11, R13, R15, R17, R19, R21, R23, R25, R26, R27, R28, R29, R30, R31, R33, R35, R37, R39, R41, R42, R43, R44, R45, R47, R49, R51, R52) .
- RC: 8.5 m (that applies to Reaches: R1, R2, R3, R5, R10).

The above values would be added to the established setback from the top of the escarpment such that the established setback from the escarpment accounts for instability associated with the current slope morphology (as well as geological and hydrogeological conditions), and the lateral migration accounts for changes that may occur to the overall slope morphology as a result of expected stream channel changes (see Section 12.0). Should mitigation measures be undertaken along the above reach sections to prevent lateral migration, then the above lateral migration value does not need to be applied.

11.4 Discussion

Table 16 summarizes the cross-section information with the terrain hazard mapping and results of the slope stability analyses. Synthesizing the information discussed to this point, it is clear that toe erosion by streams and seepage pressures within the coulee slopes are the main causal mechanisms for slope instability in the Medicine Hat area. The presence of the low strength bentonite layer, in places, is also a main cause of instability. New and existing developments can intensify these factors by some of the following:

- Increasing the height of the groundwater table through irrigation, placement of storm detention ponds at the top of slopes, placement of swimming pools, ponds or septic fields at the tops of slopes, leakage

of existing storm or sanitary lines, etc. Several examples of stability issues associated with each of these items were observed in the Medicine Hat area.

- Increasing the peak flows in the stream systems and tributary coulees through the cumulative effects of the above inputs to groundwater, by directing storm runoff to these areas, and by an expected increase in precipitation with global warming. Several examples of such occurrences were observed along SPC. EBA also documented what we believe to be an unusually high number of landslide events associated with the increased precipitation (and increased stream flow) recorded in 2010.

The results of the lateral migration analysis indicate that stream migration is significant, such that slopes currently exhibiting stable behavior could become marginally stable to unstable over the next 50 years. Similarly, the results of the stability analyses and terrain hazard mapping show that many slope sections in the City are unstable. In several cases, existing properties are at risk (as discussed in Section 13.0), indicating that an updated setback analysis and policy are needed to avoid these situations from developing in the future and to determine which properties are at risk (using modern computer technology) in order to develop and prioritize mitigation strategies.

12.0 REVISED DEVELOPMENT SETBACK GUIDELINES

12.1 Approach, Geological Sectors, and Definitions

This section describes a proposed setback policy that, similar to the previous Hardy (1984) approach, is based on Top of Escarpment and Toe of Escarpment setbacks. The Hardy (1984) approach divided the City into four, arbitrary, design sectors (A, B, C, and D) and based the setbacks on the height of slope, specifying a multiple of the height of the slope as the amount of setback that would be measured either from the Top of the Escarpment for developments at the top of the slope, or measured from the Toe of the Escarpment for developments located at the toe of the slope.

EBA's approach uses the combined results of our air photo interpretation, landslide and terrain hazard mapping, representative slope database, and results of our slope stability and lateral migration analyses for the setback policies developed. To start, we use the four Geological Sectors defined in Section 11.1, and shown on Figure 21, as the basis for defining the Geotechnical Setback Sectors over the study area, specifically:

- SSR;
- SPC;
- RC; and
- IS.

Setbacks from the top of the escarpment have been developed based on a static Factor of Safety of 1.5, as recommended in the Canadian Foundation Engineering Manual (2006). The setbacks have been expressed as a ratio of horizontal to vertical (H:V), such that the horizontal distance is measured from the toe of the escarpment. As an example, if a development is proposed at the top of a slope with a slope height of 10 m, and setback is specified as 3H:1V, then the setback distance for the development is 30 m, as measured

(horizontally) from the toe of the slope. For the purposes of establishing the top of the escarpment setback, the following definitions apply:

- The top of escarpment is the point at which the overall slope gradients increase to >15%, in the direction of decreasing elevation;
- The toe of the escarpment is the point at which the average slope gradient decreases to less than 33%, in the direction of decreasing elevation; and
- The height of slope is defined as the difference in elevation between the top of the escarpment and the toe of the escarpment (i.e., <33%).

An additional setback would be applied to this if the toe of the slope is in contact with, or in close proximity to, a stream channel, in order to provide the additional protection required for lateral stream migration.

Setbacks from the toe of the escarpment have been developed based on the height of slope, and are measured horizontally from the toe of slope. The toe of slope, in this case, is defined as the point at which the average slope gradient decreases to less than 15% (in the direction of decreasing elevation). The height of the slope is equal to the difference in elevation between the top of the escarpment and the toe of the escarpment (i.e., <15%).

The proposed setback policy is described in the sections that follow.

12.2 Revised Setback Policy

The proposed setback policy is set out below as it pertains to the Top of Escarpment Setback and the Toe of the Escarpment Setback in order to prevent development on unstable or potentially unstable terrain, and to provide access should remedial work be required. Application of these policies has resulted in the setback lines shown on Figure 26. A step-by-step guide outlining how to use this policy is provided in Appendix L.

12.2.1 Top of the Escarpment Setback

Required setback distances from the top of escarpment are determined according to slope gradation as general guidance. The gradations are based on the potential for the occurrence of a deep-seated failure, where Hardy (1984) indicates that a deep-seated failure is more likely in terrain sloping in excess of 33%, which appears to be consistent with our findings. The following three gradations are defined for the Medicine Hat area:

- Overall Slope Gradient <15% – no setback required from a geotechnical perspective;
- Overall Slope Gradient 15% to 33% – 6 m setback plus the associated lateral migration as per the applicable reach sections outlined in Table 17, measured horizontally, from the top of the escarpment; and
- Overall Slope Gradient >33% – the setback shall be established according to the Geotechnical Setback Sectors defined in Table 17, and discussed below.

Overall slope gradient is defined as the slope gradient along a hypothetical line joining the toe of the escarpment to the top of the escarpment.

In the cases where the overall slope gradient exceeds 33%, EBA has defined 17 Geotechnical Sectors as follows:

- IS – four geotechnical setbacks sectors labelled IS-a to IS-d on Figure 22;
- SSR – seven geotechnical setbacks sectors labelled SSR-a to SSR-g on Figure 23;
- SPC – four geotechnical setbacks sectors labelled SPC-a to SPC-d on Figure 24; and
- RC – two geotechnical setbacks sectors labelled RC-a and RC-b on Figure 25.

Table 17 indicates the setback applicable to each of these geotechnical setback sectors for slope gradients greater than 33%. Table 17 further indicates which areas would require additional setback for lateral migration (LM) by listing all applicable stream reaches that are in contact with, or in close proximity to, an escarpment. As an example, should a development be proposed in an undeveloped area along the SSR within reach SSR-R4 and the Geotechnical Sector identified as SSR-f, then the setback would be 2.6H:1V plus 18.2 m for lateral migration. If the height of the slope is 48 m (as measured from the 33% toe of slope line), then the setback for slope stability would be 124.8 m as measured horizontally from the toe of slope (the 33% line) plus 18.2 m (measured horizontally) for lateral migration, equaling a total setback of 142.9 m (which in this example, would be about 33 m from the top of the escarpment). In this particular example, the terrain has been rated as having a moderate hazard and has an overall slope gradient of 41%.

If the setback, calculated with the formula provided in Table 17, is less than the default of 6 m plus the associated lateral migration used in all areas with the slope gradient of 15% to 33%, then the default of the 6 m plus lateral migration (if applicable) is used, as measured from the top of the escarpment.

Within the GIS, setbacks were determined using the above procedure, where the continuous setback lines were created from interpolation between the calculated slope setback determined at regular intervals along the top of slope. Where the slope exceeded 33%, the steepest path was determined about every 10 m along the toe of slope and the "rules" were applied as described above. A continuous setback line was again interpolated between calculated setback points.

Note that any discrepancies between the results shown in the cross-sections (summarized in Table 13) and the results displayed in the GIS, the GIS is considered to be the default due to:

- The mapping of top and toe of slope in the GIS at a 1:10,000 scale, and site level representation of the cross-sections (which is accurate but not representative of mapping at the City-scale); and
- The GIS results represent the averaging of individual cross-sectional results to derive the representative "rules" for each geotechnical sector.

12.2.2 Toe of the Escarpment Setback

EBA reviewed the run-out of recent landslides occurring in the Medicine Hat area and found that they terminated within a distance equal to the slope height. As such, the setback from the toe of the escarpment is equal to the height of the slope as measured from the toe of slope (i.e., <15%) to the top of the

escarpment. The setback from the toe of escarpment applies to all slopes with an overall slope gradient >15%. For example, if the height of the slope is 10 m, then the setback from the toe of the slope, measured horizontally, is 10 m. When the overall slope gradient is less than or equal to 15%, then no setback is applied. Figure 26 shows the setback from the toe of the escarpment.

Within the GIS, setbacks were determined using the above procedure, where the continuous setback lines were created from interpolation between the calculated slope setback determined every 10 m along the toe of slope.

12.2.3 Site-Specific Geotechnical Assessments

In the following instances, a detailed, site-specific geotechnical investigation is required in order to determine the appropriate setback for geotechnical purposes or determine appropriate mitigation measures, as necessary:

- Where the terrain hazard mapping indicates a **very high** terrain hazard;
- Where the terrain hazard is rated as **high** and the development is at the toe of the escarpment; and
- Where there is any question regarding the degree of protection provided by the setbacks determined by the methods described above.

A site-specific geotechnical investigation is also considered advisable where the terrain hazard is rated high or very high and the proposed development is at the top of slope.

Although a number of unstable areas were assessed in this study, and rigorous analysis was applied to provide a high level of confidence in the setback provided for the top of the escarpment, a site specific geotechnical investigation can also be used to refine the setbacks defined in this study.

13.0 PARTIAL RISK ASSESSMENT

13.1 Overview of Risk

The CSA defines risk as the chance of injury or loss. Specifically, it is a measure of the probability or likelihood of occurrence of a hazard and the consequence of an adverse effect from the occurrence of that hazard to health, property, the environment, and other things of value. Hazards considered in this study are harmful or potentially harmful landslides. Consequence is the change, loss, or damage to the elements at risk (such as human well-being, property, environmental values, or other things of value). Elements at risk included in this study are habitable structures, specifically single and multi-story family residences.

Specific definitions used in this report include:

- Probability – is the measure of the degree of certainty than an event will occur. Probability may be determined statistically or subjectively. Statistical probability is a measured inference, expressed as a fraction or a frequency between 0 and 1. Subjective probability is a degree of belief, expressed as a rank, description, fraction, or frequency between 0 and 1. Subjective probability may be either quantitative or qualitative.

- Hazard – is the probability that an event of a given size (in this case a debris flow or debris flood or landslide) will occur within a defined period of time.
- Risk – is the likelihood of a specific adverse consequence (loss of life, loss of infrastructure, damage to infrastructure) arising from a hazard within a stated period and area.

Mathematically, risk is defined as the product of landslide probability (or likelihood of occurrence) (P_H), spatial probability ($P_{S:H}$ – the likelihood of a landslide reaching or affecting the space occupied by the element), temporal probability ($P_{T:S}$ – the potential of a mobile element to be at the site affected by the hazard at the time of its occurrence), vulnerability (V – the ability of the element to resist change or harm if impacted by the hazard), and the value or worth of the element (E):

$$Risk = P_H \times P_{S:H} \times P_{T:S} \times V \times E$$

13.2 Definition of Partial Risk

This study is intended to prioritize areas for subsequent action, including follow-up monitoring, detailed investigations, or mitigation. As such, the study utilizes the concept of partial risk analysis, P_{HA} that incorporates hazard likelihood and spatial probability only. This is described as the product of the probability of occurrence of a specific hazardous landslide (P_H) and the probability of the event reaching or otherwise affecting the site occupied by a specific element ($P_{S:H}$).

The partial risk is mathematically expressed as:

$$P_{HA} = P_H \times P_{S:H}$$

Partial risk does not consider the temporal probability or vulnerability of the element, and therefore, is not a complete estimate of risk. Temporal probability is not a factor for non-mobile elements, such as homes or buildings. In practice, partial risk is usually the preferred type of analysis when little is known about the vulnerability of the element or where an estimate of vulnerability is not required.

The partial risk has been presented qualitatively, where very low is Risk Class E, low is Risk Class D, moderate is Risk Class C, high is Risk Class B, and very high is Risk Class A. Subjective criteria were established to determine the hazard ratings as defined in Section 8.4. These ratings are based on EBA's experience and consider the most probable type of event. EBA acknowledges that these criteria are subjective and are primarily intended to provide a relative rating in order to prioritize future investigations and hazard mitigations.

13.3 Hazard Likelihood

Hazard likelihood, P_H, in this study is a qualitative measure of the likelihood of occurrence of a harmful or potentially harmful landslide. Qualitative hazard probability estimates used in this analysis are based on EBA's terrain hazard mapping that has been completed as part of this study. As previously described, the terrain hazard mapping is based on evidence of past failures and adverse slope conditions as observed during the site reconnaissance, from aerial photographs, or documented in other reports (i.e., susceptibility criteria).

13.4 Spatial Probability

Spatial probability, $P_{S:H}$, refers to the potential for a landslide to reach or affect a property. EBA provides qualitative estimates of spatial probability for properties located at the top (upslope elements) and toe (downslope elements) of the escarpment. Ratings and criteria for the spatial probability for properties located at the top of the escarpment ($P_{S:H;\ TOP}$) are presented in Table 18. Similarly, ratings and criteria for the spatial probability for properties located at the toe of the escarpment ($P_{S:H;\ TOE}$) are presented in Table 19 These ratings reflect the anticipated consequence of a landslide affecting a property located either at the top or toe of the escarpment, and are referred to as "Consequence Ratings" in later sections of this report.

Table 18: Qualitative Spatial Probability (Consequence) for Upslope Elements

Rating	Criteria
Very High	Property is within the setback area established from the top of the escarpment AND contains the top of the escarpment OR the Property intersects or is contained within a Geotechnical Setback Sector, where: ▪ Initial landslide or subsequent erosion or landslide retrogression would or very likely to impact the element(s) at risk. ▪ Loss of property.
High	Property is within the setback area established from the top of the escarpment, where: ▪ Initial landslide or subsequent erosion or landslide retrogression would or very likely to impact the element(s) at risk.
Moderate	Property boundary is within close proximity of the setback established from the top of the escarpment, where: ▪ Close proximity is defined as 25% of the maximum height of the slope; or in the case where the minimum setback has been applied, then close proximity is defined as 25% of the minimum setback. ▪ Initial landslide or subsequent erosion or landslide retrogression may impact the element(s) at risk or may occur too close to the element(s) at risk to prevent safe egress.
Low	Property boundary is not within close proximity of the setback established from the top of the escarpment.

Table 19: Qualitative Spatial Probability (Consequence) for Downslope Elements

Rating	Criteria
Very High	Property is within the setback zone established from the toe of slope and contains with the toe of the escarpment (i.e., <15%).
High	Property is within the setback area established from the toe of slope (i.e., <15%).
Moderate	Property is within 6 m* of the established setback from the toe of slope (i.e., <15%), such that some sediment may impact the property.
Low	Property is well outside the setback area established from the toe of slope (i.e., <15%) and impact is highly unlikely.

*Allows room for safe egress and equipment access for remediation.

13.5 Partial Risk

A qualitative estimate of partial risk P_{HA} was determined from the landslide and spatial interaction probabilities for properties at the top and toe of the escarpment. Partial risk ratings are defined in Table 20a below.

Table 20a: Partial Risk Matrix

$P_{HA} = P_H \times P_{S:H}$ (Probability of a Specific Landslide Impacting the Identified Elements at Risk)		P_H (Probability of Occurrence of a Specific Hazardous or Landslide)			
		Low	Moderate	High	Very High
$P_{S:H;\ TOP/TOE}$ (Spatial Probability – Probability that there will be spatial interaction with the property given that the landslide occurs).	Low	VL acceptable	L	M	M
	Moderate	L tolerable	M	H	H
	High	M	H	H unacceptable	VH
	Very High	M	H	VH	VH

Table Notes:
Risk Ratings: VL = Very Low; L = Low; M = Moderate; H = High; VH = Very High
Modified after Figure F-5 in APEGBC Professional Practice Guidelines - Legislated Flood Assessments in a Changing Climate in BC (2012)

These partial risk ratings correspond to the following classification scheme:

- Risk Class A = Very High Risk
- Risk Class B = High Risk
- Risk Class C = Moderate Risk
- Risk Class D = Low Risk
- Risk Class E = Very Low Risk

Table 20b is an extension of Table 20a and evaluates the risk and appropriate response.

Table 20b: Risk Evaluation and Response

Risk Class	Partial Risk Rating	Response
A	Very High	Risk is unacceptable in the short-term such that risk reduction is required; long-term risk reduction plan to be developed and implemented.
B	High	Risk is unacceptable; medium-term risk reduction plan must be developed and implemented within a reasonable timeframe (i.e., < 5 yrs). Planning should be begin as soon as feasible.
C	Moderate	Risk may be tolerable; reduce risk to Low where reasonably practicable, otherwise continue to monitor.
D	Low	Risk is tolerable; continue to monitor if resources allow.
E	Very Low	Risk is broadly acceptable; no further monitoring or risk reduction required.

Modified after Figure F-5 in APEGBC Professional Practice Guidelines - Legislated Flood Assessments in a Changing Climate in BC (2012)

13.6 Results

Following completion of the setback line, the GIS plan was used to assist in the determination of the partial risk assessment of all properties within the City limits. The properties are shown in Figure 27. The risk was determined using the partial risk matrix above. For Risk Classes A and B, it should be noted that although the entire property is highlighted, in many cases only a portion of the property is within the zone between the slope and the setback line. Properties categorized as Risk Class A or B either:

- Are contained within a hazardous slope section; or
- Fall within the setback boundary defined for the top or toe of slope.

A list of the properties in risk Classes A and B was then output to a spreadsheet, which was used to generate Table 21. The information contained within Table 21 is the City's data with an additional column denoting whether the property is a Class A or B risk. In total, 672 properties are categorized as Risk Class A, and 707 properties are categorized as Risk Class B. At the time that EBA was provided the properties data (by the City), there were about 28,400 properties within the City limits. This corresponds to 2.4% and 2.5% of the properties categorized as Risk Class A and B, respectively.

We note that when carrying out the partial risk assessment, if a property was associated with more than one terrain hazard, then the property was assigned the most conservative of the applicable terrain hazard ratings. Properties not intersecting any terrain hazard polygons were assigned a low hazard rating (i.e., terrain hazard class 1) for the purposes of the partial risk analysis. In some instances, on shorter slope segments, a terrain hazard rating was not defined on the terrain hazard map. In these situations, these slope sections were also assigned a default terrain rating of low (i.e., terrain hazard class 1).

As a concluding recommendation, if not already planned, EBA recommends the City inform the affected residents of the risk, and educate all City residents, in general, about the landslide hazards and risks in their community.

14.0 CLOSURE

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

Respectfully submitted,
Tetra Tech EBA Inc.



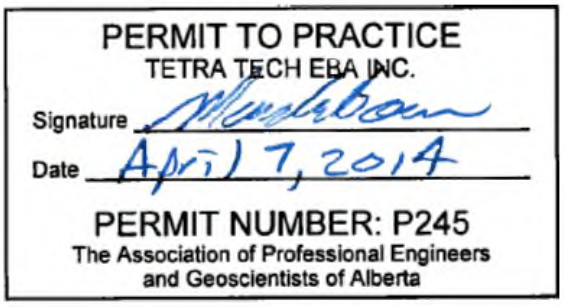


Prepared by:
Shelley Higman, M.Sc., P. Eng., P.Geo. (BC)
Senior Geotechnical Engineer
Engineering Practice, Pacific Region
Direct Line: 250.756.2256 x249
shelley.higman@tetratech.com

Prepared by:
Marc Sabourin, P.Eng.
Vice President
Engineering Practice, Prairie Region
Direct Line: 403.329.9009 x225
marc.sabourin@tetratech.com



Reviewed by:
R.A. (Bob) Patrick, M.Sc., P.Eng.
Principal Geotechnical Engineer
Engineering Practice
Direct Line: 250.756.2256 x243
bob.patrick@tetratech.com



/jbn:blw

REFERENCES

Association of Professional Engineers and Geoscientists of BC. 2012. Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC, 139 p.

Canadian Geotechnical Society. 2006. "Canadian Foundation Engineering Manual," 4th edition.

Canadian Standards Association. 1997. "Risk Management: Guidelines for Decision Makers."

Berg, T.E., and McPherson, R.A. 1972. Surficial Geology of the Medicine Hat Area," Research Council of Alberta.

Carlson, V.A. 1970. "Bedrock Topography of the Medicine Hat Area," Research Council of Alberta.

Cruden D.M., Varnes, D.J. 1996. Landslide Types and Processes. in Turner A.K.; Shuster R.L. (editors) "Landslides: Investigation and Mitigation." Transp Res Board, Spec Rep 247, pp 36–75.

Cruden, D.M., Tedder, K.H., and Thomson, S. 1989. "Setbacks from the Crests of Slopes along the North Saskatchewan River Valley, Alberta," Canadian Geotechnical Journal, Vol. 26, pp. 64-74.

Fell, R., Ho, K.K.S., Lacasse, S., and Leroi, E. 2005. "A Framework for Landslide Risk Assessment and Management," in Hungr, O., Fell, R., Couture, R., and Eberhardt E. (editors) "Landslide Risk Management," Proceedings of the International Conference on Landslide Risk Management, Vancouver, Canada, May 31-June 3, 2005.

Hardy Associates (1978) Ltd. 1984. "Report on Geotechnical Study Relative to slope Stability Aspects, City of Medicine Hat Open Space Policy." Prepared for the City of Medicine Hat.

Howes, D.E., and Kenk, E. 1997. "Terrain Classification System for British Columbia (Version 2)," Resource Inventory Branch, Ministry of Environment, Lands and Parks.

Highland, L.M., and Bobrowsky, P. 2008. "The Landslide Handbook – A Guide to Understanding Landslides," Circular 1325, U.S. Geological Survey.

Hungr, O., Evans, S.G., Bovis, M., and Hutchinson, J.N. 2001. "Review of the Classification of Landslides of the Flow Type," Environmental and Engineering Geoscience, VII, pp. 221-238.

Hutchinson, J.N. 1968. Mass Movement, in Fairbridge, R.W., (editor) "The Encyclopedia of Geomorphology," Reinhold Book Corp., New York, pp. 688–696.

Irish, E.J.W. 1968. "Bedrock Geology of the Medicine Hat Area, Map 21 – 1967," Geological Survey of Canada.

MacKay, C., and Thomson, S. 1980. "A Report on Slope Instability along the SSR and Tributaries in the Vicinity of Medicine Hat, Alberta." Prepared for Alberta Environment (AENV).

McCrossan, R.G., and Glaister, R.P. 1966. "Geological History of Western Canada," 2nd Ed., Alberta Society of Petroleum Geologists.

Stevenson, D.R., and Barneuf, D.M. 1977. "Hydrogeology of the Medicine Hat Area, Alberta," Report 75-2, Alberta Research Council.

Stalker, A.MacS., and Wyder, J.E. 1983. "Borehole and Outcrop Stratigraphy Compared with Illustrations from the Medicine Hat Area of Alberta," Bulletin 296, Geological Survey of Canada.

Stalker, A.MacS. 1969. "Quaternary Stratigraphy in Southern Alberta, Report II: Sections Near Medicine Hat," Geological Survey of Canada.

Thomson, S., and Morgenstern. 1977. "Factors Affecting Distribution of Landslides Along Rivers in Southern Alberta," Canadian Geotechnical Journal, Vol. 14, No. 4, pp. 508-523.

Westgate, J.A. 1968. "Surficial Geology of the Foremost-Cypress Hills Area, Alberta," Bulletin 22, Research Council of Alberta.

Wise, M., Moore, G., and VanDine, D. (editors). 2004. "Landslide Risk Case Studies in Forest Development Planning and Operations," Land Management Handbook 56, BC Ministry of Forests.

UNESCO Working Party World Landslide Inventory. 1993. "Multilingual Landslide Glossary," The Canadian Geotechnical Society, No.47, 53-57, 32p.

TABLES

Table 1	Previous Reports Reviewed
Table 2	Sectors in Hardy (1978) (included within the body of the report)
Table 3	Groundwater Depths for Additional Boreholes (included within the body of the report)
Table 4	Qualitative Landslide Susceptibility Criteria for Potentially Hazardous Slopes (included within the body of the report)
Table 5	Qualitative Terrain Hazard Classifications (included within the body of the report)
Table 6	Comparison of Case Studies
Table 7	ADM Mill's Soil Strength and Groundwater Parameters (EBA 2011 Report) (included within the body of the report)
Table 8	Factor of Safety Results (EnviroGeo 1999 Report) (included within the body of the report)
Table 9	Factor of Safety Results (EnviroGeo 2002 Report) (included within the body of the report)
Table 10	Slope Database
Table 11	Soil Parameters Used in Stability Analysis (included within the body of the report)
Table 12	Comparison of Soil Parameters
Table 13	Summary of Slope Stability Results
Table 14	Summary of Measurements for Lateral Migration
Table 15	Summary of Lateral Migration Results
Table 16	Slope Database Summary
Table 17	Required Geotechnical Setbacks from Top of Escarpment for Slopes >33%
Table 18	Qualitative Spatial Probability (Consequence) for Upslope Elements (included within the body of the report)
Table 19	Qualitative Spatial Probability (Consequence) for Downslope Elements (included within the body of the report)
Table 20a	Partial Risk (included within the body of the report)
Table 20b	Risk Evaluation and Response (included in the body of the report)
Table 21	Properties at Risk – Top and Toe of Escarpment

Table 1: Previous Reports Reviewed

Prepared by	Title	Date
AGRA Earth and Environmental	*"Geotechnical Report Seepage and Slope Assessment South of Rideau Manor"*	October 1997
AGRA Earth and Environmental	*"Slope Stability Setback Assessment 251 and 363 Street S.W. Medicine Hat, Alberta"*	August 1999
AGRA Earth and Environmental	*"Geotechnical Assessment Altawana Back Slope Slumping Medicine Hat, Alberta"*	April 2005
EBA Engineering Consultants Ltd.	*"Geotechnical Evaluation Slope Stability Assessment Study No. 5, Southeast Hill Medicine Hat, Alberta"*	October 2005
EnviroGeo Testing Sabatini	*"Geotechnical Slope Stabilization Study 32 Street S.W. and 10 Avenue S.W., Medicine Hat"*	November 1998
EnviroGeo Testing	*"Slope Stability Analysis/Geotechnical investigation River Ridge Estates medicine Hat, Alberta"*	April 2001
EnviroGeo Testing	*"Geotechnical Investigation and Slope Stability Report SE 15-12-6 W4M Medicine Hat, Alberta"*	June 2002
EnviroGeo Testing	*"Slope Stability Review, Saamis Heights Subdivision - Phase 3, Medicine Hat, AB"*	July 2003
EnviroGeo Testing	*"Saamis Heights Subdivision Lot 6, Block 28, Plan 0312828, Medicine Hat, AB"*	June 2005
EnviroGeo Testing	*"Slope Stability Analysis Proposed Ranchlands Residential Subdivision Phase 2F and G, and Phase 3 Medicine Hat, AB"*	November 2005
Focus Corporation Ltd.	*"Phase 4 Ranchlands Subdivision Environmental Reserve Delineation Medicine Hat, Alberta"*	November 2007
Geo-Engineering Ltd.	*"Saamis Memorial funeral Chapel and crematorium, Medicine Hat"*	December 2003
Golder Associates	*"A Report to the City of Medicine Hat Providing an Assessment of the Stability of Slopes in the Crestwood Drive Area"*	September 1976
Hardy Associates Ltd.	*"Report on Geotechnical Study Relative to Slope Stability Aspects City of Medicine Hat Open Space Policy"*	October 1984
HBT AGRA Limited	*"Slope Stability Investigation Fairway Manor Apartments Medicine Hat"*	December 2003
Pennell Geotechnical Engineering Ltd.	*"Report on Subsoil Conditions and Slope Stability Conditions at Proposed Subdivision S and T Ranch Property Medicine Hat, Alberta"*	March 1980
Pennell Geotechnical Engineering Ltd.	*"Report on Subsoil and Slope Stability Conditions at South Saskatchewan River Medicine Hat Golf Course Subdivision"*	February 1981
Pennell Geotechnical Engineering Ltd.	*"Report on Slope Stability for Ross Glen Extension Lecuyer Cattle Co. Medicine Hat, Alberta"*	July 1982
Stantec Consulting Ltd.	*"Southeast Hill Drainage Improvements and Slope Stability Study"*	November 2006
Thurber Engineering Ltd.	*"Saamis Heights Subdivision Medicine Hat, Alberta Slope Setback Study"*	November 2000
Thurber Engineering Ltd.	*"Scholen Hill Slope Stabilization Preliminary Geotechnical Investigation and Recommendations"*	August 2001
Thurber Engineering Ltd.	*"Scholen Hill Slope Stabilization Supplementary Drilling and Instrumentation Program Medicine Hat, Alberta"*	October 2003
Underwood McLellan Ltd.	*"Report on Subsoil Conditions and Slope Stability at Proposed Subdivision Medicine Hat, Alberta"*	March 1976
Underwood McLellan Ltd.	*"Report on Subsoil Conditions and Slope Stability at Ross Glen Subdivision Medicine Hat, Alberta"*	October 1976
Underwood McLellan Ltd.	*"Report on Subsurface Investigation and Slope Stability at the Proposed Golf and Country Club Medicine Hat"*	July 1980
University of Alberta	*"A Report on Slope Stability Along the South Saskatchewan River and Tributaries in the Vicinity of Medicine Hat, Alberta"*	October 1980

Table 6: Comparison of Case Studies

Landslide Name	Approximate Date of Occurrence	Landslide Width	Landslide Depth	Landslide Length	Amount of Setback Zone Lost (m)	Contributing Factors
ADM Slide	July 2010	68 m	~5 - 8 m	74 m	~26 m	Seepage pressures, toe erosion by Seven Persons Creek, and tension cracks.
Eagleview Slide	Unknown, but significant movement in 2011 according to the City	~365 m (total for the three slides that have coalesced in this area)	4 - 5 m	77 m	~ 10 m between 2006 and 2010	Seepage pressures, toe erosion by Seven Persons Creek.
Canyon Creek Slide	July 2011	40 m	~3 - 4 m	16 m	~3 - 4 m	Toe erosion by Seven Persons Creek.
Cypress County Slide TWP Rd 130 Slide	2008	110 - 125 m	10 - 12 m	255 m	17 - 47 m	Seepage pressures, translational block failure along bentonite layer overlying bedrock, ponds/septic fields, and tension cracks.

Table 10: Slope Database: Representative Cross-Sections over the City of Medicine Hat

Geological Sector	Cross-Section (37 x-sections)	Physical Description of Cross-Sectional Profile Location	Geomorphic Position	Dominant Landslide Process	Degree of Landslide Activity	Causal Mechanisms	Overall Slope Height (m)	Overall Slope Gradient (%/degrees)	Field Stratigraphy	BH Stratigraphy	Groundwater Conditions	Description
IS	IS-1	Slope above clay mine	Interior Slope	Translational (lock) occurring on slope(s) between benches	Active	Anthropogenic (oversteepened slopes)	74	50-150%/27-55	~ 110 m brown clay till interbedded with grey clay layers (0.5 m to > 4 m thick) > 15 m silt, sand (interglacial sediments)	Extrapolated from SSR-3: 5 m glaciolacustrine clay 1 m brown clay till (low plastic) 2 m glaciolacustrine clay 32 m brown clay till (low plastic) >15 m grey clay (med plastic)	Perched water table suspected in interglacial sediments	Man-made, benched slopes.
	IS-2	Southeast Hill	Interior Slope	Translational/creep	Active	Seepage	30 - 35	50-65%/25-35	~ 3- 10 m silt, some sand (glaciolacustrine) > 20 -27 m brown clay till	4 m silt, clay 20 m clay till (low to medium plastic) > 6 m clay (medium to high plastic), sand	Perched water table in glaciolacustrine sediments	Moderate slope; wet.
	IS-3A/3B	Kensington area below 13 Street SE	Interior Slope	Translational	3A/3B - Reactivated	Seepage	30 - 35	40-100%/20-45	> 30 m grown clay till	7m silt, some sand >13 m brown clay till (medium to high plastic)	Perched water table in upper silt layer	Steep slopes; dry.
	IS-4	Altawana	Interior Slope	Shallow rotational/creep	Active	Seepage	20 - 30	40-100%/20-45	0 - 3 m silt, sand (glaciolacustrine) - suspected > 20 m clay till	3.2 - 4.4 m sand > 12 m clay till	Perched water table in glaciolacustrine sediments	Moderately steep to steep slopes; saturated.
	IS-5	Slopes above Power Plant area	Interior Slope	Shallow rotational	Inactive (Dormant and portion stabilized through remediation)	Seepage	30	25-65%/13-33	None exposed - expect clay till >20 m thick, likely overlying bedrock	17 m glaciolacustrine clay overlying bedrock (assumed)	Perched water table in glaciolacustrine sediments	Moderate slopes; dry except for concentrated points of drainage in topographic depressions.
	IS-6	North side of SSR near Redcliff	Interior Slope	Shallow rotational	Inactive (Relict)	Seepage	24	21 - 50%/12 -25	No sediments exposed; infer from adjacent stratigraphy above river: ~ 3 m sand + gravel (glaciofluvial?) > 15 m brown clay till overlying bedrock (Foremost Fm w/ coal seams)	>16 m interbedded brown clay till (low plastic) and interglacial sediments	Perched water table in glaciofluvial sediments	Moderate slope; dry.
	IS-7	Slopes above Echo Dale flood plain	Interior Slope with dry coulees	Shallow rotational	Inactive (Dormant)	Seepage	20 - 55	25-70%/15-35	~ 10 m clayey sand (glaciolacustrine) 0.3 m clay layer (glaciolacustrine) > 40 m clay till bedrock may be present at river level	Not available	Perched water table in glaciolacustrine sediments; regional water table at the bedrock surface	Moderate to moderately steep; general dry slope.
RC	RC-1	Near Scholten slide	Away from creek	Shallow rotational	Inactive (Dormant)	Seepage	30 - 50	50-80%/25-45	~ 15 m silt, sand, clay (glaciolacustrine) - suspected > 5 m clay till	4.7 - 7.2 m clay fill 6.9 - 7.9 m silty sand, varying amounts of clay > 18 m clay till	Perched water table in glaciolacustrine sediments	Steep.
	RC-2	Ross Creek - mid to upper reaches	Outer bend of creek	Rotational-translational	Inactive (Relict)	Undercutting/seepage	40	30-100/17-45	~ 15 m silt, sand, clay (glaciolacustrine) - suspected > 5 m clay till	not available	Perched water table in glaciolacustrine and interglacial (if present) sediments	Moderate slopes; dry except for concentrated points on drainage in dendritic coulees; failure most probable at toe where over steepened at railway.
	RC-3	Ross Creek - mid reaches	Away from creek; coulees with water flow	Shallow rotational	Active	Seepage	30 - 35	50-80%/25-40	~ 1 m cobble, some sand (glaciofluvial) ~ 2 - 4 m sand interbedded with thin clay layers (glaciolacustrine) > 25 m brown clay till	2 m - 8 m silt, sand, gravel 2 - 28 m clay till non to medium plastic), sand lenses are encountered in the deeper holes > 1 - 19 m sand, silt	Perched water table in glaciolacustrine and interglacial (if present) sediments	Very steep, actively failing slope; seepage.
	RC-4A/4B	Ross Creek - upper reaches	Generally away from creek	Shallow rotational	4A - Inactive (Relict) 4B - Inactive (Dormant)	Seepage	30 - 35	50-80%/25-40	~ 2 m- 5 m silt, sand, clay (glaciolacustrine) - suspected > 5 m clay till	2 m - 8 m silt, sand, gravel 2 - 28 m clay till non to medium plastic), sand lenses are encountered in the deeper holes > 1 - 19 m sand, silt	Perched water table in glaciolacustrine and interglacial (if present) sediments	Generally moderately steep; dry.
SPC	SPC-1	ADM Slide; Crestwood; Saamis Funeral Home	Creek discontinuously at toe of slope	Shallow rotational	Reactivated	Seepage/undercutting	30 - 35	60-200%/30-65	~ 8 - 10 m silt, some sand (glaciolacustrine) ~ 18 m brown clay till > 2 m sand, some gravel (interglacial sediments; likely some silt as observed in creek bank across the creek)	3 m sandy, silty clay (low plastic) 4 m silty, sandy clay (medium plastic) 11.5 m brown clay till (medium to high plastic) > 16.5 m grey (contorted) clay till (medium plastic) > 10 m sand (as per Golder, 1976)	Perched water table in glaciolacustrine/interglacial sediments	V. steep, actively failing slope, seepage.
	SPC-2	mid-way along SPC downstream of Hwy 1 - Malborough	Away from creek; storm discharge into coulee	Translational	Inactive (Dormant)	Seepage	30	50-80%/25-40	> 30 m brown clay till	> 8 m clay till (with frequent sand lenses)	Perched water table in glaciolacustrine/interglacial sediments	Moderately steep, isolated area that is over steepened with active erosion.
	SPC-3	mid-way along SPC downstream of Hwy 1 - 651 and 653 13 St + Kin Coulee Park - N side	Away from creek; storm discharge into coulee	Translational	Inactive (Dormant)	Seepage/undercutting	30	50-80%/25-40	> 30 m brown clay till	2.4-5.7 m clay fill (low plastic) > 6.3 - 9.6 m clay till (low plastic)	Perched water table in glaciolacustrine sediments	Steep with some erosion.
	SPC-4A/4B	mid-way along SPC downstream of Hwy 1 - Kin Coulee Park - S side	Away from creek	Translational	4A - Reactivated 4B - Inactive (Dormant)	Seepage	30 - 35	70-100/35-45	~0-1.5 m laminated clay (glaciolacustrine) ~10.5 - 12 m clay till > 2 m sand (interglacial)	3 m clay till (includes thin sand seam) 6 m glaciolacustrine clay (low plastic) 4 m sand 3 m clay till (low to medium plastic) 1 m sand 2 m grey clay till (medium plastic) 3 m sand >4 m grey clay till (low plastic)	Perched water table in glaciolacustrine/interglacial sediments	Very steep, actively failing slope.
	SPC-5	mid-way along SPC upstream of Hwy 1 on N side	Outer bend of tributary coulee; storm discharge to coulee	Translational	Active	Seepage/undercutting	30 - 50	60-200%/30-65	~ 1- 3 m silt, some sand (glaciolacustrine) > 27 -29 m brown clay till possibly underlain by interglacial sand and gravel	Not available	Perched water table in glaciolacustrine and interglacial (if present) sediments	Steep, seepage, previous failures
	SPC-6	mid-way along SPC upstream of Hwy 1 on S side - near Sunset Dr	Away from creek; generally dry coulees	Translational	Inactive (Dormant)	Seepage	20 - 50	50-200%/25-65	~ 1 m silt, some sand (glaciolacustrine) > 19 m brown clay till	1 - 4 m silt, some to trace sand ~ 25 - > 30 m clay till (low to int plastic) > 16 m interbedded sand and silt, and less commonly gravel	Perched water table in glaciolacustrine sediments	Moderately steep; seepage zones.
	SPC-7A/7B	upstream end of SPC - Canyon Creek, Eagleview where undercut by SPC	Outer bend of creek	Rotational-translational	7A - Active 7B - Active	Undercutting/seepage	15 - 35	65-175%/35-60	~ 4 - 7 m silt, some sand (glaciolacustrine) ~ 2 m coarse sand (glaciolacustrine) - discontinuous > 24 m brown clay till	For 7B: 1.5 - 6 m silty sand > 16 - 18.5 m silty clay till (medium plastic)	Perched water table in glaciolacustrine sediments	Section 7A is through Eagleview; Section 7B is through Canyon Creek.
SSR	SSR-1A/1B/1C	Evilsmelling Bluff - 1B (GSC data) + Rattlesnake Slide - 1C (Hardy) + Fertilizer Plant Slide-1A (McKay and Thompson)	Tight outer bend or river	Rotational-translational	1A/1B/1C Active	Undercutting/seepage	50 - 130	60-200%/30-65	0 - 10 m sand, silt (glaciolacustrine) 60 m interbedded till and interglacial sediments 20 m sand, gravel, clay (preglacial) bedrock (Foremost Fm) at river level	0 - 10 m sand, silt 60 m interbedded till and interglacial sediments 20 m sand, gravel, clay bedrock (Foremost Fm) at river level	Perched water table in glaciolacustrine and interglacial sediments; ponded water noted	Steep, previous failures on outside bends of river; 1B not typed since outside City Boundary.
	SSR-2	Ranchlands	Outer bend of river + interior slope	Translational	Active	Undercutting	20	65-80%/35-40	> 25 m sand, varying amounts of gravel (alluvial terrace) - suspect slope has been regraded	> 35 m interbedded sands, gravels and clay	Well drained - water table near river elevation	Steep, uniform slope on outside bend.
	SSR-3	Police Point Slide	Outer bend of river + dry coulees	Rotational-translational	Inactive (Dormant)	Undercutting	86	80-550%/40-80	~ 110 m brown clay till interbedded with grey clay layers (0.5 m to > 4 m thick) > 15 m silt, sand (interglacial sediments)	5 m glaciolacustrine clay 1 m brown clay till (low plastic) 2 m glaciolacustrine clay 32 m brown clay till (low plastic) >15 m grey clay (med plastic)	Perched water table suspected in interglacial sediments	Very steep; outside bend.
	SSR-4	Golf and Country Club	Inland from broad outer bend of river	Translational	Active	Seepage	10	65 - 100%/35-45	> 10 m sand and gravel (alluvial terrace)	0.5 m gravel 9 m sand 7.5 m sand and gravel > 1 m sand	Well drained - water table near river elevation	Steep, dry slope.
	SSR-5A/5B	1st St SW	Broad outer bend of river	Rotational/Creep	5A - Inactive (Dormant) 5B - Active	Undercutting/seepage	50	65-80%/35-40	Clay till within depositional zone, likely as per Hardy report, i.e., glaciolacustrine veneer over interbedded till and interglacial sediments, possibly overlying bedrock at river level	For 5B: 4 m sand and gravel (fill?) 3 m clay fill (low plastic) 12 m clay till (low to medium plastic) >7 m sand	Perched water table in glaciolacustrine/interglacial sediments	Moderate slopes with seepage and creep.
	SSR-6	Rideau Manor	Broad outer bend of river	Shallow rotational	Active	Undercutting/seepage	10	50-100%/25-45	0 - 3 m silt, sand (glaciolacustrine) - suspected > 20 m clay till	1.2 m sand 6.8 m clay till (low to medium plastic) with sand layers > 4.5 m shale bedrock	Perched water table in glaciolacustrine sediments	
	SSR-7	Powerhouse Slide	Straight reach of river	Rotational-translational	Inactive (Dormant)	Undercutting/seepage	40	100%/45	~ 2 m sand + gravel (glaciofluvial?) > 8-10 m brown clay till Bedrock (Foremost Fm w/ coal seams) forms about half of slope height	15 m brown clay till (low plastic) 2 m grey clay till (low to medium plastic) 1 m sand 4 m clay till (low plastic) 0.5 m sand 3 m grey clay till (medium plastic) > 0.5 m sand	Perched water table in glaciofluvial sediments; regional water table at the bedrock surface	
	SSR-8	Surprise Bluffs (GSC data)	Outer bend of river	Rotational-translational	Inactive (Dormant)	Undercutting/seepage	60 - 90	70-100%/35-45	0 - 10 m silt, sand, gravel (glaciolacustrine) 55 - 85 interbedded till and interglacial sediments 5 m sand, gravel (preglacial) bedrock (Foremost Fm) @ river level	0 - 10 m silt, sand, gravel 55 - 85 interbedded till and interglacial sediments 5 m sand, gravel bedrock (Foremost Fm) @ river level	Perched water table in glaciolacustrine and interglacial sediments; ponded water noted	Steep; seepage.
	SSR-9A/9B	North side of SSR near Redcliff	Outer bend of the river + straight reach of river	Rotational-translational	9A - Reactivated 9B - Inactive (Relict)	Undercutting/seepage	68	60-200%/30-65	~ 3 m sand + gravel (glaciofluvial?) ~ 10 m brown clay till Bedrock (Foremost Fm w/ coal seams + bentonite layer) forms about 3/4 of slope height	Extrapolated from IS-6: >16 m interbedded brown clay till (low plastic) and interglacial sediments	Perched water table in glaciofluvial sediments; regional water table at the bedrock surface	9A appears to be actively failing from air photo interpretation.
	SSR-10	Redcliff Pumphouse Slide (McKay + Thompson and Hardy)	Outer bend of river	Rotational-translational	Inactive (Dormant)	Undercutting/seepage	82	100-200%/45-65	~ 2 m sand + gravel (glaciofluvial?) - not present at Cypress County Slide > 8-10 m brown clay till 1.75 m sand (noted at recent slide adjacent to Redcliff Pumphouse Slide) + laminated clay (> 3 m thick) noted at the Cypress County slide a short distance above bedrock Bedrock (Foremost Fm w/ coal seams) forms about half of slope height	Not available	Perched water table in glaciofluvial sediments; regional water table at the bedrock surface	
	SSR-11	Cypress County TWP Rd 130 Slide	Outer bend of river	Rotational-translational	Active	Undercutting/seepage	89	60%/30	~ 2 m sand + gravel (glaciofluvial?) - not present at Cypress County Slide > 8-10 m brown clay till 1.75 m sand (noted at recent slide adjacent to Redcliff Pumphouse Slide) + laminated clay (> 3 m thick) noted at the Cypress County slide a short distance above bedrock Bedrock (Foremost Fm w/ coal seams) forms about half of slope height	Water well log: 2 m sandy clay 6 - 8 m gravel or sand ~ 1 m sandy clay (in just one of 2 BH) Shale bedrock	Perched water table in glaciofluvial sediments; regional water table at the bedrock surface	

Notes:

IS	Interior Slope.
RC	Ross Creek.
SPC	Seven Persons Creek.
SSR	South Saskatchewan River.
Suspected	means not directly observed, but assumed to be present.

Table 12: Comparison of Soil Parameters

No.	Prepared by	Report Title	Date	No.	Stratigraphic Units	Unit Weight γ (kN/m^3)	Cohesion ς (kN/m^2)	Angle of Internal Friction φ	Porewater Pressure Ratio Ru
1.	Pennell Geotechnical Engineering Ltd.	Report on Subsoil Conditions and Slope Stability Conditions at Proposed Subdivision S&T Ranch Property, Medicine Hat, Alberta	March, 1980	1)	Sand and sandy gravel on uplands	-	-	32.5°	-
				2)	Glacial Till on uplands	23	-	30° - 38°	-
				3)	Fluvial deposited silts and sands in the lowlands	-	-	32.5°	-
2.	EnviroGeo Testing	Saamis Heights Subdivision Lot 6, Block 28, Plan 0312828, Medicine Hat, Alberta	June, 2005	1)	Silt	16	0	32°	0.1 (0.5*)
				2)	Clay Till	21	8	34°	0.1 (0.5*)
				3)	Sand	18	0	35°	0.1 (0.5*)
				4)	Clay	17	8	17°	0.1 (0.5*)
3.	Underwood McLellan & Associates Limited Consulting Professional Engineers	Report on Subsoil Conditions and Slope Stability at Proposed Subdivision, Medicine Hat, Alberta	March, 1976	1)	Clayey Silt	-	-	28°	-
				2)	Sandstone Bedrock	-	-	12° - 28°	-
				3)	Shale Bedrock	-	-	12° - 28°	-
4.	AGRA Earth & Environmental Limited	Geotechnical Assessment Altawana Back Slope Slumping, Medicine Hat, Alberta	April, 2000	1)	Sand	-	0	32°	**
				2)	Clay Till	-	5	30°	0.2
5.	EBA Engineering Consultants Ltd.	Geotechnical Evaluation, Slop Stability Assessment, Study #5, Southeast Hill, Medicine Hat, Alberta	October, 2005	1)	Upper Sand Layer	20	0	33°	-
				2)	Clay Till	19	0	26°	0.2
				3)	Lower Clay Layer (CH)	18	0	18° (8° Residual)	0.3
				4)	Lower Clay Layer (CI)	18	0	26°	0.2
				5)	Interbedded Sand Layer	20	0	33°	-
6.	Underwood McLellan & Associates Limited Consulting Professional Engineers	Report on Subsoil Conditions and Slope Stability at Ross Glen Subdivision, Medicine Hat, Alberta	October, 2005	1)	Coarse Gravel with Cobbles and Medium Sand	20.4 (130pcf)	0	37°	-
				2)	Silt Till	21 (134pcf)	9.6 (200psf)	34°	-
				3)	Clay Till	21 (134pcf)	9.6 (200psf)	32°	-
7.	Geo-Engineering (M.S.T.) Ltd.	Saamis Memorial Funeral Chapel and Crematorium, Medicine Hat	December, 203	1)	Silt A	20.5	8	34°	0
				2)	Clay (Till)	21.5	8	34°	0
				3)	Sand	21	0	34°	0
				4)	Silt B	20	0	30°	0
				5)	Gravel	22	0	40°	0
				6)	Clay	21.5	0	34°	0
8.	EnviroGeo Testing	Slope Stability Review, Slope Stability Review, Saamis Heights Subdivision - Phase 3, Medicine Hat, Alberta	July, 2003	1)	Silt, Sandy	19	0	32°	-
				2)	Silty Clay Till	20	0	28°	-
				3)	Sand	18	0	35°	-
9.	EnviroGeo Testing	Re: Geotechnical Investigation and Slope Stability Report, SE 15 - 12 - 6 - W 4 M, Medicine Hat, Alberta	June, 2002	1)	Silty Sand	19	0	32°	0
				2)	Silty Clay Till	20	0	28°	0.1
10.	EnviroGeo Testing	Re: Slope Stability Analysis / Geotechnical Investigation, River Ridge Estates, Medicine Hat, Alberta	April, 2001	1)	Silty Sand	18	0	30°	0
				2)	Clay Till	16	0	30°	0
				3)	Sand	18	0	30°	0
				4)	Clayey Gravel	20	0	30°	0
				5)	Clay	16	0	30°	0
11.	EBA Engineering Consultants Ltd.	Slope Stability Assessment, ADM Mills Slide - Seven Persons Creek, Medicine Hat, Alberta	June, 2011	1)	Upper Clay Layer***	19.3	0	25°	-
				2)	Upper Sand Layer***	20	0	32°	-
				3)	Clay Till***	19.3	0	28°	-
				4)	Lower Sand Layer***	20	0	35°	-
				1)	Glaciolacustrine Clays	18	2	30°	0.2
				2)	Upper High Plastic Clay Till	17	0	20°	0.3
				3)	Upper Medium Plastic Clay Till	18	10	30°	0.1
				4)	Lower Clay Till	18	10	30°	0.1
12.	EnviroGeo Testing	Slope Stability Analysis at 3005, Cottonwood Way SW, Medicine Hat, Alberta (SW 1/4 Sec 24-Twp 12-Rge6-W4M)	August, 2011	1)	Sandy Silt(1)	18	0	30°	0
				2)	Clayey Silt(2)	19	5	30°	0.1
				3)	Sandy Silt(3)	19	0	30°	0.1
				4)	Sandy Silt Till(4)	19	3	30°	0.3
				5)	Silt Sand Till(5)	18	0	28°	0.3
13.	Sabatini Geotechnical Inc.	Slope Stability Analyses, Woolfrey property, Medicine Hat, Alberta	July, 1995	1)	Silt and Sand	-	0	32°	-
				2)	Clay Till	-	5	32°	-
14.	EBA Engineering Consultants Ltd.	Medicine Slope Setback Report	January, 2012	1)	Clay Till	20	5	30°	0.2 - 0.3
				2)	Clay High Plastic	18	1	18°	0.3
				3)	Glaciolacustrine Clay	18	2	26°	0.2 - 0.3
				4)	Upper Silt	18	0	30°	0.2 - 0.3
				5)	Silt	18	0	32°	0.2 - 0.3
				6)	Upper Sand	19	0	30°	0.2 - 0.3
				7)	Sand	19	0	32°	0.2 - 0.3
				8)	Sandy Gravel	20	0	33°	0
				9)	Gravel	20	0	34°	0
				10)	Bedrock	22	15	28°	0
				11)	Bentonite	19	0	7°	0.3
				12)	Evil Smelling Band (Silty Clay Sand)	18	2	26°	0.2

Notes:

* 0.5 represents a fully saturated slope.

** Phreatic surface 2.6 m below the ground surface (mbgs) and day lighting half way up the back slope.

*** Referenced from Golder Associates Ltd. (Golder) 1975.

Table 13: Summary of Slope Stability Results

Cross-Section No.	Setback Distance from the Top of Escarpment*	Setback Specified in Prev. Report** (as applicable)	Slope Height	Angle (H:V) as Measured from Toe of Escarpment to Crest of Escarpment	Angle (H:V) as Measured from Toe of Escarpment to Setback	Factor of Safety for Most Probable Failure at/beyond Crest of Escarpment
Interior Slopes						
IS-1	34 m		25 m	1.8 : 1	3.0 : 1	0.9
IS-2	40 m	39 m	39 m	3.6 : 1	4.6 : 1	1.2
IS-3A	56 m	n/a	22 m	1.1 : 1	3.0 : 1	0.6
IS-3B	6 m		34 m	3.1 : 1	3.3 : 1	1.6
IS-4	27 m	32 m	12 m	2.1 : 1	3.7 : 1	0.9
IS-5	6 m	27 m	11 m	7.2 : 1	7.7 : 1	2.3
IS-6	6 m	50 m	12 m	3.5 : 1	4.0 : 1	1.9
IS-7	11 m	18 m	28 m	2.9 : 1	3.0 : 1	1.3
Ross Creek						
RC-1	62 m	21 m	43 m	2.1 : 1	3.2 : 1	1.0
RC-2	6 m	43 m	39 m	13.1 : 1	13.3 : 1	5.3
RC-3	30 m	13 m	19 m	2.1 : 1	3.0 : 1	1.1
RC-4A	6 m		5 m	3.2 : 1	4.4 : 1	2.3
RC-4B	22 m	34 m	13 m	1.7 : 1	2.9 : 1	1.0
Seven Persons Creek						
SPC-1	80 m	16 m	43 m	1.5 : 1	3.2 : 1	0.7
SPC-2	9 m	22 m	16 m	2.5 : 1	3.1 : 1	1.3
SPC-3	8 m	18 m	9 m	2.0 : 1	2.6 : 1	1.4
SPC-4A	52 m	10 m	33 m	1.5 : 1	3.0 : 1	0.7
SPC-4B	38 m		32 m	1.7 : 1	2.8 : 1	0.9
SPC-5	12 m	43 m	16 m	3.1 : 1	3.7 : 1	1.3
SPC-6	6 m	99 m	10 m	3.0 : 1	3.6 : 1	1.8
SPC-7A	33 m	74 m	33 m	1.7 : 1	2.6 : 1	0.9
SPC-7B	24 m	81 m	13 m	0.9 : 1	2.6 : 1	0.7
South Saskatchewan River						
SSR-1A	53 m	81 m	44 m	3.4 : 1	3.6 : 1	0.9
SSR-1B	58 m	28 m	65 m	1.9 : 1	2.8 : 1	1.0
SSR-1C	23 m		20 m	1.6 : 1	2.7 : 1	1.0
SSR-2	17 m	103 m	22 m	1.9 : 1	2.7 : 1	1.0
SSR-3	97 m	78 m	72 m	1.7 : 1	2.9 : 1	0.6
SSR-4	8 m	95 m	16 m	2.0 : 1	2.5 : 1	1.2
SSR-5A	6 m	74 m	10 m	2.3 : 1	2.9 : 1	1.7
SSR-5B	6 m	50 m	25 m	4.0 : 1	4.2 : 1	2.5
SSR-6	12 m	n/a	7 m	1.3 : 1	2.2 : 1	0.8
SSR-7	72 m	9 m	46 m	1.6 : 1	3.2 : 1	0.9
SSR-8	38 m	16 m	68 m	2.0 : 1	2.5 : 1	1.3
SSR-9A	34 m	16 m	31 m	2.6 : 1	3.3 : 1	1.2
SSR-9B	21 m	33 m	48 m	2.0 : 1	2.6 : 1	1.2
SSR-10	90 m	n/a	75 m	1.5 : 1	2.6 : 1	0.8
SSR-11	80 m	106 m	83 m	1.7 : 1	2.6 : 1	0.2

Notes: *Minimum 6 m required for slopes exceeding 15% (8.5^{o}) referenced from Hardy Associates.

Table 14: Summary of Measurements for Lateral Migration

Watercourse	Reach	# of Stream Measurements	Comment
South Saskatchewan River	SSR-R1	5	High slopes; no bedrock control
	SSR-R2	1	Low slopes; no bedrock control
	SSR-R3	2	Low slopes; bedrock control
	SSR-R4	2	High slopes; bedrock control
		10	
Ross Creek	RC-R1	1	Below confluence with SPC; one steep slope section near outlet to SSR
	RC-R2	1	Mostly on floodplain; 2 steep slope sections
	RC-R3	2	Rail grade now adjacent to stream protecting south slopes from stream erosion issues; 3 steep slope sections on north side
	RC-R4	1	Outside City limits
	RC-R5	2	Rail grade adjacent to stream protecting main west slopes from stream erosion issues; a few potentially affected steam slopes immediately adjacent to stream
	RC-R6	n/a	Outside City limits
	RC-R7	0	Rail grade adjacent to stream protecting west slopes from stream erosion issues; main west slopes are further inland
	RC-R8	n/a	Outside City limits
	RC-R9	0	Floodplain
	RC-R10	*no data from 1955	Stream at toe of steep slope
	RC-R11	0	Floodplain
	RC-R12	0	Stream flows under Highway 1 where bridge abutments have erosion control; stream not adjacent to natural slopes
		7	
Seven Persons Creek	SPC-R1	0	Floodplain
	SPC-R2	0	Rip rapped slope for bridge abutment
	SPC-R3	0	Toe of Crestwood slope comes close to creek
	SPC-R4	0	Toe of slope away from creek
	SPC-R5	1	Toe of Crestwood/ADM slide at creek
	SPC-R6	0	Toe of slope away from creek; but severe bank erosion observed
	SPC-R7	1	Toe of slope at creek
	SPC-R8	0	Toe of slope away from creek
	SPC-R9	1	Toe of slope at creek
	SPC-R10	0	Toe of slope well away from creek
	SPC-R11	0	Toe of slope at creek (outer bend)
	SPC-R12	0	Toe of slope away from creek
	SPC-R13	1	Toe of slope at creek (outer bend)
	SPC-R14	0	Toe of slope well away from creek
	SPC-R15	1	Toe of slope at creek
	SPC-R16	0	Toe of slope well away from creek
	SPC-R17	1	Toe of slope at creek (outer bend)
	SPC-R18	0	Toe of slope away from creek
	SPC-R19	0	Toe of slope at creek
	SPC-R20	0	Toe of slope away from creek
	SPC-R21	1	Toe of slope at creek (outer bend)
	SPC-R22	0	Toe of slope away from creek
	SPC-R23	0	Toe of short slope at creek
	SPC-R24	0	Toe of slope away from creek
	SPC-R25	1	Toe of slope at creek (outer bend)
	SPC-R26	0	Toe of short slope at creek
	SPC-R27	1	Toe of slope at creek (outer bend)
	SPC-R28	0	Toe of short slope at creek
	SPC-R29	1	Toe of slope at creek (outer bend)
	SPC-R30	0	Toe of slope at creek
	SPC-R31	1	Toe of slope at creek (outer bend)
	SPC-R32	0	Toe of slope away from creek
	SPC-R33	0	Toe of short slope at creek
	SPC-R34	0	Toe of slope away from creek
	SPC-R35	1	Toe of slope at creek (outer bend)
	SPC-R36	0	Toe of slope away from creek
	SPC-R37	1	Toe of slope at creek (outer bend)
	SPC-R38	0	Toe of slope away from creek
	SPC-R39	1	Toe of slope at creek (outer bend)
	SPC-R40	0	Toe of slope away from creek
	SPC-R41	1	Toe of slope at creek (outer bend)
	SPC-R42	0	Toe of short slope at creek
	SPC-R43	0	Toe of slope at creek (outer bend); gap in 1955 air photo coverage
	SPC-R44	0	Toe of short slope at creek
	SPC-R45	0	Toe of slope at creek (outer bend)
	SPC-R46	0	Toe of slope away from creek; no 1955 air photo coverage
	SPC-R47	0	Toe of slope at creek; no 1955 air photo coverage
	SPC-R48	0	Toe of slope away from creek; no 1955 air photo coverage
	SPC-R49	0	Toe of slope at creek (outer bend); no 1955 air photo coverage
	SPC-R50	0	Toe of slope away from creek; no 1955 air photo coverage
	SPC-R51	0	Toe of slope at creek (outer bend); no 1955 air photo coverage
	SPC-R52	0	Toe of short slope at creek; no 1955 air photo coverage
		15	

Table 15: Summary of Lateral Migration Results

Geological Sector	Cross-Section	Representative Cross-Sectional Profile	Geomorphic Position	Reach	Degree of Lateral Channel Migration						Timeframe (years):	50
					Channel Width 1955 (m)	Channel Width 2010 (m)	Change in LB (m) from 1955 to 2010	Rate of Change in LB (m/yr)	Change in RB (m) from 1955 to 2010	Rate of Change in RB (m/yr)	Required Additional LB Setback (m)	Required Additional RB Setback (m)
Interior Slopes												
IS	IS-1	Slope above clay mine	Interior Slope		n/a	n/a	n/a		n/a			
	IS2	Southeast Hill	Interior Slope		n/a	n/a	n/a		n/a			
	IS-3A	Kensington area below 13 ST SE	Interior Slope		n/a	n/a	n/a		n/a			
	IS-3B	Kensington area below 13 ST SE	Interior Slope		n/a	n/a	n/a		n/a			
	IS-4	Altawana	Interior Slope		n/a	n/a	n/a		n/a			
	IS-5	Slopes above Power Plant area	Interior Slope		n/a	n/a	n/a		n/a			
	IS-6	North side of SSR near Redcliff	Interior Slope		n/a	n/a	n/a		n/a			
	IS-7	Slopes above Echo Dale flood plain	Interior Slope with dry coulees		n/a	n/a	n/a		n/a			
Ross Creek												
RC	RC-1	Near Scholten slide	Away from creek		n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	**n/a**
	RC-2	Ross Creek - mid to upper reaches	Outer bend of creek	R4	2.93	14.3	1.77	0.03	9.55	0.17	**1.61**	**8.68**
	RC-3	Ross Creek - mid reaches	Away from creek; coulees with water flow		n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	**n/a**
	RC-4	Ross Creek - upper reaches	Generally away from creek		n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	**n/a**
				R1	10.80	16.71	-9.84	-0.18	16.41	0.30	**8.95**	**14.91**
				R2	6.76	11.37	20.06	0.36	-16.25	-0.30	**18.23**	**14.77**
				R3	4.31	10.42	-12.44	-0.23	19.02	0.35	**11.31**	**17.29**
				R3	13.54	11.79	-4.58	-0.08	2.83	0.05	**4.16**	**2.57**
				R5	10.85	15.88	1.66	0.03	3.32	0.06	**1.51**	**3.01**
				R5	10.18	23.42	6.16	0.11	7.25	0.13	**5.60**	**6.59**
				R10	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955
Subtotal					59.37	103.89	2.79	0.05	42.12	0.77	51.36	67.84
Average	7				8.48	14.84	0.40	0.01	6.02	0.11	**7.34**	**9.69**
Seven Persons Creek												
SPC	SPC-1	ADM Slide; Crestwood; Saamis Funeral Home	Creek discontinuously at toe of slope	R5	6.25	5.22	-0.52	-0.01	-0.56	-0.01	**0.47**	**0.51**
	SPC-2	Mid-way along SPC downstream of Highway 1 - Malborough	Away from creek; storm discharge into coulee		n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	**n/a**
	SPC-3	mid-way along SPC downstream of Highway 1 - 651 and 653 13 St + Kin Coulee Park - N side	Away from creek; storm discharge into coulee		n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	**n/a**
	SPC-4A	mid-way along SPC downstream of Highway 1 - Kin Coulee Park - S side	Away from creek		n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	**n/a**
	SPC-4B	mid-way along SPC downstream of Highway 1 - Kin Coulee Park - S side	Away from creek		n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	**n/a**
	SPC-5	Mid-way along SPC upstream of Highway 1 on N side	Outer bend of tributary coulee; storm discharge to coulee		n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	**n/a**
	SPC-6	Mid-way along SPC upstream of Highway 1 on S side - near Sunset Drive	Away from creek; generally dry coulees		n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	**n/a**
	SPC-7A	Upstream - Eagleview where undercut by SPC	Outer bend of creek	R25	11.16	3.63	-23.73	-0.43	16.23	0.30	**21.57**	**14.75**
	SPC-7B	Upstream - Canyon Creek where undercut by SPC	Outer bend of creek		* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955
				R7	8.58	4.73	3.52	0.06	-7.32	-0.13	**3.20**	**6.65**
				R9	5.77	7.98	-2.20	-0.04	4.40	0.08	**2.00**	**4.00**
				R13	10.73	6.86	10.23	0.19	-24.15	-0.44	**9.30**	**21.95**
				R15	7.79	6.83	-28.01	-0.51	27.02	0.49	**25.46**	**24.56**
				R17	8.96	4.67	-17.29	-0.31	12.92	0.23	**15.72**	**11.74**
				R21	4.17	4.78	-5.09	-0.09	5.43	0.10	**4.63**	**4.94**
				R29	10.58	7.17	-9.87	-0.18	6.48	0.12	**8.97**	**5.89**
				R27	7.68	7.90	-6.21	-0.11	6.49	0.12	**5.65**	**5.90**
				R31	6.56	10.95	4.53	0.08	-0.27	0.00	**4.12**	**0.24**
				R35	9.96	7.17	1.52	0.03	-4.42	-0.08	**1.38**	**4.02**
				R37	20.29	5.84	-21.41	-0.39	6.97	0.13	**19.46**	**6.33**
				R39	15.85	10.92	-1.26	-0.02	-3.59	-0.07	**1.14**	**3.26**
				R41	16.66	7.66	-2.17	-0.04	-6.84	-0.12	**1.97**	**6.22**
Subtotal					151.00	102.29	-97.95	-1.78	38.79	0.71	125.04	120.97
Average	15				10.07	6.82	-6.53	-0.12	2.59	0.05	**8.34**	**8.06**
South Saskatchewan River												
SSR	SSR-1A	Fertilizer Plant Slide	Tight outer bend or river	R1	104.81	151.40	-22.53	-0.41	69.19	1.26	**20.48**	**62.90**
	SSR-1B	Evilsmelling Bluff	Tight outer bend or river	R1	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955
	SSR-1C	Rattlesnake Slide	Tight outer bend or river	R1	120.53	134.55	37.08	0.67	-22.90	-0.42	**33.71**	**20.82**
	SSR-2	Ranchlands	Outer bend of river and interior slope	R1	165.57	150.22	2.17	0.04	-18.23	-0.33	**1.97**	**16.57**
	SSR-3	Police Point Slide	Outer bend of river and dry coulees	R1	89.66	88.65	-31.19	-0.57	35.54	0.65	**28.35**	**32.31**
Subtotal	4				480.57	524.82	-14.47	-0.26	63.60	1.16	84.52	132.60
Average					120.14	131.21	-3.62	-0.07	15.90	0.29	**21.13**	**33.15**
SSR	SSR-4	Golf and Country Club	Inland from broad outer bend of river	R2	n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	**n/a**
				R2	167.98	181.53	18.88	0.34	-5.72	-0.10	**17.16**	**5.20**
Subtotal	1				167.98	181.53	18.88	0.34	-5.72	-0.10	17.16	5.20
Average					167.98	181.53	18.88	0.34	-5.72	-0.10	**17.16**	**5.20**
SSR	SSR-5A	1st St SW	Broad outer bend of river	R3	166.29	203.37	51.83	0.94	2.97	0.05	**47.12**	**2.70**
	SSR-5B	1st St SW	Broad outer bend of river	R3	180.00	215.90	36.52	0.66	4.71	0.09	**33.20**	**4.28**
	SSR-6	Rideau Manor	Broad outer bend of river	R3	150.90	141.07	7.07	0.13	-16.60	-0.30	**6.43**	**15.09**
Subtotal	3				497.19	560.34	95.42	1.73	-8.92	-0.16	86.75	22.07
Average					165.73	186.78	31.81	0.58	-2.97	-0.05	**28.92**	**7.36**
SSR	SSR-7	Powerhouse Slide	Straight reach of river	R4	183.69	173.05	18.45	0.34	-29.67	-0.54	**16.77**	**26.97**
	SSR-8	Surprise Bluffs	Outer bend of river	R4	166.50	167.00	-15.48	-0.28	16.51	0.30	**14.07**	**15.01**
	SSR-9A	North side of SSR near Redcliff	Outer bend of the river and straight reach of river	R4	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955
	SSR-9B	North side of SSR near Redcliff	Outer bend of the river and straight reach of river	R4	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955
	SSR-10	Redcliff Pumphouse Slide	Outer bend of river	R4	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955
	SSR-11	Cypress County Slide TWP RD 130	Outer bend of river	R4	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955	* no data from 1955
Subtotal	2				350.19	340.05	2.97	0.05	-13.16	-0.24	30.85	41.98
Average					175.10	170.03	1.49	0.03	-6.58	-0.12	15.42	20.99
Total (all SSR sections)					1495.93	1606.74	102.80	1.87	35.80	0.65	219.27	201.85
Average (all SSR sections)	10				149.59	160.67	10.28	0.19	3.58	0.07	**21.93**	**20.19**

Table 16: Slope Database: Representative Cross-Sections over the City of Medicine Hat

Geological Sector	Cross-Section (37 x-sections)	Physical Description of Cross-Sectional Profile Location	Geomorphic Position	Dominant Landslide Process	Degree of Landslide Activity	Causal Mechanisms	Overall Slope Height (m)	Overall Slope Gradient (%/Degrees)	Field Stratigraphy	BH Stratigraphy	Groundwater Conditions	Description	Associated Polygon and Terrain Hazard	FoS for Most Probable Failure at/beyond Crest of Escarpment	Setback Distance (m) Required for FoS ≥ 1.5 Measured from Crest of Escarpment
IS	IS-1	Slope above clay mine	Interior slope	Translational (block) occurring on slope(s) between benches	Active	Anthropogenic (oversteepened slopes)	74	50-150%/27-55	~ 110 m brown clay till interbedded with grey clay layers (0.5 m to > 4 m thick) > 15 m silt, sand (interglacial sediments)	Extrapolated from SSR-3: 5 m glaciolacustrine clay 1 m brown clay till (low plastic) 2 m glaciolacustrine clay 32 m brown clay till (low plastic) >15 m grey clay (med plastic).	Perched water table suspected in interglacial sediments	Man-made, benched slopes	P117 /VH	0.9	34
	IS-2	Southeast Hill	Interior slope	Creep	Active	Seepage	30 - 35	50-65%/25-35	~ 3- 10 m silt, some sand (glaciolacustrine) > 20 -27 m brown clay till	4 m silt, clay 20 m clay till (low to medium plastic) > 6 m clay (medium to high plastic), sand.	Perched water table in glaciolacustrine sediments	Moderate slope; wet	P58/M	1.3	40
	IS-3A/3B	Kensigton area below 13 Street SE	Interior slope	Translational	3A/3B - Reactivated	Seepage	30 - 35	40-100%/20-45	> 30 m grown clay till	7 m silt, some sand >13 m brown clay till (medium to high plastic).	Perched water table in upper silt layer	Steep slopes; dry	P48/VH	3A - 0.6 3B - 1.6	3A - 56 3B - 6
	IS-4	Altawana	Interior slope	Shallow rotational/creep	Active	Seepage	20 - 30	40-100%/20-45	0 - 3 m silt, sand (glaciolacustrine) - suspected > 20 m clay till	3.2 - 4.4 m sand > 12 m clay till.	Perched water table in glaciolacustrine sediments	Moderately steep to steep slopes; saturated	P285/VH	0.9	27
	IS-5	Slopes above Power Plant area	Interior slope	Shallow rotational	Inactive (Dormant and portion stabilized through remediation)	Seepage	30	25-65%/13-33	None exposed - expect clay till >20 m thick, likely overlying bedrock	17 m glaciolacustrine clay overlying bedrock (assumed).	Perched water table in glaciolacustrine sediments	Moderate slopes; dry except for concentrated points of drainage in topographic depressions	P269/H	2.3	6
	IS-6	North side of SSR near Redcliff	Interior slope	Shallow rotational	Inactive (Relict)	seepage	24	21 - 50%/12 -25	No sediments exposed; infer from adjacent stratigraphy above river: ~ 3 m sand + gravel (glaciofluvial?) > 15 m brown clay till overlying bedrock (Foremost Fm w/ coal seams)	>16 m interbedded brown clay till (low plastic) and interglacial sediments.	Perched water table in glaciofluvial sediments	Moderate slope; dry	P268/L	1.9	6
	IS-7	Slopes above Echo Dale flood plain	Interior slope with dry coulees	Shallow rotational	Inactive (Dormant)	Seepage	20 - 55	25-70%/15-35	~ 10 m clayey sand (glaciolacustrine) 0.3 m clay layer (glaciolacustrine) > 40 m clay till bedrock may be present at river level	Not available.	Perched water table in glaciolacustrine sediments; regional water table at the bedrock surface	Moderate to moderately steep; general dry slope	P264/H	1.3	11
RC	RC-1	Near Scholten slide	Away from creek	Shallow rotational	Inactive (Dormant)	Seepage	30 - 50	50-80%/25-45	~ 15 m silt, sand, clay (glaciolacustrine) - suspected > 5 m clay till	4.7 - 7.2 m clay fill 6.9 - 7.9 m silty sand, varying amounts of clay > 18 m clay till.	Perched water table in glaciolacustrine sediments	Steep	P80/H	0.9	62
	RC-2	Ross Creek - mid to upper reaches	Outer bend of creek	Rotational-translational	Inactive (Relict)	Undercutting/seepage	40	30-100/17-45	~ 15 m silt, sand, clay (glaciolacustrine) - suspected > 5 m clay till	Not available.	Perched water table in glaciolacustrine and interglacial (if present) sediments	Moderate slopes; dry except for concentrated points on drainage in dendritic coulees; failure most probable at toe where oversteepened at railway.	P87/L and P91/VH	5.3	6
	RC-3	Ross Creek - mid reaches	Away from creek; coulees with water flow	Translational	Active	Seepage	30 - 35	50-80%/25-40	~ 1 m cobble, some sand (glaciofluvial) ~ 2 - 4 m sand interbedded with thin clay layers (glaciolacustrine) > 25 m brown clay till	2 m - 8 m silt, sand, gravel 2 - 28 m clay till non to medium plastic), sand lenses are encountered in the deeper holes > 1 m - 19 m sand, silt.	Perched water table in glaciolacustrine and interglacial (if present) sediments	Very steep, actively failing slope; seepage.	P106/VH	1.1	30
	RC-4A/4B	Ross Creek - upper reaches	Generally away from creek	Shallow rotational	4A - Inactive (Relict) 4B - Inactive (Dormant)	Seepage	30 - 35	50-80%/25-40	~ 2 m- 5 m silt, sand, clay (glaciolacustrine) - suspected > 5 m clay till	2 m - 8 m silt, sand, gravel 2 - 28 m clay till non to medium plastic), sand lenses are encountered in the deeper holes > 1 m - 19 m sand, silt.	Perched water table in glaciolacustrine and interglacial (if present) sediments	Generally moderately steep; dry	4A: P108/M 4B: P110/M	4A: 2.3 4B: 1.0	4A: 6 4B: 22
SPC	SPC-1	ADM Slide; Crestwood; Saamis Funeral Home	Creek discontinuously at toe of slope	Shallow rotational	Reactivated	Seepage/undercutting	30 - 35	60-200%/30-65	~ 8 - 10 m silt, some sand (glaciolacustrine) ~ 18 m brown clay till > 2 m sand, some gravel (interglacial sediments; likely some silt as observed in creek bank across the creek)	3 m sandy, silty clay (low plastic) 4 m silty, sandy clay (medium plastic) 11.5 m brown clay till (medium to high plastic) > 16.5 m grey (contorted) clay till (medium plastic) > 10 m sand (as per Golder 1976).	Perched water table in glaciolacustrine/interglacial sediments	V. steep, actively failing slope, seepage	P78/VH	0.6	80
	SPC-2	Mid-way along SPC downstream of Highway 1 - Malborough	Away from creek; storm discharge into coulee	Translational	Inactive (Dormant)	Seepage	30	50-80%/25-40	> 30 m brown clay till	> 8 m clay till (with frequent sand lenses).	Perched water table in glaciolacustrine/interglacial sediments	Moderately steep, isolated area that is oversteepened with active erosion	P64/M and P65/L	1.3	9
	SPC-3	Mid-way along SPC downstream of Highway 1 - 651 and 653 13 St and Kin Coulee Park - N side	Away from creek; storm discharge into coulee	Translational	Inactive (Dormant)	Seepage/undercutting	30	50-80%/25-40	> 30 m brown clay till	2.4-5.7 m clay fill (low plastic) > 6.3 - 9.6 m clay till (low plastic).	Perched water table in glaciolacustrine sediments	Steep with some erosion	P13/H	1.4	8
	SPC-4A/4B	Mid-way along SPC downstream of Highway 1 - Kin Coulee Park - S side	Away from creek	Translational	4A - Reactivated 4B - Inactive (Dormant)	Seepage	30 - 35	70-100/35-45	~0-1.5 m laminated clay (glaciolacustrine) ~10.5 - 12 m clay till > 2 m sand (interglacial)	3 m clay fill (includes thin sand seam) 6 m glaciolacustrine clay (low plastic) 4 m sand 3 m clay till (low to medium plastic) 1 m sand 2 m grey clay till (medium plastic) 3 m sand >4 m grey clay till (low plastic).	Perched water table in glaciolacustrine/interglacial sediments	V. steep, actively failing slope	P38/VH	4A - 0.7 4B - 0.9	4A - 52 4B - 38
	SPC-5	Mid-way along SPC upstream of Highway 1 on N side	Outer bend of tributary coulee; storm discharge to coulee	Translational	Active	Seepage/undercutting	30 - 50	60-200%/30-65	~ 1- 3 m silt, some sand (glaciolacustrine) > 27 -29 m brown clay till possibly underlain by interglacial sand and gravel	Not available.	Perched water table in glaciolacustrine and interglacial (if present) sediments	Steep, seepage, previous failures	P20/VH	1.3	12
	SPC-6	Mid-way along SPC upstream of Highway 1 on S side - near Sunset Dr	Away from creek; generally dry coulees	Translational	Inactive (Dormant)	Seepage	20 - 50	50-200%/25-65	~ 1 m silt, some sand (glaciolacustrine) > 19 m brown clay till	1 - 4 m silt, some to trace sand ~ 25 - > 30 m clay till (low to int plastic) > 16 m interbedded sand and silt, and less commonly gravel.	Perched water table in glaciolacustrine sediments	Moderately steep; seepage zones	P177/M	1.8	6
	SPC-7A/7B	Upstream end of SPC - Canyon Creek, Eagleview where undercut by SPC	Outer bend of creek	Rotational-translational	7A - Active 7B - Active	Undercutting/seepage	15 - 35	65-175%/35-60	~ 4 - 7 m silt, some sand (glaciolacustrine) ~ 2 m coarse sand (glaciolacustrine) - discontinuous > 24 m brown clay till	For 7B: 1.5 - 6 m silty sand > 16 - 18.5 m silty clay till (medium plastic).	Perched water table in glaciolacustrine sediments	Section 7A is through Eagleview; Section 7B is through Canyon Creek	7A - P186/VH 7B - P240/VH	7A - 0.9 7B - 0.7	7A - 33 7B - 24

Table 16: Slope Database: Representative Cross-Sections over the City of Medicine Hat

Geological Sector	Cross-Section (37 x-sections)	Physical Description of Cross-Sectional Profile Location	Geomorphic Position	Dominant Landslide Process	Degree of Landslide Activity	Causal Mechanisms	Overall Slope Height (m)	Overall Slope Gradient (%/Degrees)	Field Stratigraphy	BH Stratigraphy	Groundwater Conditions	Description	Associated Polygon and Terrain Hazard	FoS for Most Probable Failure at/beyond Crest of Escarpment	Setback Distance (m) Required for FoS ≥ 1.5 Measured from Crest of Escarpment
SSR	SSR-1A/1B/1C	Evilsmelling Bluff - 1B (GSC data) + Rattlesnake Slide - 1C (Hardy) + Fertilizer Plant Slide-1A (McKay and Thompson)	Tight outer bend or river	Rotational-translational	1A/1B/1C Active	Undercutting/seepage	50 - 130	60-200%/30-65	0 - 10 m sand, silt (glaciolacustrine) 60 m interbedded till and interglacial sediments 20 m sand, gravel, clay (preglacial) bedrock (Foremost Fm) at river level	0 - 10 m sand, silt 60 m interbedded till and interglacial sediments 20 m sand, gravel, clay bedrock (Foremost Fm) at river level.	Perched water table in glaciolacustrine and interglacial sediments; ponded water noted	Steep, previous failures on outside bends of river; 1B not typed since outside City Boundary	1A - P335/VH 1B - not typed 1C - P331/VH	1A - 0.9 1B - 1.0 1C - 1.1	1A - 53 m 1B - 58 m 1C - 23 m
	SSR-2	Ranchlands	Outer bend of river and interior slope	Translational	Active	Undercutting	20	65-80%/35-40	> 25 m sand, varying amounts of gravel (alluvial terrace) - suspect slope has been regraded	> 35 m interbedded sands, gravels and clay.	Well drained - water table near river elevation	steep, uniform slope on outside bend	P328/H	1.0	17
	SSR-3	Police Point Slide	Outer bend of river and dry coulees	Rotational-translational	Inactive (Dormant)	Undercutting	86	80-550%/40-80	~ 110 m brown clay till interbedded with grey clay layers (0.5 m to > 4 m thick) > 15 m silt, sand (interglacial sediments)	5 m glaciolacustrine clay 1 m brown clay till (low plastic) 2 m glaciolacustrine clay 32 m brown clay till (low plastic) >15 m grey clay (medium plastic).	Perched water table suspected in interglacial sediments	v. steep; outside bend	P120/VH	0.6	97
	SSR-4	Golf and Country Club	Inland from broad outer bend of river	Translational	Active	Seepage	10	65 - 100%/35-45	> 10 m sand and gravel (alluvial terrace)	0.5 m gravel 9 m sand 7.5 m sand and gravel > 1 m sand.	Well drained - water table near river elevation	steep, dry slope	P308/H	1.3	8
	SSR-5A/5B	1 Street SW	Broad outer bend of river	Rotational/Creep	5A - Inactive (Dormant) 5B - Active	Undercutting/seepage	50	65-80%/35-40	Clay till within depositional zone, likely as per Hardy report i.e., glaciolacustrine veneer over interbedded till and interglacial sediments, possibly overlying bedrock at river level.	For 5B: 4 m sand and gravel (fill?) 3 m clay fill (low plastic) 12 m clay till (low to medium plastic) >7 m sand.	Perched water table in glaciolacustrine/interglacial sediments	moderate slopes with seepage + creep	P318/M	5A - 1.7 5B - 2.5	5A - 6 5B - 6
	SSR-6	Rideau Manor	Broad outer bend of river	Translational	Active	Undercutting/seepage	10	50-100%/25-45	0 - 3 m silt, sand (glaciolacustrine) - suspected > 20 m clay till.	1.2 m sand 6.8 m clay till (low to medium plastic) with sand layers > 4.5 m shale bedrock.	Perched water table in glaciolacustrine sediments		P315/VH	0.8	12
	SSR-7	Powerhouse Slide	Straight reach of river	Rotational-translational	Inactive (Dormant)	Undercutting/seepage	40	100%/45	~ 2 m sand + gravel (glaciofluvial?) > 8-10 m brown clay till Bedrock (Foremost Fm w/ coal seams) forms about half of slope height.	15 m brown clay till (low plastic) 2 m grey clay till (low to medium plastic) 1 m sand 4 m clay till (low plastic) 0.5 m sand 3 m grey clay till (medium plastic) > 0.5 m sand.	Perched water table in glaciofluvial sediments; regional water table at the bedrock surface		P12/VH	0.9	72
	SSR-8	Surprise Bluffs (GSC data)	Outer bend of river	Rotational-translational	Inactive (Dormant)	Undercutting/seepage	60 - 90	70-100%/35-45	0 - 10 m silt, sand, gravel (glaciolacustrine) 55 - 85 interbedded till and interglacial sediments 5 m sand, gravel (preglacial) bedrock (Foremost Fm) at river level.	0 - 10 m silt, sand, gravel 55 - 85 interbedded till and interglacial sediments 5 m sand, gravel bedrock (Foremost Fm) at river level.	Perched water table in glaciolacustrine and interglacial sediments; ponded water noted	Steep; seepage.	P5/M	1.3	38
	SSR-9A/9B	North side of SSR near Redcliff	Outer bend of the river and straight reach of river	Rotational-translational	9A - Reactivated 9B - Inactive (Relict)	Undercutting/seepage	68	60-200%/30-65	~ 3 m sand + gravel (glaciofluvial?) ~ 10 m brown clay till Bedrock (Foremost Fm w/ coal seams + bentonite layer) forms about 3/4 of slope height.	Extrapolated from IS-6: >16 m interbedded brown clay till (low plastic) and interglacial sediments.	Perched water table in glaciofluvial sediments; regional water table at the bedrock surface	9A appears to be actively failing from air photo interpretation	9A: P266/VH 9B: P267/VH	9A - 1.2 9B - 1.2	9A - 34 9B - 21
	SSR-10	Redcliff Pumphouse Slide (McKay + Thompson and Hardy)	Outer bend of river	Rotational-translational	Inactive (Dormant)	Undercutting/seepage	82	100-200%/45-65	~ 2 m sand + gravel (glaciofluvial?) - not present at Cypress County Slide > 8-10 m brown clay till 1.75 m sand (noted at recent slide adjacent to Redcliff Pumphouse Slide) + laminated clay (> 3 m thick) noted at the Cypress County slide a short distance above bedrock Bedrock (Foremost Fm w/ coal seams) forms about half of slope height.	Not available	Perched water table in glaciofluvial sediments; regional water table at the bedrock surface		P257/VH	0.8	90
	SSR-11	Cypress County TWP Rd 130 Slide	Outer bend of river	Rotational-translational	Active	Undercutting/seepage	89	60%/30	~ 2 m sand + gravel (glaciofluvial?) - not present at Cypress County Slide > 8 m - 10 m brown clay till 1.75 m sand (noted at recent slide adjacent to Redcliff Pumphouse Slide) and laminated clay (> 3 m thick) noted at the Cypress County slide a short distance above bedrock Bedrock (Foremost Fm w/ coal seams) forms about half of slope height.	Water well log: 2 m sandy clay 6 m - 8 m gravel or sand. ~ 1 m sandy clay (in just one of 2 BH) Shale bedrock	Perched water table in glaciofluvial sediments; regional water table at the bedrock surface		P253/VH	0.2	80

Notes:

IS	Interior Slope
RC	Ross Creek
SPC	Seven Persons Creek
SSR	South Saskatchewan River
Suspected	Means not directly observed, but assumed to be present

Table 17: City of Medicine Hat Geotechnical Setbacks for Top-of-Slope for Slopes > 33%

Geological Sector	Geotechnical Setback Sector (4 main sectors; 17 schemes)	Representative X-Sections	General Setback (H:V)[1]	Total Geotechnical Setback[2, 5]
Interior Slopes (IS)				
IS	IS-a	IS-1, IS-3A, IS-7	3.0H:1V	3.0H:1V
IS	IS-b	IS-2	4.6H:1V	4.6H:1V
IS	IS-c	IS-4	3.7H:1V	3.7H:1V
IS	IS-d	IS-5, IS-6	6 m (minimum)[3]	6 m (minimum)
Ross Creek (RC)				
RC	RC-a	RC-1, RC-3, RC-4B	3.0H:1V	3.0H:1V + LM
RC	RC-b	RC-2	6 m (minimum)[3]	6 m (minimum)+ LM
Seven Persons Creek (SPC)				
SPC	SPC-a	SPC-1, SPC-2, SPC-4A/B	3.0H:1V	3.0H:1V+ LM
SPC	SPC-b	SPC-3, SPC-7A, SPC-7B	2.6H:1V	2.6H:1V+ LM
SPC	SPC-c	SPC-5	3.7H:1V	3.7H:1V+ LM
SPC	SPC-d	SPC-6	6 m (minimum)[3]	6 m (minimum) + LM
South Saskatchewan River (SSR)				
SSR	SSR-a	SSR-1A	3.6H:1V	3.6H:1V + LM
SSR	SSR-b	SSR-1B/1C, SSR-2, SSR-3	2.8H:1V	2.8H:1V + LM
SSR	SSR-c	SSR-4	2.5H:1V	2.5H:1V + LM
SSR	SSR-d	SSR-6	2.2H:1V	2.2H:1V + LM
SSR	SSR-e	SSR-7, SSR-9A	3.3H:1V	3.3H:1V + LM
SSR	SSR-f	SSR-8, SSR-9B, SSR-10, SSR-11	2.6H:1V	2.6H:1V + LM
SSR	SSR-g	SSR-5A5/B	6 m (minimum)[3]	6 m (minimum) + LM

Reaches to which Lateral Migration Applies	Additional Setback Due to Lateral Stream Migration[4] (m)
Interior Slopes (IS)	
n/a	**n/a**
Ross Creek (RC)	
R1, R2, R3, R5, R10	8.5
Seven Persons Creek (SPC)	
R2, R3, R5, R7, R9, R11, R13, R15, R17, R19, R21, R23, R25, R26, R27, R28, R29, R30, R31, R33, R35, R37, R39, R41, R42, R43, R44, R45, R47, R49, R51, and R52.	8.2
South Saskatchewan River (SSR)	
R1	27.1
R2	11.2
R3	18.1
R4	18.2

Notes: [1] As measured from toe of the escarpment (<33%), except where otherwise stated.

[2] LM = Lateral Migration from table to the right.

3 As measured from the top of the escarpment.

[4] Horizontal distance measured from the general setback line.

[5] If the setback calculated with the formula is less than the default of 6 m plus the associated lateral migration used in all areas with the slope gradient of 15% to 33%, then the default of the 6 m plus lateral migration (if applicable) is used, as measured from the top of the escarpment.

Table 21: Properties at Risk – Top and Toe of Escarpment

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
709	2703AV			4	6	13	9	SE	2703AV	4	Very High	A
1361	1595M	29	9A	4	5	12	30	NE	1595M;29;9A	2	Very High	B
1680	9511347	6	1MR	4	5	13	5	NW	9511347;6;1MR	3	High	B
1683	9511347	6	2ER	4	5	13	5	NW	9511347;6;2ER	3	Very High	A
1754	47JK	8	23	4	5	13	6	SE	47JK;8;23	3	High	B
1799				4	6	13	5	SW	4;6;13;5;SW	4	Very High	A
1817	7710885	B		4	5	13	5	SW	7710885;B	4	Very High	A
1866										4	Very High	A
1941		S.E.1/4 SEC		4	5	13	5	SE	4;5;13;5;SE	3	Very High	A
1950	1433HS	R4		4	5	13	6	SW	1433HS;R4	3	Very High	A
1954		N.W.1/4 SEC.		4	6	12	36	NW	4;6;12;36;NW	2	Very High	B
1955		N.W.1/4 SEC.		4	6	12	36	NW	4;6;12;36;NW	2	Very High	B
1956		N.E.1/4 SEC.		4	6	12	35	NE	4;6;12;35;NE	2	Very High	B
2117	8910288		3ER	4	5	13	5	SE	8910288;;3ER	3	Very High	A
2135	8910288		2MR	4	5	13	5	SE	8910288;;2MR	3	High	B
2149	7710789	1	2	4	6	13	4	SE	7710789;1;2	4	Very High	A
2277		S.W.1/4 SEC.		4	6	13	1	SW	4;6;13;1;SW	2	Very High	B
2282		S.E.1/4 SEC.		4	6	13	4	SE	4;6;13;4;SE	4	Very High	A
2350		S.E.1/4 SEC.		4	6	13	2	SE		3	Very High	A
2364	8110153	3MR		4	5	13	6	SW	8110153;3MR	3	Very High	A
2636	8110153	8		4	5	13	6	SW	8110153;8	2	Very High	B
2641	3776HJ	A		4	6	13	2	SE	3776HJ;A	3	Very High	A
2648	7710885	R1		4	5	13	5	SW	7710885;R1	4	Very High	A
2740	703HE	15	15	4	6	13	1	SE	703HE;15;15	4	Very High	A
2741	703HE	15	14	4	6	13	1	SE	703HE;15;14	4	Very High	A
2742	703HE	15	13	4	6	13	1	SE	703HE;15;13	4	Very High	A
2743	703HE	15	12	4	6	13	1	SE	703HE;15;12	4	Very High	A
2744	703HE	15	11	4	6	13	1	SE	703HE;15;11	4	Very High	A
2745	703HE	15	10	4	6	13	1	SE	703HE;15;10	4	High	A
2746	703HE	15	9	4	6	13	1	SE	703HE;15;9	4	High	A
2747	703HE	15	8	4	6	13	1	SE	703HE;15;8	4	High	A
2749	703HE	15	6	4	6	13	1	SE	703HE;15;6	4	Moderate	B
2750	703HE	15	5	4	6	13	1	SE	703HE;15;5	4	High	A
2751	703HE	15	4	4	6	13	1	SE	703HE;15;4	4	High	A
2752	703HE	15	3	4	6	13	1	SE	703HE;15;3	4	High	A
2753	703HE	15	2	4	6	13	1	SE	703HE;15;2	4	High	A
2857				4	6	13	5	SE	4;6;13;5;SE	3	Very High	A
2876	8110153	7MR		4	6	12	14	NW	8110153;7MR	3	Very High	A
2877	794LK	B		4	5	13	6	SW	794LK;B	3	Very High	A
2878	794LK	B		4	5	13	6	SW	794LK;B	3	Very High	A
2879	794LK			4	5	13	6	SW	794LK	4	Very High	A
2888	8010828			4	5	13	6	SW	8010828	2	Very High	B
2938				4	6	13	5	SE	4;6;13;5;SE	3	Very High	A
3016	7989HD	8	10	4	6	13	1	SE	7989HD;8;10	4	Moderate	B
3034	7710885	R4		4	5	13	6	SE	7710885;R4	4	Very High	A
3138	7710789			4	6	13	4	SE	7710789	4	Very High	A
3231	7710789	1	1	4	6	13	4	SE	7710789;1;1	4	Very High	A
3267	0012283	14	2ER	4	5	12	31	NE	0012283;14;2ER	3	Very High	A
3274	8110153	4MR		4	5	12	31	NW	8110153;4MR	4	Very High	A
3276	8110153			4	6	12	14	NW	8110153	4	Very High	A
3316		S.W.1/4 SEC.		4	6	13	2	SW	4;6;13;2;SW	4	Very High	A
3363	7610160	J		4	6	12	35	NE	7610160;J	2	Very High	B
3437		N.W.1/4 SEC.		4	6	12	27	NW	4;6;12;27;NW	4	Very High	A
3505		S.E.1/4 SEC.		4	6	13	4	SE	4;6;13;4;SE	4	High	A
3676		N.E.1/4 SEC.		4	6	12	33	NE	4;6;12;33;NE	4	Very High	A
3680		N.W.1/4 SEC.		4	6	12	33	NW	4;6;12;33;NW	3	Very High	A
3681				4	6	12	32	NE	4;6;12;32;NE	3	Very High	A
3682				4	6	12	32	NE	4;6;12;32;NE	3	Very High	A
3683				4	6	12	32	NE	4;6;12;32;NE	3	Very High	A
3684	7710885	R5		4	5	12	32	NW	7710885;R5	3	Very High	A
3685				4	6	12	32	NW	4;6;12;32;NW	4	Very High	A
3689	0012283	14	1	4	5	12	31	NW	1599JK;24;7	3	Very High	A
3692	0012283	15	1	4	5	12	31	NE	0012283;15;1	3	Very High	A
3705	8110153	6	1	4	5	12	31	NW	8110153;6;1	2	Very High	B
3706	8110153	6	2	4	5	12	31	NW	8110153;6;2	2	High	B
3708	8110153	6	3	4	5	12	31	NW	8110153;6;3	2	High	B
3711	0012283	13	1	4	5	12	31	NW	0012283;13;1	3	Moderate	B
3716	0112294	7		4	6	12	36	NE	0112294;7	4	Moderate	B

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
3717	6844AT	1		4	5	12	31	NW	6844AT;1	4	Moderate	B
3782	731596	5	3	4	6	12	36	NW	731596;5;3	3	High	B
3787	731596	5	2	4	6	12	36	NW	731596;5;2	3	High	B
3793	731596	5	1	4	6	12	36	NW	731596;5;1	3	High	B
3824	47748	B	8	4	5	12	31	NW	47748;B;8	2	High	B
3838	47748	B	7	4	5	12	31	NW	47748;B;7	2	High	B
3883		S.W.1/4 SEC.		4	6	12	34	SW	4;6;12;34;SW	4	Very High	A
4030	9211125	B	14	4	5	12	31	NW	9211125;B;14	2	High	B
4096	23560	A	10	4	6	12	36	SE	23560;A;10	3	Moderate	B
4126		N.E.1/4 SEC.		4	6	12	33	NE	4;6;12;33;NE	3	Very High	A
4224	731596	4	7	4	6	12	36	NW	731596;4;7	3	High	B
4236	47748	A	19	4	5	12	31	SW	47748;A;19	2	Very High	B
4257	7910998	46		4	6	12	35	NE	7910998;46	3	High	B
4266	47748	A	18	4	5	12	31	SW	47748;A;18	2	Very High	B
4319	833M	1	17	4	6	12	36	SE	833M;1;17	2	Very High	B
4321	833M	1	18	4	6	12	36	SE	833M;1;18	2	Very High	B
4324	833M	1	19	4	6	12	36	SE	833M;1;19	2	Very High	B
4326	833M	1	20	4	6	12	36	SE	833M;1;20	2	Very High	B
4328	833M	1	21	4	6	12	36	SE	833M;1;21	2	Very High	B
4378	6296HN	1	7	4	6	12	36	NW	6296HN;1;7	3	High	B
4380	6296HN	1	7	4	6	12	36	NW	6296HN;1;7	3	High	B
4391	6296HN	3	17	4	6	12	36	NW	6296HN;3;17	3	High	B
4393	6296HN	3	18	4	6	12	36	NW	6296HN;3;18	3	High	B
4396	6296HN	3	18	4	6	12	36	NW	6296HN;3;18	3	High	B
4397	6296HN	3	19	4	6	12	36	NW	6296HN;3;19	3	High	B
4399	6296HN	3	19	4	6	12	36	NW	6296HN;3;19	3	High	B
4403	6296HN	3	20	4	6	12	36	NW	6296HN;3;20	3	High	B
4411	47748	A	17	4	5	12	31	SW	47748;A;17	2	Very High	B
4429	47748	A	16	4	5	12	31	SW	47748;A;16	2	Very High	B
4448										4	Very High	A
4449										2	Very High	B
4565	47748	A	15	4	5	12	31	SW	47748;A;15	2	Very High	B
4671	6296HN	3	21	4	6	12	36	NW	6296HN;3;21	3	High	B
4682	6296HN	3	24	4	6	12	36	NW	6296HN;3;24	3	Moderate	B
4683	6296HN	3	23	4	6	12	36	NW	6296HN;3;23	3	Moderate	B
4685	6296HN	3	22	4	6	12	36	NW	6296HN;3;22	3	High	B
4692	6296HN	H		4	6	12	36	NW	6296HN;H	3	Very High	A
4695	47748	A	14	4	5	12	31	SW	47748;A;14	2	Very High	B
4708	4465FL		F	4	5	12	31	SW	4465FL;;F	2	Very High	B
4785	4465FL		E	4	5	12	31	SW	4465FL;;E	2	Very High	B
4788		S.W.1/4 SEC.		4	6	12	35	SW	4;6;12;35;SW	3	Very High	A
4791		S.W.1/4 SEC.		4	6	12	35	SW	4;6;12;35;SW	4	Very High	A
4795	397JK		22	4	5	12	31	SW	397JK;;22	2	Very High	B
4809	8110916	CDE 8110916		4	6	12	35	NE	8110916;CDE 81109	4	Very High	A
4902	8590AH	Z		4	6	12	35	SE	8590AH;Z	3	Very High	A
4908	397JK		21	4	5	12	31	SW	397JK;;21	2	Very High	B
4911		S.E.1/4 SEC.		4	6	12	33	SE	4;6;12;33;SE	3	Very High	A
4912		S.E.1/4 SEC.		4	6	12	33	SE	4;6;12;33;SE	3	Very High	A
4916		S.W.1/4 SEC.		4	6	12	33	SW	4;6;12;33;SW	3	Very High	A
4922	9111241	11	5	4	6	12	35	NE	9111241;11;5	4	Very High	A
4925	9111241	11	6	4	6	12	35	NE	9111241;11;6	4	Very High	A
4929	7711578	13	1	4	6	12	35	NE	7711578;13;1	4	Very High	A
4932	7711578	13	2	4	6	12	35	NE	7711578;13;2	4	Very High	A
4982	47748	D		4	5	12	31	NW	47748;D	2	High	B
5014				4	6	12	32	SE	4;6;12;32;SE	3	Very High	A
5021	397JK		20	4	5	12	31	SW	397JK;;20	2	Very High	B
5050	47748	A	12	4	5	12	31	SW	47748;A;12	2	Very High	B
5052	47748	A	9	4	5	12	31	SW	47748;A;9	2	Very High	B
5053	47748	A	10	4	5	12	31	SW	47748;A;10	2	Very High	B
5054	47748	A	8	4	5	12	31	SW	47748;A;8	2	Very High	B
5055	47748	A	6	4	5	12	31	SW	47748;A;6	2	Very High	B
5120	8810499	5	40	4	6	12	36	NW	8810499;5;40	4	Very High	A
5128	6296HN	G		4	6	12	36	NW	6296HN;G	3	Very High	A
5133		N.W.1/4 SEC.		4	6	12	35	NW	4;6;12;35;NW	4	Very High	A
5161	47748	A	5	4	5	12	31	SW	47748;A;5	2	Very High	B
5169	47748	A	4	4	5	12	31	SW	47748;A;4	2	Very High	B
5177	4455JK	A	R1	4	5	12	31	SW	4455JK;A;R1	2	Very High	B
5205	8810499	5	39	4	6	12	36	NW	8810499;5;39	4	High	A
5209	8810499	5	38	4	6	12	36	NW	8810499;5;38	4	High	A

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
5216	8810499	5	37	4	6	12	36	NW	8810499;5;37	4	High	A
5223	731596	5	27	4	6	12	36	NW	731596;5;27	3	High	B
5224	8810499	5	36	4	6	12	36	NW	8810499;5;36	4	High	A
5226	731596	R1		4	6	12	36	NW	731596;R1	4	Very High	A
5227	8810499	5	32	4	6	12	36	NW	8810499;5;32	4	High	A
5228	8810499	5	33	4	6	12	36	NW	8810499;5;33	4	High	A
5299	7410061	A	R1	4	6	12	36	SE	7410061;A;R1	3	Very High	A
5328	8810499	5	34	4	6	12	36	NW	8810499;5;34	4	High	A
5329	8810499	5	35	4	6	12	36	NW	8810499;5;35	4	High	A
5384	8210743	1	12	4	5	12	31	NW	8210743;1;12	2	High	B
5398	833M		Z	4	6	12	36	SE	833M;;Z	3	Very High	A
5413	23560	A	5	4	6	12	36	SE	23560;A;5	3	Very High	A
5428		N.E.1/4 SEC		4	6	12	33	NE	4;6;12;33;NE	3	Very High	A
5430				4	6	12	32	NW	4;6;12;32;NW	3	Very High	A
5495	7711578	13	R1	4	6	12	35	NE	7711578;13;R1	4	Very High	A
5496	8168HL	14		4	6	12	35	NE	8168HL;14	4	Very High	A
5498	731596	5	25	4	6	12	36	NW	731596;5;25	3	High	B
5528	7710675	6	R6	4	6	12	35	SE	7710675;6;R6	2	Very High	B
5553	4455JK	A	21	4	5	12	31	SW	4455JK;A;21	2	Very High	B
5558	23560	A	6	4	6	12	36	SE	23560;A;6	3	Very High	A
5580	23560	A	7	4	6	12	36	SE	23560;A;7	3	Very High	A
5583	7410061	A	11	4	6	12	36	SE	7410061;A;11	3	Very High	A
5738	23560	A	8	4	6	12	36	SE	23560;A;8	3	Very High	A
5742	23560	A	9	4	6	12	36	SE	23560;A;9	3	Very High	A
5794	23560	A	1	4	6	12	36	SE	23560;A;1	3	High	B
5884	731596	5	24	4	6	12	36	NW	731596;5;24	3	High	B
5906	731596	5	22	4	6	12	36	NW	731596;5;22	3	High	B
5914	731596	5	23	4	6	12	36	NW	731596;5;23	3	High	B
5995	32380	D	1	4	6	12	36	SE	32380;D;1	3	Very High	A
6000	32380	D	2	4	6	12	36	SE	32380;D;2	3	Very High	A
6007	9112244	D	11	4	6	12	36	SE	9112244;D;11	3	Very High	A
6008	9112244	D	13ER	4	6	12	36	SE	9112244;D;13ER	3	Very High	A
6009	9112244	D	12	4	6	12	36	SE	9112244;D;12	3	Very High	A
6011	32380	D	6	4	6	12	36	SE	32380;D;6	3	Very High	A
6012	381JK	F	12	4	6	12	36	SE	381JK;F;12	3	Very High	A
6013	23560	A	1	4	6	12	36	SE	23560;A;1	3	Moderate	B
6015	32380	D	7	4	6	12	36	SE	32380;D;7	3	Very High	A
6019	32380	D	8	4	6	12	36	SE	32380;D;8	3	Very High	A
6023	32380	D	9	4	6	12	36	SE	32380;D;9	3	Very High	A
6076	731596	5	6	4	6	12	36	NW	731596;5;6	3	High	B
6087	9090FT	C		4	6	12	36	NW	9090FT;C	4	Very High	A
6097	731596	5	5	4	6	12	36	NW	731596;5;5	3	High	B
6100	731596	5	4	4	6	12	36	NW	731596;5;4	3	High	B
6101	9090FT	B		4	6	12	36	NW	9090FT;B	3	Very High	A
6109	47748	B	10	4	5	12	31	NW	47748;B;10	2	High	B
6127	47748	B	9	4	5	12	31	NW	47748;B;9	2	High	B
6142	32380	D	10	4	6	12	36	SE	32380;D;10	3	Very High	A
6148	381JK	F	13	4	6	12	36	SE	381JK;F;13	3	Very High	A
6204	7710675	6	3	4	6	12	35	SE	7710675;6;3	2	Very High	B
6309	1595M	20	21	4	5	12	30	NE	1595M;20;21	2	Very High	B
6317	1595M	20	22	4	5	12	30	NE	1595M;20;22	2	Very High	B
6323	1595M	20	23	4	5	12	30	NE	1595M;20;23	2	Very High	B
6462	1595M	20	24	4	5	12	30	NE	1595M;20;24	2	Very High	B
6479	59191	V	17	4	5	12	30	NE	59191;V;17	2	High	B
6480	483M	2	16	4	5	12	30	NE	483M;2;16	2	High	B
6481	483M	2	14	4	5	12	30	NE	483M;2;14	2	Very High	B
6482	483M	2	15	4	5	12	30	NE	483M;2;15	2	High	B
6483	1595M	2	28	4	5	12	30	NE	1595M;2;28	2	Very High	B
6484	1595M	2	27	4	5	12	30	NE	1595M;2;27	2	Very High	B
6485	1595M	2	30	4	5	12	30	NE	1595M;2;30	2	Very High	B
6486	1595M	2	29	4	5	12	30	NE	1595M;2;29	2	Very High	B
6487	1595M	2	31	4	5	12	30	NE	1595M;2;31	2	Very High	B
6488	1595M	2	32	4	5	12	30	NE	1595M;2;32	2	Very High	B
6690	1595M	21	14	4	5	12	30	NE	1595M;21;14	2	Very High	B
6691	1595M	21	13	4	5	12	30	NE	1595M;21;13	2	Very High	B
6692	1595M	21	12	4	5	12	30	NE	1595M;21;12	2	High	B
6693	1595M	21	11	4	5	12	30	NE	1595M;21;11	2	High	B
6694	1595M	21	10	4	5	12	30	NE	1595M;21;10	2	High	B
6695	1595M	21	9	4	5	12	30	NE	1595M;21;9	2	High	B

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
6696	1595M	21	8	4	5	12	30	NE	1595M;21;8	2	High	B
6885	833M	1	22	4	6	12	36	SE	833M;1;22	2	Very High	B
6890	833M	1	23	4	6	12	36	SE	833M;1;23	2	Very High	B
6894	833M	1	24	4	6	12	36	SE	833M;1;24	2	Very High	B
6899	833M	1	25	4	6	12	36	SE	833M;1;25	2	Very High	B
6904	833M	1	26	4	6	12	36	SE	833M;1;26	2	Very High	B
6905	833M	1	27	4	6	12	36	SE	833M;1;27	2	Very High	B
6911	833M	1	28	4	6	12	36	SE	833M;1;28	2	Very High	B
6915	833M	1	29	4	6	12	36	SE	833M;1;29	2	Very High	B
6918	833M	1	30	4	6	12	36	SE	833M;1;30	2	Very High	B
6921	833M	1	31	4	6	12	36	SE	833M;1;31	2	Very High	B
6927	833M	1	32	4	6	12	36	SE	833M;1;32	2	Very High	B
6929	833M	1	33	4	6	12	36	SE	833M;1;33	2	Very High	B
6935	833M	1	34	4	6	12	36	SE	833M;1;34	2	Very High	B
7056	832LK	1		4	6	12	25	NW	832LK;1	2	Very High	B
7065	833M	1	35	4	6	12	36	SE	833M;1;35	2	Very High	B
7067	833M			4	6	12	36	SE	833M	2	Very High	B
7069	833M	1	36	4	6	12	36	SE	833M;1;36	2	Very High	B
7074	833M	1	37	4	6	12	36	SE	833M;1;37	2	Very High	B
7086	833M	1	38	4	6	12	36	SE	833M;1;38	2	Very High	B
7092	833M	1	39	4	6	12	36	SE	833M;1;39	2	Very High	B
7098	833M	1	40	4	6	12	36	SE	833M;1;40	2	Very High	B
7108	833M	1	41	4	6	12	36	SE	833M;1;41	2	Very High	B
7112	833M	1	42	4	6	12	36	SE	833M;1;42	2	Very High	B
7172		N.W.1/4 SEC.		4	6	12	27	NW	4;6;12;27;NW	4	Very High	A
7237	833M	1	43	4	6	12	36	SE	833M;1;43	2	Very High	B
7246	833M	1	44	4	6	12	36	SE	833M;1;44	2	Very High	B
7341	832LK		U2						832LK;;U2	2	High	B
7388	833M	1	75	4	6	12	36	SE	833M;1;75	2	Very High	B
7448	832LK			4	6	12	36	SW	832LK	2	Very High	B
7552	833M	1	73	4	6	12	36	SE	833M;1;73	2	Very High	B
7554	833M	1	72	4	6	12	36	SE	833M;1;72	2	Very High	B
7557	833M	1	71	4	6	12	36	SE	833M;1;71	2	Very High	B
7565	833M	1	68	4	6	12	36	SE	833M;1;68	2	Very High	B
7576	833M	1	64	4	6	12	36	SE	833M;1;64	2	Very High	B
7694	833M	1	61	4	6	12	36	SE	833M;1;61	2	Very High	B
7706	833M	1	59	4	6	12	36	SE	833M;1;59	2	High	B
7712	833M	1	57	4	6	12	36	SE	833M;1;57	2	Very High	B
7717	833M	1	56	4	6	12	36	SE	833M;1;56	2	Very High	B
7796	8311711			4	5	12	31	SE	8311711	2	Very High	B
7804	8311711	98	10	4	5	12	31	SE	8311711;98;10	2	Very High	B
7813	636M	98	8	4	5	12	31	SE	636M;98;8	2	Very High	B
7816	1595M	20	17	4	5	12	30	NE	1595M;20;17	2	Very High	B
7817	1595M	20	16	4	5	12	30	NE	1595M;20;16	2	Very High	B
7818	1595M	20	15	4	5	12	30	NE	1595M;20;15	2	Very High	B
7820	1595M	20	14	4	5	12	30	NE	1595M;20;14	2	Very High	B
7821	1595M	20	13	4	5	12	30	NE	1595M;20;13	2	Very High	B
7822	9311743	20	38	4	5	12	30	NE	9311743;20;38	2	Very High	B
7835	1595M	20	18	4	5	12	30	NE	1595M;20;18	2	Very High	B
7850		N.W.1/4 SEC.		4	6	12	26	NW	4;6;12;26;NW	2	Very High	B
7876	833M	1	53	4	6	12	36	SE	833M;1;53	2	Very High	B
7886	833M	1	50	4	6	12	36	SE	833M;1;50	2	Very High	B
7962	636M	98	7	4	5	12	31	SE	636M;98;7	2	Very High	B
7971	636M	98	6	4	5	12	31	SE	636M;98;6	2	Very High	B
8017	0910424			4	6	12	26	NE	0910424	2	Very High	B
8022	7710675	6	2	4	6	12	26	NE	7710675;6;2	2	Very High	B
8026	9612346								9612346	2	High	B
8073	833M	1	47	4	6	12	36	SE	833M;1;47	2	Very High	B
8182	636M	98	6	4	5	12	31	SE	636M;98;6	2	Very High	B
8192	9612346								9612346	2	Very High	B
8214	636M	98	5	4	5	12	31	SE	636M;98;5	2	Very High	B
8363	636M	98	5	4	5	12	31	SE	636M;98;5	2	Very High	B
8370	636M	98	4	4	5	12	31	SE	636M;98;4	2	Very High	B
8375	832LK		R1	4	6	12	36	SW	832LK;;R1	2	Very High	B
8376	832LK		U1	4	6	12	36	SW	832LK;;U1	2	Very High	B
8385	636M	98	3	4	5	12	31	SE	636M;98;3	2	Very High	B
8408	1595M	20	19	4	5	12	30	NE	1595M;20;19	2	Very High	B
8548	8311711	96	31ER	4	5	12	31	SE	8311711;96;31ER	2	Very High	B
8630	59191	V	4	4	5	12	30	NE	59191;V;4	2	High	B

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
8631	483M	2	5	4	5	12	30	NE	483M;2;5	2	High	B
8632	483M	2	5	4	5	12	30	NE	483M;2;5	2	High	B
8633	483M	2	6	4	5	12	30	NE	483M;2;6	2	High	B
8634	483M	2	7	4	5	12	30	NE	483M;2;7	2	Very High	B
8635	483M	2	7	4	5	12	30	NE	483M;2;7	2	Very High	B
8636	1595M	2	25	4	5	12	30	NE	1595M;2;25	2	Very High	B
8637	1595M	2	26	4	5	12	30	NE	1595M;2;26	2	Very High	B
8638	1595M	2	24	4	5	12	30	NE	1595M;2;24	2	Very High	B
8639	1595M	2	23	4	5	12	30	NE	1595M;2;23	2	Very High	B
8640	1595M	2	22	4	5	12	30	NE	1595M;2;22	2	Very High	B
8641	1595M	2	21	4	5	12	30	NE	1595M;2;21	2	Very High	B
8652	1595M	20	20	4	5	12	30	NE	1595M;20;20	2	Very High	B
8653		N.E.1/4 SEC.		4	5	12	28	NE	4;5;12;28;NE	2	Very High	B
8655	1595M	20	27	4	5	12	30	NE	1595M;20;27	2	Very High	B
8656	1595M	20	25	4	5	12	30	NE	1595M;20;25	2	Very High	B
8657	1595M	20	28	4	5	12	30	NE	1595M;20;28	2	High	B
8658	1595M	20	29	4	5	12	30	NE	1595M;20;29	2	High	B
8659	1595M	20	30	4	5	12	30	NE	1595M;20;30	2	High	B
8980	636M	98	2	4	5	12	31	SE	636M;98;2	2	Very High	B
8994	636M	98	2	4	5	12	31	SE	636M;98;2	2	High	B
9001	636M	98	1	4	5	12	31	SE	636M;98;1	2	High	B
9201	483M	7	1	4	5	12	30	NE	483M;7;1	2	High	B
9202	483M	7	2	4	5	12	30	NE	483M;7;2	2	High	B
9203	483M	7	3	4	5	12	30	NE	483M;7;3	2	Very High	B
9204	483M	7	4	4	5	12	30	NE	483M;7;4	2	Very High	B
9205	483M	7	5	4	5	12	30	NE	483M;7;5	2	Very High	B
9207	483M	7	6	4	5	12	30	NE	483M;7;6	2	Very High	B
9208	1595M	7	27	4	5	12	30	NE	1595M;7;27	2	Very High	B
9209	1595M	7	28	4	5	12	30	NE	1595M;7;28	2	Very High	B
9210	1595M	7	25	4	5	12	30	NE	1595M;7;25	2	Very High	B
9211	1595M	7	26	4	5	12	30	NE	1595M;7;26	2	Very High	B
9212	1595M	7	24	4	5	12	30	NE	1595M;7;24	2	Very High	B
9213	1595M	7	23	4	5	12	30	NE	1595M;7;23	2	Very High	B
9214	1595M	7	22	4	5	12	30	NE	1595M;7;22	2	Very High	B
9215	1595M	7	21	4	5	12	30	NE	1595M;7;21	2	Very High	B
9216	1595M	25	19	4	5	12	30	NE	1595M;25;19	2	Very High	B
9273	1595M	18	35	4	5	12	30	NE	1595M;18;35	2	Very High	B
9282	1595M	18	19	4	5	12	30	NE	1595M;18;19	2	Very High	B
9284	1595M	18	34	4	5	12	30	NE	1595M;18;34	2	Very High	B
9366	483M	11	11	4	5	12	30	NE	483M;11;11	4	High	A
9367	483M	10	20	4	5	12	30	NE	483M;10;20	4	Very High	A
9368	483M	10	19	4	5	12	30	NE	483M;10;19	4	Very High	A
9369	483M	10	18	4	5	12	30	NE	483M;10;18	4	Very High	A
9370	483M	10	17	4	5	12	30	NE	483M;10;17	4	Very High	A
9371	483M	10	16	4	5	12	30	NE	483M;10;16	2	Very High	B
9384	7510486	1		4	5	12	29	NE	7510486;1	4	Very High	A
9391	1595M	18	20	4	5	12	30	NE	1595M;18;20	2	Very High	B
9393	1595M	18	33	4	5	12	30	NE	1595M;18;33	2	Very High	B
9486	1595M	25	20	4	5	12	30	NE	1595M;25;20	2	Very High	B
9487	1595M	25	22	4	5	12	30	NE	1595M;25;22	2	Very High	B
9488	1595M	25	25	4	5	12	30	NE	1595M;25;25	2	High	B
9489	1595M	25	26	4	5	12	30	NE	1595M;25;26	2	High	B
9553	8838HG	34A	1	4	6	12	25	NW	8838HG;34A;1	3	High	B
9554	1729M	35	1	4	6	12	25	NW	1729M;35;1	3	Very High	A
9556	1729M	35	2	4	6	12	25	NW	1729M;35;2	3	Very High	A
9557	1729M	35	3	4	6	12	25	NW	1729M;35;3	3	Very High	A
9558	1729M	35	4	4	6	12	25	NW	1729M;35;4	3	Very High	A
9559	1729M	35	5	5	6	12	25	NW	1729M;35;5	3	Very High	A
9560	1729M	35	6	4	6	12	25	NW	1729M;35;6	3	Very High	A
9561	1729M	35	7	4	6	12	25	NW	1729M;35;7	3	Very High	A
9562	1729M	35	9	4	6	12	25	NW	1729M;35;9	3	Very High	A
9563	1729M	35	12	4	6	12	25	NW	1729M;35;12	3	Very High	A
9564	1729M	35	13	4	6	12	25	NW	1729M;35;13	3	High	B
9565	1729M	35	14	4	6	12	25	NW	1729M;35;14	3	High	B
9566	1729M	35	15	4	6	12	25	NW	1729M;35;15	3	High	B
9567	9310399	35	14A	4	6	12	25	NE	9310399;35;14A	3	High	B
9569	2177M	35	13	4	6	12	25	NE	2177M;35;13	3	High	B
9570	2177M	35	12	4	6	12	25	NE	2177M;35;12	3	High	B
9578	2177M	35	3	4	6	12	25	NE	2177M;35;3	3	Moderate	B

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
9579	2177M	35	2	4	6	12	25	NE	2177M;35;2	3	High	B
9580	2177M	35	1	4	6	12	25	NE	2177M;35;1	3	Very High	A
9609	1595M	24	15	4	5	12	30	NE	1595M;24;15	2	Very High	B
9616	1595M	24	16	4	5	12	30	NE	1595M;24;16	2	Very High	B
9712	4373JK	1	1	4	5	12	29	NE	4373JK;1;1	3	Moderate	B
9805	1595M	24	17	4	5	12	30	NE	1595M;24;17	2	Very High	B
9811	1595M	24	18	4	5	12	30	NE	1595M;24;18	2	Very High	B
9827	1595M	25	21	4	5	12	30	NE	1595M;25;21	2	Very High	B
9836	1595M	25	23	4	5	12	30	NE	1595M;25;23	2	Very High	B
9916	1595M	18	12	4	5	12	30	NE	1595M;18;12	2	Very High	B
9917	1595M	18	11	4	5	12	30	NE	1595M;18;11	2	Very High	B
9918	1595M	18	10	4	5	12	30	NE	1595M;18;10	2	Very High	B
9919	1595M	18	9	4	5	12	30	NE	1595M;18;9	2	Very High	B
9920	1595M	18	8	4	5	12	30	NE	1595M;18;8	2	High	B
9921	1595M	18	7	4	5	12	30	NE	1595M;18;7	2	High	B
9922	1595M	18	6	4	5	12	30	NE	1595M;18;6	2	High	B
9924	1595M	18	5	4	5	12	30	NE	1595M;18;5	2	High	B
9926	1595M	18	4	4	5	12	30	NE	1595M;18;4	2	High	B
9927	1595M	18	3	4	5	12	30	NE	1595M;18;3	2	High	B
9928	1595M	18	2	4	5	12	30	NE	1595M;18;2	2	Very High	B
9929	1595M	18	1	4	5	12	30	NE	1595M;18;1	2	Very High	B
9930	1595M	29	9	4	5	12	30	NE	1595M;29;9	2	Very High	B
10001	483M	4	2	4	5	12	30	NE	483M;4;2	2	High	B
10002	483M	4	3	4	5	12	30	NE	483M;4;3	2	High	B
10003	483M	4	4	4	5	12	30	NE	483M;4;4	2	High	B
10005	483M	4	5	4	5	12	30	NE	483M;4;5	2	Very High	B
10006	483M	4	6	4	5	12	30	NE	483M;4;6	2	Very High	B
10007	1595M	4	28	4	5	12	30	NE	1595M;4;28	2	Very High	B
10008	1595M	4	27	4	5	12	30	NE	1595M;4;27	2	Very High	B
10009	1595M	4	26	4	5	12	30	NE	1595M;4;26	2	Very High	B
10010	1595M	4	25	4	5	12	30	NE	1595M;4;25	2	Very High	B
10011	1595M	4	24	4	5	12	30	NE	1595M;4;24	2	Very High	B
10012	1595M	4	22	4	5	12	30	NE	1595M;4;22	2	Very High	B
10013	1595M	4	23	4	5	12	30	NE	1595M;4;23	2	Very High	B
10014	1595M	4	21	4	5	12	30	NE	1595M;4;21	2	Very High	B
10016	1595M	24	19	4	5	12	30	NE	1595M;24;19	2	Very High	B
10051	483M	7	20	4	5	12	30	NE	483M;7;20	2	High	B
10052	483M	7	19	4	5	12	30	NE	483M;7;19	2	High	B
10053	483M	7	18	4	5	12	30	NE	483M;7;18	2	High	B
10054	483M	7	17	4	5	12	30	NE	483M;7;17	2	Very High	B
10055	483M	7	16	4	5	12	30	NE	483M;7;16	2	Very High	B
10056	483M	7	15	4	5	12	30	NE	483M;7;15	2	Very High	B
10057	1595M	7	30	4	5	12	30	NE	1595M;7;30	2	Very High	B
10058	1595M	7	29	4	5	12	30	NE	1595M;7;29	2	Very High	B
10059	1595M	7	32	4	5	12	30	NE	1595M;7;32	2	Very High	B
10060	1595M	7	31	4	5	12	30	NE	1595M;7;31	2	Very High	B
10061	1595M	7	34	4	5	12	30	NE	1595M;7;34	2	Very High	B
10062	1595M	7	33	4	5	12	30	NE	1595M;7;33	2	Very High	B
10063	1595M	7	35	4	5	12	30	NE	1595M;7;35	2	Very High	B
10064	1595M	7	36	4	5	12	30	NE	1595M;7;36	2	Very High	B
10071	9913193	2	14ER	4	5	12	28	NW	9913193;2;14ER	4	High	A
10081	1595M	29	8	4	5	12	30	NE	1595M;29;8	2	High	B
10087	1595M	31	A	4	5	12	30	NE	1595M;31;A	2	Very High	B
10222	1595M	24	20	4	5	12	30	NE	1595M;24;20	2	Very High	B
10288	4373JK	1	2	4	5	12	29	NE	4373JK;1;2	3	High	B
10340	1595M	21	15	4	5	12	30	NE	1595M;21;15	2	Very High	B
10345	1595M	21	16	4	5	12	30	NE	1595M;21;16	2	Very High	B
10347	1595M	21	17	4	5	12	30	NE	1595M;21;17	2	Very High	B
10348	1595M	21	18	4	5	12	30	NE	1595M;21;18	2	Very High	B
10362	1595M	24	25	4	5	12	30	NE	1595M;24;25	2	Very High	B
10363	1595M	24	26	4	5	12	30	NE	1595M;24;26	2	High	B
10364	1595M	24	27	4	5	12	30	NE	1595M;24;27	2	High	B
10365	1595M	24	28	4	5	12	30	NE	1595M;24;28	2	High	B
10366	1595M	24	29	4	5	12	30	NE	1595M;24;29	2	High	B
10456	4373JK	1	3	4	5	12	29	NE	4373JK;1;3	3	High	B
10460	4373JK	1	4	4	5	12	29	NE	4373JK;1;4	3	High	B
10464	4373JK	1	5	4	5	12	29	NE	4373JK;1;5	3	Very High	A
10483	1837F	U	4	4	5	12	30	NE	1837F;U;4	2	High	B
10484	0612117			4	5	12	30	NE	0612117	2	High	B

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
10485	483M	3	6	4	5	12	30	NE	483M;3;6	2	Very High	B
10486	483M	3	7	4	5	12	30	NE	483M;3;7	2	Very High	B
10487	1595M	3	24	4	5	12	30	NE	1595M;3;24	2	Very High	B
10488	1595M	3	25	4	5	12	30	NE	1595M;3;25	2	Very High	B
10489	1595M	3	26	4	5	12	30	NE	1595M;3;26	2	Very High	B
10490	1595M	3	23	4	5	12	30	NE	1595M;3;23	2	Very High	B
10491	1595M	3	22	4	5	12	30	NE	1595M;3;22	2	Very High	B
10492	1595M	3	21	4	5	12	30	NE	1595M;3;21	2	Very High	B
10493	5792JK	D		4	6	12	27	NE	5792JK;D	2	High	B
10494	1595M	21	19	4	5	12	30	NE	1595M;21;19	2	Very High	B
10498	1595M	21	20	4	5	12	30	NE	1595M;21;20	2	Very High	B
10499	1595M	21	25	4	5	12	30	NE	1595M;21;25	2	Very High	B
10500	1595M	21	26	4	5	12	30	NE	1595M;21;26	2	Very High	B
10501	1595M	21	27	4	5	12	30	NE	1595M;21;27	2	High	B
10604	1111522			4	5	12	28	NW	1111522	4	Very High	A
10611	1595M	18	13	4	5	12	30	NE	1595M;18;13	4	Very High	A
10612	1595M	18	22	4	5	12	30	NE	1595M;18;22	4	Very High	A
10613	1595M	18	23	4	5	12	30	NE	1595M;18;23	4	Very High	A
10614	1595M	18	24	4	5	12	30	NE	1595M;18;24	2	Very High	B
10688	1595M	24	21	4	5	12	30	NE	1595M;24;21	2	Very High	B
10696	1595M	24	22	4	5	12	30	NE	1595M;24;22	2	Very High	B
10703	1595M	24	23	4	5	12	30	NE	1595M;24;23	2	Very High	B
10708	1595M	24	24	4	5	12	30	NE	1595M;24;24	2	Very High	B
10719	483M	4	20	4	5	12	30	NE	483M;4;20	2	High	B
10720	483M	4	19	4	5	12	30	NE	483M;4;19	2	High	B
10721	483M	4	18	4	5	12	30	NE	483M;4;18	2	High	B
10722	483M	4	17	4	5	12	30	NE	483M;4;17	2	Very High	B
10723	483M	4	16	4	5	12	30	NE	483M;4;16	2	Very High	B
10724	483M	4	15	4	5	12	30	NE	483M;4;15	2	Very High	B
10725	1595M	4	29	4	5	12	30	NE	1595M;4;29	2	Very High	B
10726	1595M	4	31	4	5	12	30	NE	1595M;4;31	2	Very High	B
10727	1595M	4	30	4	5	12	30	NE	1595M;4;30	2	Very High	B
10728	1595M	4	32	4	5	12	30	NE	1595M;4;32	2	Very High	B
10729	1595M	4	33	4	5	12	30	NE	1595M;4;33	2	Very High	B
10731		N.W.1/4 SEC.		4	5	12	28	NW	4;5;12;28;NW	4	High	A
10732	5216GO	B		4	5	12	28	NW	5216GO;B	4	Very High	A
10897	1595M	4	34	4	5	12	30	NE	1595M;4;34	2	Very High	B
10898	1595M	4	36	4	5	12	30	NE	1595M;4;36	2	Very High	B
10899	1595M	4	35	4	5	12	30	NE	1595M;4;35	2	Very High	B
10901	5792JK	E		4	6	12	27	NE	5792JK;E	2	Very High	B
10951	5046AD	3	2	4	5	12	28	NW	5046AD;3;2	4	Moderate	B
10994	9812457	1	2ER	4	5	12	29	NW	9812457;1;2ER	4	Very High	A
10995	1595M	18	14	4	5	12	30	NE	1595M;18;14	4	Very High	A
10999	1595M	18	25	4	5	12	30	NE	1595M;18;25	2	Very High	B
11000	1595M	18	26	4	5	12	30	NE	1595M;18;26	3	Very High	A
11001	1595M	18	27	4	5	12	30	NE	1595M;18;27	3	Very High	A
11002	1595M	18	28	4	5	12	30	NE	1595M;18;28	3	Very High	A
11003	1595M	18	29	4	5	12	30	NE	1595M;18;29	3	Very High	A
11058	1595M	21	21	4	5	12	30	NE	1595M;21;21	2	Very High	B
11064	1595M	21	22	4	5	12	30	NE	1595M;21;22	2	Very High	B
11111	9012097	11	21	4	5	12	30	NE	9012097;11;21	2	High	B
11112	483M	10	1	4	5	12	30	NE	483M;10;1	2	Very High	B
11113	483M	10	2	4	5	12	30	NE	483M;10;2	2	Very High	B
11114	483M	10	3	4	5	12	30	NE	483M;10;3	2	Very High	B
11115	483M	10	4	4	5	12	30	NE	483M;10;4	2	Very High	B
11116	483M	10	5	4	5	12	30	NE	483M;10;5	2	Very High	B
11117	1595M	10	30	4	5	12	30	NE	1595M;10;30	2	Very High	B
11118	1595M	10	29	4	5	12	30	NE	1595M;10;29	2	Very High	B
11120	1595M	10	28	4	5	12	30	NE	1595M;10;28	2	Very High	B
11121	1595M	10	26	4	5	12	30	NE	1595M;10;26	2	Very High	B
11122	1595M	10	27	4	5	12	30	NE	1595M;10;27	2	Very High	B
11123	1595M	10	24	4	5	12	30	NE	1595M;10;24	2	Very High	B
11124	1595M	10	25	4	5	12	30	NE	1595M;10;25	2	Very High	B
11125	1595M	10	22	4	5	12	30	NE	1595M;10;22	2	Very High	B
11126	1595M	10	23	4	5	12	30	NE	1595M;10;23	2	Very High	B
11127	1595M	10	21	4	5	12	30	NE	1595M;10;21	2	Very High	B
11141	1595M	18	30	4	5	12	30	NE	1595M;18;30	3	Very High	A
11142	1595M	18	31	4	5	12	30	NE	1595M;18;31	3	Very High	A
11145	1595M	18	38	4	5	12	30	NE	1595M;18;38	2	Very High	B

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
11146	1595M	29	10	4	5	12	30	NE	1595M;29;10	2	Very High	B
11147	1595M	29	11	4	5	12	30	NE	1595M;29;11	2	Very High	B
11148	1595M	29	12	4	5	12	30	NE	1595M;29;12	2	Very High	B
11149	1595M	29	13	4	5	12	30	NE	1595M;29;13	2	Very High	B
11150	1595M	29	14	4	5	12	30	NE	1595M;29;14	2	Very High	B
11151	1595M	29	15	4	5	12	30	NE	1595M;29;15	2	High	B
11152	1595M	29	16	4	5	12	30	NE	1595M;29;16	2	Very High	B
11153	1595M	29	17	4	5	12	30	NE	1595M;29;17	2	Very High	B
11154	1595M	29	18	4	5	12	30	NE	1595M;29;18	2	Very High	B
11155	1595M	31	25	4	5	12	30	NE	1595M;31;25	2	Very High	B
11158	1595M	21	23	4	5	12	30	NE	1595M;21;23	2	Very High	B
11160	1595M	21	24	4	5	12	30	NE	1595M;21;24	2	Very High	B
11171	1837F	U	18	4	5	12	30	NE	1837F;U;18	2	High	B
11172	1837F	U	17	4	5	12	30	NE	1837F;U;17	2	High	B
11173	1837F	U	17	4	5	12	30	NE	1837F;U;17	2	High	B
11174	483M	3	16	4	5	12	30	NE	483M;3;16	2	High	B
11175	483M	3	15	4	5	12	30	NE	483M;3;15	2	Very High	B
11176	483M	3	14	4	5	12	30	NE	483M;3;14	2	Very High	B
11177	1595M	3	28	4	5	12	30	NE	1595M;3;28	2	Very High	B
11178	1595M	3	27	4	5	12	30	NE	1595M;3;27	2	Very High	B
11179	1595M	3	29	4	5	12	30	NE	1595M;3;29	2	Very High	B
11180	1595M	3	30	4	5	12	30	NE	1595M;3;30	2	Very High	B
11181	1595M	3	31	4	5	12	30	NE	1595M;3;31	2	Very High	B
11182	1595M	3	32	4	5	12	30	NE	1595M;3;32	2	Very High	B
11208	1595M	25	14	4	5	12	30	NE	1595M;25;14	2	Very High	B
11210	1595M	25	12	4	5	12	30	NE	1595M;25;12	2	High	B
11211	1595M	25	13	4	5	12	30	NE	1595M;25;13	2	High	B
11212	1595M	25	11	4	5	12	30	NE	1595M;25;11	2	High	B
11216	8610822	16	56ER	4	5	12	29	NE	8610822;16;56ER	4	Very High	A
11217	1595M	31	26	4	5	12	30	NE	1595M;31;26	2	Very High	B
11218	4373JK	1	6	4	5	12	29	NE	4373JK;1;6	4	Very High	A
11219	1595M	31	27	4	5	12	30	NE	1595M;31;27	2	Very High	B
11220	1595M	31	28	4	5	12	30	NE	1595M;31;28	2	Very High	B
11221	1595M	31	29	4	5	12	30	NE	1595M;31;29	2	Very High	B
11222	1595M	31	30	4	5	12	30	NE	1595M;31;30	2	Very High	B
11320	1595M	18	15	4	5	12	30	NE	1595M;18;15	4	Very High	A
11334	1595M	24	14	4	5	12	30	NE	1595M;24;14	2	Very High	B
11336	1595M	24	13	4	5	12	30	NE	1595M;24;13	2	Very High	B
11340	1595M	24	12	4	5	12	30	NE	1595M;24;12	2	High	B
11343	1595M	24	11	4	5	12	30	NE	1595M;24;11	2	High	B
11346	1595M	24	10	4	5	12	30	NE	1595M;24;10	2	High	B
11352	1595M	24	9	4	5	12	30	NE	1595M;24;9	2	High	B
11376										4	Very High	A
11377										4	Very High	A
11378	1112269		'B'	4	5	12	30	NE	1112269;'B'	2	Very High	B
11379	1112269		'C'	4	5	12	30	NE	1112269;'C'	2	Very High	B
11380										4	Very High	A
11460	5046AD	3	1	4	5	12	28	NW	5046AD;3;1	4	Moderate	B
11580	1595M	25	15	4	5	12	30	NE	1595M;25;15	2	Very High	B
11589	1595M	25	16	4	5	12	30	NE	1595M;25;16	2	Very High	B
11592	9913193	2	15ER	4	5	12	28	NW	9913193;2;15ER	4	High	A
11595	1595M	25	17	4	5	12	30	NE	1595M;25;17	2	Very High	B
11597	9913193	2	12	4	5	12	28	NW	9913193;2;12	4	High	A
11600	1595M	25	18	4	5	12	30	NE	1595M;25;18	2	Very High	B
11648	1595M	18	16	4	5	12	30	NE	1595M;18;16	4	Very High	A
11653	1595M	18	37	4	5	12	30	NE	1595M;18;37	2	Very High	B
11657	1595M	18	17	4	5	12	30	NE	1595M;18;17	2	Very High	B
11658	1595M	18	36	4	5	12	30	NE	1595M;18;36	2	Very High	B
11670	1595M	18	18	4	5	12	30	NE	1595M;18;18	2	Very High	B
11677									;;;;	4	Very High	A
11691	7510142	3	13	4	5	12	30	SE	7510142;3;13	4	High	A
11699	252HD	3	20	4	6	12	25	SE	252HD;3;20	3	Moderate	B
11706	745M	2	25	4	5	12	30	SE	745M;2;25	3	Very High	A
11721	7510142	3	20	4	5	12	30	SE	7510142;3;20	4	High	A
11738	9810318	3	road	4	5	12	30	SE	9810318;3;road wide	3	Very High	A
11760	2177M	39	26	4	6	12	25	NE	2177M;39;26	3	Very High	A
11761	2177M	39	25	4	6	12	25	NE	2177M;39;25	3	Very High	A
11762	2177M	39	24	4	6	12	25	NE	2177M;39;24	3	High	B
11763	2177M	39	30	4	6	12	25	NE	2177M;39;30	3	Very High	A

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
11764	2177M	39	29	4	6	12	25	NE	2177M;39;29	3	Very High	A
11765	2177M	39	28	4	6	12	25	NE	2177M;39;28	3	Very High	A
11769	252HD	1	5	4	6	12	25	NW	252HD;1;5	3	High	B
11781	252HD	1	6	4	6	12	25	NW	252HD;1;6	3	High	B
11799	0113524			4	5	12	30	NE	0113524	2	High	B
11800	9412430	15	22	4	5	12	30	NE	9412430;15;22	3	High	B
11801	9412430	15	23	4	5	12	30	NE	9412430;15;23	3	Moderate	B
11811	252HD	3	10	4	6	12	25	SE	252HD;3;10	3	Very High	A
11812	190AN	15	11	4	5	12	30	SW	190AN;15;11	4	Moderate	B
11814	7510142	3	R3	4	5	12	30	SE	7510142;3;R3	4	Very High	A
11840	7510142	3	12						7510142;3;12	4	High	A
11846	745M	2	26	4	5	12	30	SE	745M;2;26	3	Very High	A
11872	745M	2	27	4	5	12	30	SE	745M;2;27	3	Very High	A
11894	1887JK	Z	R1	4	5	12	28	NW	1887JK;Z;R1	4	Very High	A
11912	252HD	3	11	4	6	12	25	SE	252HD;3;11	3	Very High	A
11919	252HD	3	12	4	6	12	25	SE	252HD;3;12	3	Very High	A
11922		S.W.1/4 SEC.		4	5	12	30	SW	4;5;12;30;SW	3	Very High	A
11927	252HD	3	13	4	6	12	25	SE	252HD;3;13	3	High	B
11933	7510142	3	4	4	5	12	29	SW	7510142;3;4	4	Very High	A
11934	7510142	3	3	4	5	12	29	SW	7510142;3;3	4	High	A
11935	7510142	3	5	4	5	12	29	SW	7510142;3;5	4	Very High	A
11936	7510142	3	6	4	5	12	29	SW	7510142;3;6	4	High	A
11937	7510142	3	7	4	5	12	29	SW	7510142;3;7	4	High	A
11938	7510646	3	40	4	5	12	29	SW	7510646;3;40	4	High	A
11940	7510646	3	41	4	5	12	29	SW	7510646;3;41	4	High	A
11941	7510646	3	42	4	5	12	29	SW	7510646;3;42	4	High	A
11942	7510142	3	11	4	5	12	29	SW	7510142;3;11	4	High	A
11950	745M	2	28	4	5	12	30	SE	745M;2;28	3	Very High	A
11964	7510142	3	2	4	5	12	29	SW	7510142;3;2	4	Very High	A
12028	9711103	K	1ER	4	5	12	29	NW	9711103;K;1ER	4	High	A
12030	483M	17	5	4	5	12	30	NE	483M;17;5	3	Moderate	B
12033	2630AM	L		4	5	12	29	NW	2630AM;L	4	High	A
12036	1595M	34	7	4	5	12	30	NE	1595M;34;7	4	Moderate	B
12037	1595M	34	6	4	5	12	30	NE	1595M;34;6	4	High	A
12038	1595M	34	5	4	5	12	30	NE	1595M;34;5	4	High	A
12039	1595M	34	4	4	5	12	30	NE	1595M;34;4	4	High	A
12040	1595M	34	3	4	5	12	30	NE	1595M;34;3	4	High	A
12041	1595M	34	2	4	5	12	30	NE	1595M;34;2	4	High	A
12042	1595M	34	1	4	5	12	30	NE	1595M;34;1	4	High	A
12043	1595M	33	8	4	5	12	30	NE	1595M;33;8	2	High	B
12045	1595M	33	7	4	5	12	30	NE	1595M;33;7	2	Very High	B
12046	1595M	33	6	4	5	12	30	NE	1595M;33;6	2	Very High	B
12047	1595M	33	5	4	5	12	30	NE	1595M;33;5	2	Very High	B
12048	1595M	33	4	4	5	12	30	NE	1595M;33;4	2	Very High	B
12050	1595M	33	3	4	5	12	30	NE	1595M;33;3	2	Very High	B
12051	1595M	33	2	4	5	12	30	NE	1595M;33;2	2	Very High	B
12052	1595M	33	1	4	5	12	30	NE	1595M;33;1	3	Very High	A
12071	252HD	3	14	4	6	12	25	SE	252HD;3;14	3	High	B
12075		S.W.1/4 SEC		4	5	12	30	SW	4;5;12;30;SW	4	Very High	A
12076	8010099								8010099	3	Very High	A
12078	745M	2	29	4	5	12	30	SE	745M;2;29	3	Very High	A
12087	7510142	3	1	4	5	12	29	SW	7510142;3;1	4	Very High	A
12155	4824EO	L		4	5	12	29	NE	4824EO;L	3	Very High	A
12156	1111751			4	5	12	29	NE	1111751	3	Very High	A
12161	2177M	37	89	4	6	12	25	NE	2177M;37;89	3	Very High	A
12162	2177M	37	96	4	6	12	25	NE	2177M;37;96	3	Very High	A
12163	2177M	38	66	4	6	12	25	NE	2177M;38;66	3	Very High	A
12164	2177M	38	73	4	6	12	25	NE	2177M;38;73	3	Very High	A
12165	2177M	39	43	4	6	12	25	NE	2177M;39;43	3	Very High	A
12166	2177M	39	50	4	6	12	25	NE	2177M;39;50	3	Very High	A
12195	2177M	37	90	4	6	12	25	NE	2177M;37;90	3	Very High	A
12196	2177M	37	95	4	6	12	25	NE	2177M;37;95	3	Very High	A
12205	252HD	3	15	4	6	12	25	SE	252HD;3;15	3	High	B
12260	745M	2	30	4	5	12	30	SE	745M;2;30	3	Very High	A
12269	1595M	18	32	4	5	12	30	NE	1595M;18;32	2	Very High	B
12275	1595M	18	21	4	5	12	30	NE	1595M;18;21	2	Very High	B
12279	1595M	30	5	4	5	12	30	NE	1595M;30;5	2	Very High	B
12280	1595M	30	4	4	5	12	30	NE	1595M;30;4	4	Very High	A
12281	1595M	30	3	4	5	12	30	NE	1595M;30;3	2	Very High	B

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
12283	1595M	30	2	4	5	12	30	NE	1595M;30;2	2	Very High	B
12284	1595M	30	1	4	5	12	30	NE	1595M;30;1	2	Very High	B
12285	1595M	32	24	4	5	12	30	NE	1595M;32;24	2	Very High	B
12286	1595M	32	23	4	5	12	30	NE	1595M;32;23	2	Very High	B
12287	1595M	32	22	4	5	12	30	NE	1595M;32;22	2	Very High	B
12288	1595M	32	21	4	5	12	30	NE	1595M;32;21	2	Very High	B
12289	1595M	32	20	4	5	12	30	NE	1595M;32;20	2	Very High	B
12290	1595M	32	19	4	5	12	30	NE	1595M;32;19	2	Very High	B
12291	1595M	32	18	4	5	12	30	NE	1595M;32;18	2	Very High	B
12292	1595M	32	17	4	5	12	30	NE	1595M;32;17	2	High	B
12294	1595M	32	16	4	5	12	30	NE	1595M;32;16	3	High	B
12295	1595M	32	15	4	5	12	30	NE	1595M;32;15	3	High	B
12296	1595M	32	14	4	5	12	30	NE	1595M;32;14	3	High	B
12297	1595M	32	13	4	5	12	30	NE	1595M;32;13	3	High	B
12298	1595M	32	11	4	5	12	30	NE	1595M;32;11	3	Very High	A
12299	1595M	32	12	4	5	12	30	NE	1595M;32;12	3	High	B
12300	7510538	32	33	4	5	12	30	NE	7510538;32;33	3	Very High	A
12301	7510538	32	34	4	5	12	30	NE	7510538;32;34	3	Very High	A
12302	1595M	32	8	4	5	12	30	NE	1595M;32;8	3	Very High	A
12304	2177M	38	67	4	6	12	25	NE	2177M;38;67	3	Very High	A
12305	2177M	38	72	4	6	12	25	NE	2177M;38;72	3	Very High	A
12306	2177M	39	44	4	6	12	25	NE	2177M;39;44	3	Very High	A
12307	2177M	39	49	4	6	12	25	NE	2177M;39;49	3	Very High	A
12327	745M	2	31	4	5	12	30	SE	745M;2;31	3	Very High	A
12342	1595M	32	7	4	5	12	30	NE	1595M;32;7	3	Very High	A
12343	1595M	32	6	4	5	12	30	NE	1595M;32;6	3	Very High	A
12344	1595M	32	5	4	5	12	30	NE	1595M;32;5	3	Very High	A
12345	1595M	32	4	4	5	12	30	NE	1595M;32;4	3	Very High	A
12346	1595M	32	3	4	5	12	30	NE	1595M;32;3	3	Very High	A
12347	1595M	32	2	4	5	12	30	NE	1595M;32;2	3	Very High	A
12388	252HD	3	16	4	6	12	25	SE	252HD;3;16	3	Moderate	B
12390	317LK	5	18	4	5	12	29	SW	317LK;5;18	4	Moderate	B
12394	7738JK	R1		4	5	12	29	SW	7738JK;R1	4	Very High	A
12395	317LK	5	17	4	5	12	29	SW	317LK;5;17	4	Moderate	B
12399	317LK	5	16	4	5	12	29	SW	317LK;5;16	4	High	A
12434		N.E.1/4		4	5	12	29	NE	4;5;12;29;NE	3	Very High	A
12435	rw363E	C.P.R. SPUR		4	5	12	29	NE	rw363E;C.P.R. SPUR	3	Very High	A
12440	2177M	37	91	4	6	12	25	NE	2177M;37;91	3	Very High	A
12441	2177M	37	94	4	6	12	25	NE	2177M;37;94	3	Very High	A
12442	2177M	38	68	4	6	12	25	NE	2177M;38;68	3	Very High	A
12443	2177M	38	71	4	6	12	25	NE	2177M;38;71	3	Very High	A
12444	2177M	39	45	4	6	12	25	NE	2177M;39;45	3	Very High	A
12445	2177M	39	48	4	6	12	25	NE	2177M;39;48	3	Very High	A
12446		S.E.1/4 SEC.		4	5	12	28	SE	4;5;12;28;SE	4	Very High	A
12464	317LK	5	15	4	5	12	29	SW	317LK;5;15	4	High	A
12469	317LK	5	14	4	5	12	29	SW	317LK;5;14	4	High	A
12472	317LK	5	13	4	5	12	29	SW	317LK;5;13	4	High	A
12478	317LK	5	12	4	5	12	29	SW	317LK;5;12	4	High	A
12479	7510142	2	5	4	5	12	29	SW	7510142;2;5	4	Moderate	B
12480	7510142	2	4	4	5	12	29	SW	7510142;2;4	4	Moderate	B
12481	7510142	2	3	4	5	12	29	SW	7510142;2;3	4	Moderate	B
12498	7510142	2	6	4	5	12	29	SW	7510142;2;6	4	Moderate	B
12499		N.E.1/4 SEC		4	5	12	29	NE	4;5;12;29;NE	3	Very High	A
12503	1595M	30	6	4	5	12	30	NE	1595M;30;6	2	Very High	B
12505	1729M	35	1	4	6	12	25	NW	1729M;35;1	3	Very High	A
12506	1729M	35	2	4	6	12	25	NW	1729M;35;2	3	Very High	A
12507	1729M	35	3	4	6	12	25	NW	1729M;35;3	3	Very High	A
12508	1729M	35	4	4	6	12	25	NW	1729M;35;4	3	Very High	A
12509	1729M	35	5	4	6	12	25	NW	1729M;35;5	3	Very High	A
12517	1595M	15	16	4	5	12	30	NE	1595M;15;16	2	Very High	B
12522	1595M	15	16	4	5	12	30	NE	1595M;15;16	2	Very High	B
12523	1595M	15	15	4	5	12	30	NE	1595M;15;15	2	Very High	B
12524	1595M	15	14	4	5	12	30	NE	1595M;15;14	3	Very High	A
12525	1595M	15	13	4	5	12	30	NE	1595M;15;13	3	Very High	A
12526	1595M	15	12	4	5	12	30	NE	1595M;15;12	3	Very High	A
12527	1595M	15	11	4	5	12	30	NE	1595M;15;11	3	Very High	A
12528	1595M	15	10	4	5	12	30	NE	1595M;15;10	3	Very High	A
12529	1595M	15	9	4	5	12	30	NE	1595M;15;9	3	Very High	A
12531	1595M	15	8	4	5	12	30	NE	1595M;15;8	3	Very High	A

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
12532	1595M	15	7	4	5	12	30	NE	1595M;15;7	4	Very High	A
12533	1595M	15	6	4	5	12	30	NE	1595M;15;6	4	Very High	A
12541	7286JK	C		4	5	12	29	SE	7286JK;C	4	Very High	A
12543	317LK	R1		4	5	12	29	SW	317LK;R1	4	Very High	A
12544		S.W.1/4 SEC.		4	5	12	29	SW	4;5;12;29;SW	4	Very High	A
12609	1595M	15	1	4	5	12	30	NE	1595M;15;1	2	Very High	B
12610	1729M	35	6	4	6	12	25	NW	1729M;35;6	3	Very High	A
12611	1729M	35	7	4	6	12	25	NW	1729M;35;7	3	Very High	A
12612	1595M	30	7	4	5	12	30	NE	1595M;30;7	2	Very High	B
12622	1595M	15	17	4	5	12	30	NE	1595M;15;17	2	Very High	B
12625	1595M	15	2	4	5	12	30	NE	1595M;15;2	2	Very High	B
12627	1595M	30	8	4	5	12	30	NE	1595M;30;8	2	Very High	B
12645	317LK	5	11	4	5	12	29	SW	317LK;5;11	4	High	A
12668	252HD	3	17	4	6	12	25	SE	252HD;3;17	3	Moderate	B
12670	317LK	5	10	4	5	12	29	SW	317LK;5;10	4	Moderate	B
12715	1595M	15	18	4	5	12	30	NE	1595M;15;18	2	Very High	B
12716	8838HG	34A	2	4	6	12	25	NW	8838HG;34A;2	3	Very High	A
12717	1729M	35	27	4	6	12	25	NW	1729M;35;27	3	Very High	A
12718	1729M	35	26	4	6	12	25	NW	1729M;35;26	3	Very High	A
12719	1729M	35	25	4	6	12	25	NW	1729M;35;25	3	Very High	A
12720	1729M	35	21	4	6	12	25	NW	1729M;35;21	3	Very High	A
12721	1729M	35	20	4	6	12	25	NW	1729M;35;20	3	Very High	A
12722	1729M	35	19	4	6	12	25	NW	1729M;35;19	3	Very High	A
12723	1729M	35	18	4	6	12	25	NW	1729M;35;18	3	Very High	A
12724	1729M	35	17	4	6	12	25	NW	1729M;35;17	3	Very High	A
12725	1729M	35	16	4	6	12	25	NW	1729M;35;16	3	Very High	A
12726	1729M	35	23	4	6	12	25	NW	1729M;35;23	3	Very High	A
12727	1729M	35	22	4	6	12	25	NW	1729M;35;22	3	Very High	A
12728	2177M	35	16	4	6	12	25	NE	2177M;35;16	3	Very High	A
12729	2177M	35	17	4	6	12	25	NE	2177M;35;17	3	Very High	A
12730	2177M	35	25	4	6	12	25	NE	2177M;35;25	3	Very High	A
12731	2177M	35	26	4	6	12	25	NE	2177M;35;26	3	Very High	A
12732	2177M	35	27	4	6	12	25	NE	2177M;35;27	3	Very High	A
12733	2177M	35	28	4	6	12	25	NE	2177M;35;28	3	Very High	A
12734	2177M	35	29	4	6	12	25	NE	2177M;35;29	3	Very High	A
12735	2177M	35	30	4	6	12	25	NE	2177M;35;30	3	Very High	A
12736	2177M	35	18	4	6	12	25	NE	2177M;35;18	3	Very High	A
12737	2177M	35	19	4	6	12	25	NE	2177M;35;19	3	Very High	A
12738	2177M	35	20	4	6	12	25	NE	2177M;35;20	3	Very High	A
12739	2177M	35	21	4	6	12	25	NE	2177M;35;21	3	Very High	A
12740	2177M	35	22	4	6	12	25	NE	2177M;35;22	3	Very High	A
12741	2177M	35	23	4	6	12	25	NE	2177M;35;23	3	Very High	A
12742	2177M	35	24	4	6	12	25	NE	2177M;35;24	3	Very High	A
12770	7620AS	1	11	4	5	12	28	SW	7620AS;1;11	2	Very High	B
12771	7620AS	1	10	4	5	12	28	SW	7620AS;1;10	2	Very High	B
12772	7620AS	1	9	4	5	12	28	SW	7620AS;1;9	2	High	B
12773	7620AS	1	8	4	5	12	28	SW	7620AS;1;8	2	High	B
12774	7620AS	1	14	4	5	12	28	SW	7620AS;1;14	2	Very High	B
12775	7620AS	1	13	4	5	12	28	SW	7620AS;1;13	2	Very High	B
12776	7620AS	1	12	4	5	12	28	SW	7620AS;1;12	2	Very High	B
12778	7620AS	1	19	4	5	12	28	SW	7620AS;1;19	2	Very High	B
12779	7620AS	1	18	4	5	12	28	SW	7620AS;1;18	2	Very High	B
12780	7620AS	1	17	4	5	12	28	SW	7620AS;1;17	2	Very High	B
12781	7620AS	1	16	4	5	12	28	SW	7620AS;1;16	2	Very High	B
12782	7620AS	1	15	4	5	12	28	SW	7620AS;1;15	2	Very High	B
12783	7620AS	1	23	4	5	12	28	SW	7620AS;1;23	2	Very High	B
12784	7620AS	1	22	4	5	12	28	SW	7620AS;1;22	2	Very High	B
12785	7620AS	1	21	4	5	12	28	SW	7620AS;1;21	2	Very High	B
12786	7620AS	1	20	4	5	12	28	SW	7620AS;1;20	2	Very High	B
12787	7620AS	1	24	4	5	12	28	SW	7620AS;1;24	2	Very High	B
12820	317LK	5	9	4	5	12	29	SW	317LK;5;9	4	Moderate	B
12821	7510142	3	18	4	5	12	30	SE	7510142;3;18	4	High	A
12822	7510142	3	17	4	5	12	30	SE	7510142;3;17	4	High	A
12835	317LK	5	8	4	5	12	29	SW	317LK;5;8	4	Moderate	B
12886	1595M	15	3	4	5	12	30	NE	1595M;15;3	4	Very High	A
12887	1595M	30	9	4	5	12	30	NE	1595M;30;9	2	Very High	B
12890	8210783			4	5	12	28	NW	8210783	4	Very High	A
12900	1595M	15	19	4	5	12	30	NE	1595M;15;19	2	Very High	B
12902	1595M	15	4	4	5	12	30	NE	1595M;15;4	4	Very High	A

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
12903	1595M	30	10	4	5	12	30	NE	1595M;30;10	4	Very High	A
12904	994IC	43	1	4	6	12	25	NE	994IC;43;1	3	Very High	A
12905	994IC	43	2	4	6	12	25	NE	994IC;43;2	3	Very High	A
12906	994IC	43	3	4	6	12	25	NE	994IC;43;3	3	Very High	A
12907	0010433	43	22ER	4	6	12	25	NE	0010433;43;22ER	3	Very High	A
12908	994IC	43	24	4	6	12	25	NE	0011783;43;24	3	High	B
12909	994IC	43	9	4	6	12	25	NE	994IC;43;9	3	High	B
12911	994IC	43	7	4	6	12	25	NE	994IC;43;7	3	High	B
12912	994IC	43	8	4	6	12	25	NE	994IC;43;8	3	High	B
12917	994IC	43	15	4	6	12	25	NE	994IC;43;15	3	Very High	A
12918	994IC	43	16	4	6	12	25	NE	994IC;43;16	3	Very High	A
12919	994IC	43	18	4	6	12	25	NE	994IC;43;18	3	Very High	A
12920	994IC	43	19	4	6	12	25	NE	994IC;43;19	3	Very High	A
12921	994IC	43	20	4	6	12	25	NE	994IC;43;20	3	Moderate	B
12929		S.W.1/4 SEC.		4	5	12	30	SW	4;5;12;30;SW	4	Very High	A
12945	4454JK	1	45	4	5	12	30	SE	4454JK;1;45	2	High	B
12953	6099JK	R5		4	5	12	30	SW	6099JK;R5	4	Very High	A
12962	1595M	15	20	4	5	12	30	NE	1595M;15;20	2	Very High	B
12981	1595M	15	5	4	5	12	30	NE	1595M;15;5	4	Very High	A
12983	1595M	30	11	4	5	12	30	NE	1595M;30;11	4	Very High	A
12984		S.E.1/4 SEC.		4	6	12	25	SE	4;6;12;25;SE	3	Very High	A
12985	4454JK	1	46	4	5	12	30	SE	4454JK;1;46	2	Very High	B
12986	4454JK	1	47	4	5	12	30	SE	4454JK;1;47	3	Very High	A
12991	7510142	3	16	4	5	12	30	SE	7510142;3;16	4	High	A
12998	745M	2	20	4	5	12	30	SE	745M;2;20	3	Moderate	B
13002	190AN	1	1	4	5	12	30	SW	190AN;1;1	3	High	B
13013	9710115	6	1	4	5	12	29	SW	9710115;6;1	4	Moderate	B
13014	252HD	F		4	6	12	25	SE	252HD;F	3	Very High	A
13015	7510142	1	4	4	5	12	29	SW	7510142;1;4	4	Moderate	B
13016	7510142	1	3	4	5	12	29	SW	7510142;1;3	4	Moderate	B
13019	7610613	1	8	4	5	12	29	SW	7610613;1;8	4	Moderate	B
13028	644IB	C		4	5	12	28	NW	644IB;C	4	Very High	A
13042	9412430	15	22	4	5	12	30	NE	9412430;15;22	2	Very High	B
13043	483M	15	3	4	5	12	30	NE	483M;15;3	2	Very High	B
13045	661JK	1		4	5	12	30	SE	661JK;1	4	Very High	A
13046	252HD	2	10	4	6	12	25	SE	252HD:2:10	3	Moderate	B
13047	190AN	16	7	4	5	12	30	SW	190AN;16;7	4	High	A
13048		S.W.1/4 SEC.		4	5	12	30	SW	4;5;12;30;SW	3	Very High	A
13049	190AN	16	6	4	5	12	30	SW	190AN;16;6	4	High	A
13050	190AN	16	5	4	5	12	30	SW	190AN;16;5	4	High	A
13051	190AN	16	4	4	5	12	30	SW	190AN;16;4	4	High	A
13052	190AN	16	3	4	5	12	30	SW	190AN;16;3	4	High	A
13053	190AN	16	2	4	5	12	30	SW	190AN;16;2	4	High	A
13054	190AN	16	1	4	5	12	30	SW	190AN;16;1	4	High	A
13061	190AN	15	5	4	5	12	30	SW	190AN;15;5	4	Very High	A
13064	190AN	15	4	4	5	12	30	SW	190AN;15;4	4	Very High	A
13065	252HD	3	18	4	6	12	25	SE	252HD;3;18	3	High	B
13074	745M	2	21	4	5	12	30	SE	745M;2;21	3	High	B
13077	190AN	1	2	4	5	12	30	SW	190AN;1;2	3	Moderate	B
13079	7510142	3	15	4	5	12	30	SE	7510142;3;15	4	High	A
13082	7510142	3	19	4	5	12	30	SE	7510142;3;19	4	High	A
13109	483M	15	4	4	5	12	30	NE	483M;15;4	3	Very High	A
13110	483M	15	5	4	5	12	30	NE	483M;15;5	3	Very High	A
13111	483M	15	6	4	5	12	30	NE	483M;15;6	3	Very High	A
13113	483M	15	7	4	5	12	30	NE	483M;15;7	4	Very High	A
13115	483M	15	8	4	5	12	30	NE	483M;15;8	4	Very High	A
13116	483M	15	9	4	5	12	30	NE	483M;15;9	4	Very High	A
13117	8610124	15	21	4	5	12	30	NE	8610124;15;21	4	Very High	A
13119	1595M	30	12	4	5	12	30	NE	1595M;30;12	4	Very High	A
13121	1595M	30	13	4	5	12	30	NE	1595M;30;13	4	Very High	A
13123	1595M	30	14	4	5	12	30	NE	1595M;30;14	4	Very High	A
13124	1595M	30	15	4	5	12	30	NE	1595M;30;15	4	Very High	A
13125	1595M	30	16	4	5	12	30	NE	1595M;30;16	4	Very High	A
13126	1595M	30	17	4	5	12	30	NE	1595M;30;17	4	Very High	A
13127	1595M	30	18	4	5	12	30	NE	1595M;30;18	4	Very High	A
13128	1595M	30	19	4	5	12	30	NE	1595M;30;19	2	Very High	B
13129	1595M	30	20	4	5	12	30	NE	1595M;30;20	2	Very High	B
13130	1595M	32	25	4	5	12	30	NE	1595M;32;25	2	Very High	B
13131	1595M	32	26	4	5	12	30	NE	1595M;32;26	2	Very High	B

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
13132	1595M	32	27	4	5	12	30	NE	1595M;32;27	2	Very High	B
13133	1595M	32	28	4	5	12	30	NE	1595M;32;28	2	Very High	B
13134	1595M	32	29	4	5	12	30	NE	1595M;32;29	2	Very High	B
13135	1595M	32	30	4	5	12	30	NE	1595M;32;30	2	Very High	B
13136	1595M	32	31	4	5	12	30	NE	1595M;32;31	2	Very High	B
13138	1595M	32	32	4	5	12	30	NE	1595M;32;32	2	Very High	B
13150	190AN	15	3	4	5	12	30	SW	190AN;15;3	4	Very High	A
13151	190AN	15	2	4	5	12	30	SW	190AN;15;2	4	Very High	A
13152	190AN	15	1	4	5	12	30	SW	190AN;15;1	4	Very High	A
13153		S.W.1/4 SEC.		4	5	12	30	SW	4;5;12;30;SW	4	Very High	A
13173	252HD	3	1	4	6	12	25	SE	252HD;3;1	3	Moderate	B
13203	745M	2	22	4	5	12	30	SE	745M;2;22	3	High	B
13204	7510646	3	R4	4	5	12	29	SW	7510646;3;R4	4	Very High	A
13236	1887JK			4	5	12	28	SE	1887JK	3	Very High	A
13255	8210783	1	3ER	4	5	12	28	NW	8210783;1;3ER	4	Very High	A
13256	252HD	1	4	4	6	12	25	NW	252HD;1;4	3	High	B
13263	190AN	15	6	4	5	12	30	SW	190AN;15;6	4	High	A
13273	190AN	15	7	4	5	12	30	SW	190AN;15;7	4	High	A
13278	661JK	R1		4	5	12	30	SE	661JK;R1	4	Very High	A
13285	190AN	15	8	4	5	12	30	SW	190AN;15;8	4	High	A
13292	7510142	3	14	4	5	12	30	SE	7510142;3;14	4	High	A
13299	252HD	3	19	4	6	12	25	SE	252HD;3;19	3	High	B
13301	745M	2	23	4	5	12	30	SE	745M;2;23	3	High	B
13310	8610817	16	11	4	5	12	28	SW	8610817;16;11	2	Very High	B
13311	8610817	16	12	4	5	12	28	SW	8610817;16;12	2	Very High	B
13317	745M	2	24	4	5	12	30	SE	745M;2;24	3	High	B
13319	0112178	16	57ER	4	5	12	21	NE	0112178;16;57ER	4	Very High	A
13334	1729M	36	15	4	6	12	25	NW	1729M;36;15	3	Very High	A
13335	2177M	36	96	4	6	12	25	NE	2177M;36;96	3	Very High	A
13336	2177M	36	95	4	6	12	25	NE	2177M;36;95	3	Very High	A
13337	2177M	36	94	4	6	12	25	NE	2177M;36;94	3	Very High	A
13338	2177M	36	93	4	6	12	25	NE	2177M;36;93	3	Very High	A
13339	2177M	36	92	4	6	12	25	NE	2177M;36;92	3	Very High	A
13343	2177M	36	99	4	6	12	25	NE	2177M;36;99	3	High	B
13344	2177M	36	98	4	6	12	25	NE	2177M;36;98	3	Very High	A
13345	2177M	36	97	4	6	12	25	NE	2177M;36;97	3	Very High	A
13346	2177M	36	105	4	6	12	25	NE	2177M;36;105	3	High	B
13349	2177M	37	88	4	6	12	25	NE	2177M;37;88	3	Very High	A
13350	2177M	37	87	4	6	12	25	NE	2177M;37;87	3	Very High	A
13351	2177M	37	86	4	6	12	25	NE	2177M;37;86	3	Very High	A
13352	2177M	37	85	4	6	12	25	NE	2177M;37;85	3	Very High	A
13353	2177M	37	84	4	6	12	25	NE	2177M;37;84	3	Very High	A
13354	2177M	37	83	4	6	12	25	NE	2177M;37;83	3	Very High	A
13355	2177M	37	82	4	6	12	25	NE	2177M;37;82	3	Very High	A
13356	2177M	37	81	4	6	12	25	NE	2177M;37;81	3	Very High	A
13357	2177M	37	80	4	6	12	25	NE	2177M;37;80	3	Very High	A
13358	2177M	37	79	4	6	12	25	NE	2177M;37;79	3	Very High	A
13359	2177M	37	78	4	6	12	25	NE	2177M;37;78	3	Very High	A
13360	2177M	37	77	4	6	12	25	NE	2177M;37;77	3	Very High	A
13361	2177M	37	76	4	6	12	25	NE	2177M;37;76	3	Very High	A
13362	2177M	37	75	4	6	12	25	NE	2177M;37;75	3	Very High	A
13363	2177M	37	74	4	6	12	25	NE	2177M;37;74	3	Very High	A
13364	2177M	37	73	4	6	12	25	NE	2177M;37;73	3	Very High	A
13365	2177M	37	72	4	6	12	25	NE	2177M;37;72	3	Very High	A
13366	2177M	37	71	4	6	12	25	NE	2177M;37;71	3	Very High	A
13367	2177M	37	70	4	6	12	25	NE	2177M;37;70	3	Very High	A
13368	2177M	37	69	4	6	12	25	NE	2177M;37;69	3	Very High	A
13369	2177M	38	65	4	6	12	25	NE	2177M;38;65	3	Very High	A
13370	2177M	38	64	4	6	12	25	NE	2177M;38;64	3	Very High	A
13371	2177M	38	63	4	6	12	25	NE	2177M;38;63	3	Very High	A
13372	2177M	38	62	4	6	12	25	NE	2177M;38;62	3	Very High	A
13373	2177M	38	61	4	6	12	25	NE	2177M;38;61	3	Very High	A
13374	2177M	38	60	4	6	12	25	NE	2177M;38;60	3	Very High	A
13375	2177M	38	59	4	6	12	25	NE	2177M;38;59	3	Very High	A
13376	2177M	38	58	4	6	12	25	NE	2177M;38;58	3	Very High	A
13377	2177M	38	57	4	6	12	25	NE	2177M;38;57	3	Very High	A
13378	2177M	38	56	4	6	12	25	NE	2177M;38;56	3	Very High	A
13379	2177M	38	55	4	6	12	25	NE	2177M;38;55	3	Very High	A
13380	2177M	38	54	4	6	12	25	NE	2177M;38;54	3	Very High	A

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
13381	2177M	38	53	4	6	12	25	NE	2177M;38;53	3	Very High	A
13382	2177M	38	52	4	6	12	25	NE	2177M;38;52	3	Very High	A
13383	2177M	38	51	4	6	12	25	NE	2177M;38;51	3	Very High	A
13384	2177M	38	50	4	6	12	25	NE	2177M;38;50	3	Very High	A
13385	2177M	38	49	4	6	12	25	NE	2177M;38;49	3	Very High	A
13386	2177M	38	48	4	6	12	25	NE	2177M;38;48	3	High	B
13388	2177M	39	42	4	6	12	25	NE	2177M;39;42	3	Very High	A
13389	2177M	39	41	4	6	12	25	NE	2177M;39;41	3	Very High	A
13390	2177M	39	40	4	6	12	25	NE	2177M;39;40	3	Very High	A
13391	2177M	39	39	4	6	12	25	NE	2177M;39;39	3	Very High	A
13392	2177M	39	38	4	6	12	25	NE	2177M;39;38	3	Very High	A
13393	2177M	39	37	4	6	12	25	NE	2177M;39;37	3	Very High	A
13394	2177M	39	36	4	6	12	25	NE	2177M;39;36	3	Very High	A
13395	2177M	39	35	4	6	12	25	NE	2177M;39;35	3	Very High	A
13396	2177M	39	34	4	6	12	25	NE	2177M;39;34	3	Very High	A
13397	2177M	39	33	4	6	12	25	NE	2177M;39;33	3	Very High	A
13398	2177M	39	32	4	6	12	25	NE	2177M;39;32	3	Very High	A
13399	2177M	39	31	4	6	12	25	NE	2177M;39;31	3	Very High	A
13400	2177M	39	27	4	6	12	25	NE	2177M;39;27	3	Very High	A
13410	7620AS	1	36	4	5	12	28	SW	7620AS;1;36	2	Very High	B
13411	7620AS	1	37	4	5	12	28	SW	7620AS;1;37	2	Very High	B
13412	7620AS	1	35	4	5	12	28	SW	7620AS;1;35	2	Very High	B
13413	7620AS	1	34	4	5	12	28	SW	7620AS;1;34	2	Very High	B
13414	7620AS	1	33	4	5	12	28	SW	7620AS;1;33	2	Very High	B
13415	7620AS	1	32	4	5	12	28	SW	7620AS;1;32	2	Very High	B
13416	7620AS	1	31	4	5	12	28	SW	7620AS;1;31	2	Very High	B
13417	7620AS	1	30	4	5	12	28	SW	7620AS;1;30	2	Very High	B
13418	7620AS	1	29	4	5	12	28	SW	7620AS;1;29	2	Very High	B
13420	7620AS	1	27	4	5	12	28	SW	7620AS;1;27	2	High	B
13421	7620AS	1	28	4	5	12	28	SW	7620AS;1;28	2	Very High	B
13423	7620AS	1	25	4	5	12	28	SW	7620AS;1;25	2	High	B
13424	1710AJ			4	5	12	29	SE	1710AJ	4	High	A
13429	190AN	15	9	4	5	12	30	SW	190AN;15;9	4	High	A
13431	1710AJ	40	25	4	5	12	29	SE	1710AJ;40;25	4	Moderate	B
13434	252HD	3	8	4	6	12	25	SE	252HD;3;8	3	High	B
13440	190AN	15	10	4	5	12	30	SW	190AN;15;10	4	High	A
13441	252HD	3	9	4	6	12	25	SE	252HD;3;9	3	Very High	A
13448	9112245	1	8ER	4	6	12	24	NE	9112245;1;8ER	3	Very High	A
13553	7410139	2	6	4	5	12	30	SW	7410139;2;6	2	High	B
13554	9011188	3	4	4	6	12	25	SW	9011188;3;4	4	Very High	A
13565	9011188	3	3	4	6	12	25	SW	9011188;3;3	4	Very High	A
13583	6160JK	4	23	4	5	12	30	SE	6160JK;4;23	2	Very High	B
13584	6160JK	4	22	4	5	12	30	SE	6160JK;4;22	2	Very High	B
13676		N.E.1/4 SEC.		4	5	12	21	NE	4;5;12;21;NE	3	Very High	A
13679	7410139	4	9	4	5	12	30	SE	7410139;4;9	2	High	B
13686	7410139	1	1	4	5	12	30	SW	7410139;1;1	2	High	B
13716	6160JK	4	24	4	5	12	30	SE	6160JK;4;24	2	Very High	B
13720	6160JK	4	26	4	5	12	30	SE	6160JK;4;26	2	Very High	B
13725	6160JK	4	21	4	5	12	30	SE	6160JK;4;21	2	Very High	B
13819	6160JK	4	4	4	5	12	30	SE	6160JK;4;4	2	High	B
13829	6160JK	4	27	4	5	12	30	SE	6160JK;4;27	2	High	B
13834	6160JK	4	28	4	5	12	30	SE	6160JK;4;28	2	Very High	B
13836	6160JK	4	29	4	5	12	30	SE	6160JK;4;29	2	Very High	B
13837	6160JK	4	19	4	5	12	30	SE	6160JK;4;19	2	Very High	B
13840	6160JK	4	18	4	5	12	30	SE	6160JK;4;18	2	Very High	B
13924	6160JK	3	4	4	5	12	30	SE	6160JK;3;4	3	Very High	A
13943	252HD	3	32	4	6	12	25	SE	252HD;3;32	2	Very High	B
13966	6160JK	4	5	4	5	12	30	SE	6160JK;4;5	2	Very High	B
14056	6160JK	3	3	4	5	12	30	SE	6160JK;3;3	3	High	B
14112	7510258	A		4	6	12	25	SW	7510258;A	4	Very High	A
14116	7410139	5	R2	4	5	12	30	SE	7410139;5;R2	2	Very High	B
14186	8010570	2	12	4	6	12	24	NW	8010570;2;12	3	Moderate	B
14286	6160JK	4	6	4	5	12	30	SE	6160JK;4;6	2	Very High	B
14352	252HD	E		4	6	12	25	SE	252HD;E	2	Very High	B
14356	7510258	B		4	6	12	25	SW	7510258;B	4	High	A
14357	6160JK	3	2	4	5	12	30	SE	6160JK;3;2	3	Very High	A
14410	9812791	2	21	4	6	12	24	NW	9812791;2;21	3	High	B
14446	7410139	5	5	4	5	12	30	SE	7410139;5;5	2	High	B
14448	7410139	5	4	4	5	12	30	SE	7410139;5;4	2	High	B

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
14455	7410139	5	3	4	5	12	30	SE	7410139;5;3	2	High	B
14468	7410139	5	2	4	5	12	30	SW	7410139;5;2	2	High	B
14473	6160JK	3	1	4	5	12	30	SE	6160JK;3;1	3	Very High	A
14532	7410139	5	1	4	5	12	30	SW	7410139;5;1	2	High	B
14581	7410139	4	18	4	5	12	30	SE	7410139;4;18	2	Very High	B
14713	7510258	R1							7510258;R1	4	Very High	A
14721	6160JK	4	1	4	5	12	30	SE	6160JK;4;1	3	High	B
14722	7410139	4	7	4	5	12	30	SE	7410139;4;7	2	Very High	B
14736	6160JK	4	9	4	5	12	30	SE	6160JK;4;9	2	High	B
14829	7410139	4	8	4	5	12	30	SE	7410139;4;8	2	Very High	B
14858		N.E.1/4 SEC.		4	5	12	21	NE	4;5;12;21;NE	3	Very High	A
14904	9112245	1	1	4	6	12	24	NE	9112245;1;1	3	High	B
14908	8010570	2	15	4	6	12	24	NW	8010570;2;15	3	High	B
14924	9112245	1	8ER	4	6	12	24	NW	9112245;1;8ER	4	Very High	A
15022	7410139	2	3	4	5	12	30	SW	7410139;2;3	2	High	B
15045	8010570	2	16	4	6	12	24	NW	8010570;2;16	3	High	B
15096	7410139	2	4	4	5	12	30	SW	7410139;2;4	2	High	B
15108	6160JK	4	3	4	5	12	30	SE	6160JK;4;3	3	High	B
15110	7410139	2	5	4	5	12	30	SW	7410139;2;5	2	High	B
15198	8010570	2	17	4	6	12	24	NW	8010570;2;17	3	Moderate	B
15343	9112245	1	7ER	4	6	12	24	NE	9112245;1;7ER	2	Very High	B
15533		S.W.1/4 SEC.		4	6	12	24	SW	4;6;12;24;SW	3	Very High	A
15758		S.E.1/4 sec.		4	5	12	21	SE	4;5;12;21;SE	3	Very High	A
15831	7810535	15		4	5	12	21	NE	7810535;15;R3	4	Very High	A
15991				4	5	12	21	NE	4;5;12;21;NE	3	Very High	A
16069	9611601	3	8	4	6	12	24	SW	9611601;3;8	2	High	B
16076		N.E.1/4 SEC.		4	6	12	24	NE	4;6;12;24;NE	3	Very High	A
16186	9611601	3	9	4	6	12	24	SW	9611601;3;9	2	Very High	B
16281		S.W.1/4 SEC.		4	6	12	24	SW	4;6;12;24;SW	4	Very High	A
16282		S.E.1/4 SEC.		4	6	12	24	SE	4;6;12;24;SE	3	Very High	A
16284	9611601	3	1	4	6	12	24	SW	9611601;3;1	4	Very High	A
16397	7322BC	X		4	6	12	24	SW	7322BC;X	4	Very High	A
16407				4	6	12	24	SE	4;6;12;24;SE	3	High	B
16530	8110690	2	5	4	6	12	23	SE	8110690;2;5	4	High	A
16535	8110690	2	6	4	6	12	23	SE	8110690;2;6	4	High	A
16537	8110690	2	7	4	6	12	23	SE	8110690;2;7	4	High	A
16538	8110690	2	8	4	6	12	23	SE	8110690;2;8	4	High	A
17092		N.E.1/4 SEC.		4	6	12	24	NE	4;6;12;24;NE	3	Very High	A
17180	7810488	3		4	6	12	23	SE	7810488;3	4	Very High	A
17290	7910729	23	66MR	4	5	12	21	SE	7910729;23;66MR	2	High	B
17291	7910729	23	45	4	5	12	21	SE	7910729;23;45	2	High	B
17315	9710074	2	21	4	6	12	23	SE	9710074;2;21	4	Very High	A
17418	7910729	23	46	4	5	12	21	SE	7910729;23;46	2	High	B
17485	9710790	2		4	6	12	24	SW	9710790;2	3	High	B
17524	0210545	2	28	4	6	12	23	SE	0210545;2;28	4	High	A
17525	8110690	2	16	4	6	12	23	SE	8110690;2;16	4	High	A
17591				4	6	12	24	SE	4;6;12;24;SE	2	Very High	B
17612	7910729	23	47	4	5	12	21	SE	7910729;23;47	2	High	B
17659	9710074	2	23	4	6	12	23	SE	9710074;2;23	4	Moderate	B
17660	9710074	2	22	4	6	12	23	SE	9710074;2;22	4	Very High	A
17671	9710790	CS		4	6	12	24	SW	9710790;CS	4	Moderate	B
17770	9710790	3		4	6	12	24	SW	9710790;3	3	High	B
17844	9710790	4		4	6	12	24	SW	9710790;4	4	Very High	A
17948	9712417	21		4	6	12	24	SW	9712417;21	3	High	B
17949	9712417	20		4	6	12	24	SW	9712417;20	3	High	B
17950	9712417	22		4	6	12	24	SW	9712417;22	3	Very High	A
17954	8110690	2	11	4	6	12	23	SE	8110690;2;11	4	Moderate	B
18042	9712417	23		4	6	12	24	SW	9712417;23	3	Very High	A
18043	9712417	19		4	6	12	24	SW	9712417;19	3	Moderate	B
18049	9710790	5		4	6	12	24	SW	9710790;5	4	High	A
18053	9712417	24		4	6	12	24	SW	9712417;24	3	High	B
18059	9712417	25		4	6	12	24	SW	9712417;25	3	High	B
18062	9712417	18		4	6	12	24	SW	9712417;18	3	High	B
18064	7810488	R1		4	6	12	23	SE	7810488;R1	4	Very High	A
18119	9712417	26		4	6	12	24	SW	9712417;26	3	Very High	A
18124	9712417	27		4	6	12	24	SW	9712417;27	3	Very High	A
18131	8110690	2	20ER	4	6	12	23	SE	8110690;2;20ER	4	Very High	A
18132	9710790	6		4	6	12	24	SW	9710790;6	4	Very High	A
18217		S.E.1/4 SEC.		4	5	12	21	SE	4;5;12;21;SE	2	Very High	B

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
18223	9710790	7		4	6	12	24	SW	9710790;7	4	Very High	A
18229	9710790	8		4	6	12	24	SW	9710790;8	4	Very High	A
18230	9712417	17		4	6	12	24	SW	9712417;17	3	High	B
18283	7810488	R1		4	6	12	23	SE	7810488;R1	4	Very High	A
18284	9710790	9		4	6	12	24	SW	9710790;9	4	High	A
18285	9710790	10		4	6	12	24	SW	9710790;10	4	High	A
18378	7810488	2		4	6	12	23	SE	7810488;2	4	Very High	A
18381	9710790	11		4	6	12	24	SW	9710790;11	4	High	A
18391	9712417	12		4	6	12	24	SW	9712417;12	4	High	A
18393	9712417	16		4	6	12	24	SW	9712417;16	4	High	A
18404	9712417	13		4	6	12	24	SW	9712417;13	4	High	A
18476	9710074	2	24	4	6	12	23	SE	9710074;2;24	4	High	A
18512	9712417	15		4	6	12	24	SW	9712417;15	4	High	A
18513	9712417	14		4	6	12	24	SW	9712417;14	4	High	A
18533	0210545	2	27	4	6	12	23	SE	0210545;2;27	4	High	A
18705	9410585	1	1	4	6	12	14	NW	9410585;1;1	4	Moderate	B
18776	0213535	11	74	4	6	12	24	SE	0213535;11;74	3	Very High	A
18799	0213535	11	75	4	6	12	24	SE	0213535;11;75	3	High	B
18849	8010786	29	17	4	5	12	16	NE	8010786;29;17	2	High	B
18851	8010786	29	18	4	5	12	16	NE	8010786;29;18	2	Very High	B
18964	8010786	29	27ER	4	5	12	21	SE	8010786;29;27ER	2	Very High	B
19036		N.W.1/4 SEC.		4	6	12	14	NW	4;6;12;14;NW	4	Very High	A
19628	8010786	29	5	4	5	12	16	NE	8010786;29;5	2	High	B
19658	8010786	29	6	4	5	12	16	NE	8010786;29;6	2	High	B
19729		N.E.1/4 SEC.		4	5	12	16	NE	4;5;12;16;NE	2	Very High	B
19955		N.E.1/4 SEC.		4	6	12	14	NE	4;6;12;14;NE	4	Very High	A
19975	8010786	29	7	4	5	12	16	NE	8010786;29;7	2	Very High	B
20051	0213535	11	65	4	6	12	13	NE	0213535;11;65	2	Very High	B
20075	8010786	29	8	4	5	12	16	NE	8010786;29;8	2	High	B
20263	9010219	51	10	4	5	12	16	SE	9010219;51;10	2	Very High	B
20368	8610792	32	59	4	5	12	16	SE	8610792;32;59	2	High	B
20369	8610792	32	60	4	5	12	16	SE	8610792;32;60	2	High	B
20464	9911441	1	3	4	6	12	14	SW	9911441;1;3	2	Very High	B
20529		N.W.1/4 SEC.		4	6	12	14	NW	4;6;12;14;NW	4	Very High	A
20631	8311431	32	41ER	4	5	12	16	NE	8311431;32;41ER	2	Very High	B
20702	8211350	1		4	6	12	14	SW	8211350;1	4	Very High	A
20727	8110818	32	26ER	4	5	12	16	NE	8110818;32;26ER	2	Very High	B
20851	8610792	32	63	4	5	12	16	SE	8610792;32;63	2	High	B
21298	8610792	32	24ER	4	5	12	16	SE	8610792;32;24ER	2	Very High	B
21489		S.E.1/4 SEC.		4	6	12	14	SE	4;6;12;14;SE	3	Very High	A
21495		S.W.1/4 SEC.		4	6	12	14	SW	4;6;12;14;SW	4	Very High	A
21587	9911441	1	7ER	4	6	12	14	SW	9911441;1;7ER	4	Very High	A
21592	9911441	1	2	4	6	12	14	SW	9911441;1;2	4	High	A
21636	9010219	51	27ER	4	5	12	16	SE	9010219;51;27ER	3	Very High	A
21637	9010219	51	8	4	5	12	16	SE	9010219;51;8	2	High	B
21638	9010219	51	9	4	5	12	16	SE	9010219;51;9	2	Very High	B
21774		S.W.1/4 SEC.		4	6	12	14	SW	4;6;12;14;SW	4	Very High	A
21804	0011756	1	25MR	4	5	12	16	SE	0011756;1;25MR	2	Very High	B
21833	23593			4	5	12	32	NW	23593	4	Very High	A
22101		S.W.1/4 SEC.		4	6	12	24	SW	4;6;12;24;SW	2	Very High	B
22150	0312609	15		4	6	12	13	NE	0312609;15	2	Very High	B
22151	0312609	16		4	6	12	13	NE	0312609;16	2	Very High	B
22153	0312609	14		4	6	12	13	NE	0312609;14	2	High	B
22154	0312609	18		4	6	12	13	NE	0312609;18	2	Very High	B
22155	0312609	13		4	6	12	13	NE	0312609;13	2	Very High	B
22156	0312609	12		4	6	12	13	NE	0312609;12	2	Very High	B
22157	0312609	19		4	6	12	13	NE	0312609;19	2	Very High	B
22158	0312609	11		4	6	12	13	NE	0312609;11	2	Very High	B
22159	0312609	10		4	6	12	13	NE	0312609;10	2	Very High	B
22160	0312609	20		4	6	12	13	NE	0312609;20	2	Very High	B
22161	0312609	9		4	6	12	13	NE	0312609;9	2	Very High	B
22162	0312609	21		4	6	12	13	NE	0312609;21	2	Very High	B
22219	5113AV	Z		4	6	12	24	SE	5113AV;Z	3	Very High	A
22220		S.W.1/4 SEC.		4	6	12	24	SW	4;6;12;24;SW	4	Very High	A
22221				4	6	12	24	SE	4;6;12;24;SE	4	Very High	A
22231	7711294	10	47	4	6	12	24	SE	7711294;10;47	3	Moderate	B
22241	0213535	17	7	4	6	12	24	SE	0213535;17;7	3	High	B
22242	0213535	17	8	4	6	12	24	SE	0213535;17;8	3	Very High	A
22250	0213535	11	76	4	6	12	24	SE	0213535;11;76	3	Very High	A

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
22251	0213535	11	73	4	6	12	24	SE	0213535;11;73	3	Very High	A
22252	0213535	11	72	4	6	12	24	SE	0213535;11;72	3	Very High	A
22253	0111061	11	58ER	4	5	12	18	NW	0111061;11;58ER	2	Very High	B
22255	0213535	11	71	4	6	12	24	SE	0213535;11;71	3	Very High	A
22256	0213535	11	70	4	6	12	24	SE	0213535;11;70	2	Very High	B
22257	0213535	11	69	4	6	12	24	SE	0213535;11;69	2	Very High	B
22258	0213535	11	67	4	6	12	24	SE	0213535;11;67	2	High	B
22259	0213535	11	66	4	6	12	13	NE	0213535;11;66	2	Very High	B
22260										2	Very High	B
22261	1919AV	A		4	6	12	24	SW	1919AV;A	4	Very High	A
22377	6099JK	H		4	5	12	30	SW	6099JK;H	4	Very High	A
22393		S.E.1/4 SEC.		4	6	13	2	SE	4;6;13;2;SE	2	Very High	B
22447	0312828	28	6	4	6	12	24	SW	0312828;28;6	4	Very High	A
22569	7710677	B		4	5	12	19	SW	7710677;B	2	Very High	B
22571										2	Very High	B
22579	0312615	11	80	4	6	12	24	SE	0312615;11;80	3	Very High	A
22580	0312615	11	79	4	6	12	24	SE	0312615;11;79	3	Very High	A
22583	1807M	F	6	4	6	12	36	SE	1807M;F;6	3	Very High	A
22584	1807M	F	7	4	6	12	36	SE	1807M;F;7	3	Very High	A
22585	1807M	F	3	4	6	12	36	SE	1807M;F;3	3	Very High	A
22586	1807M	F	5	4	6	12	36	SE	1807M;F;5	3	Very High	A
22587	1807M	F	4	4	6	12	36	SE	1807M;F;4	3	Very High	A
22588	1807M	F	8	4	6	12	36	SE	1807M;F;8	3	Very High	A
22589	1807M	F	9	4	6	12	36	SE	1807M;F;9	3	Very High	A
22590	1807M	F	1	4	6	12	36	SE	1807M;F;1	3	Very High	A
22591	1807M	F	2	4	6	12	36	SE	1807M;F;2	3	Very High	A
22653	0313097	1	1ER	4	6	12	36	NE	0313097;1;1ER	4	Very High	A
22791		S.E.1/4 SEC.		4	6	12	24	SE	4;6;12;24;SE	4	Very High	A
22817	7710885	9	7	4	5	12	32	NW	7710885;9;7	4	Very High	A
22836	0312836	22	38ER	4	6	12	24	SE	0312836;22;38ER	4	Very High	A
22984	0413168	1	1	4	6	12	14	NE	0413168;1;1	4	Very High	A
22985		N.E.1/4 SEC.		4	6	12	14	NE	4;6;12;14;NE	4	Very High	A
22998	0012161	2	1	4	5	12	16	SE	0012161;2;1	2	Very High	B
22999				4	6	13	27	SW	4;6;13;27;SW	3	Very High	A
23000										3	Very High	A
23001										3	Very High	A
23004										3	Very High	A
23008										3	Very High	A
23009	7410337	1		4	6	13	26	SE	7410337;1	3	Very High	A
23010				4	6	13	25	SW	4;6;13;25;SW	3	Very High	A
23011				4	6	13	26	SE	4;6;13;26;SE	3	Very High	A
23012				4	6	13	26	SW	4;6;13;26;SW	3	Very High	A
23013				4	6	13	25	NW	4;6;13;25;NW	3	Very High	A
23014		S.E.1/4 SEC.		4	5	12	16	SE	4;5;12;16;SE	2	Very High	B
23029		N.W.1/4 SEC.		4	5	13	17	NW	4;5;13;17;NW	4	Very High	A
23035	8711494	1	2ER	4	5	13	18	NE	8711494;1;2ER	4	Very High	A
23036	8711494	1	1	4	5	13	18	NE	8711494;1;1	4	Very High	A
23037				4	6	13	1	SW		4	Very High	A
23038		N.E.1/4 SEC.		4	5	13	18	NE	4;5;13;18;NE	4	Very High	A
23045		N.E.1/4 SEC.		4	6	13	13	NE	4;6;13;13;NE	4	Very High	A
23051				4	5	13	20	SW	4;5;13;20;SW	4	Very High	A
23054				4	5	13	19	SE	4;5;13;19;SE	4	Very High	A
23060				4	6	13	23	SE	4;6;13;23;SE	3	Very High	A
23061				4	6	13	24	SW	4;6;13;24;SW	4	High	A
23064				4	6	13	24	SE	4;6;13;24;SE	4	Very High	A
23065				4	6	13	23	NE	4;6;13;23;NE	3	Very High	A
23066				4	6	13	24	NW	4;6;13;24;NW	3	Very High	A
23068	8010129	1		4	6	13	24	NW	8010129;1	4	Very High	A
23069				4	6	13	24	NE	4;6;13;24;NE	4	Very High	A
23099	483M	16	10	4	5	12	30	NE	483M;16;10	2	High	B
23101	9310227	16	13A	4	5	12	30	NE	9310227;16;13A	2	High	B
23117		N.E.1/4 SEC.		4	5	13	8	NE	4;5;13;8;NE	4	Very High	A
23120		S.E.1/4 SEC.		4	5	13	9	SE	4;5;13;9;SE	2	Very High	B
23121		S.W.1/4 SEC.		4	5	13	9	SW	4;5;13;9;SW	3	Very High	A
23124		N.W.1/4 SEC.		4	5	13	8	NW	4;5;13;8;NW	4	Very High	A
23295	0411633	1	29	4	5	12	16	SE	0411633;1;29	2	High	B
23370		S.W.1/4 SEC.		4	5	13	17	SW	4;5;13;17;SW	4	Very High	A
23451	7710885	R2		4	5	13	5	NW	7710885;R2	3	Very High	A
23914	0514096	1	3	4	6	12	15	SE	0514096;1;3	4	Very High	A

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
23916	0512832	1	1PUL	4	6	12	15	SE	0512832;1;1PUL	4	Moderate	B
23917	0512832	1	ROAD	4	6	12	15	SE	0512832;1;ROAD	4	High	A
23921	9210482	1	1	4	6	12	15	SE	9210482;1;1	3	Very High	A
24778	7322BC	X		4	6	12	24	SW	7322BC;X	4	Very High	A
24780	0412814	29	77ER	4	6	12	13	NW	0412814;29;77ER	3	Very High	A
24785	0512629	281		4	6	12	35	NE	0512629;281	4	Very High	A
24812	0512629	274		4	6	12	35	NE	0512629;274	4	Moderate	B
24813	0512629	268		4	6	12	35	NE	0512629;268	4	Moderate	B
24814	0512634	327		4	6	12	35	NE	0512634;327	4	Very High	A
24815	0512629	273		4	6	12	35	NE	0512629;273	4	High	A
24816	0512629	269		4	6	12	35	NE	0512629;269	4	Moderate	B
24817	0512629	272		4	6	12	35	NE	0512629;272	4	High	A
24818	0512629	270		4	6	12	35	NE	0512629;270	4	High	A
24819	0512634	294							0512634;294	4	High	A
24820	0512629	271		4	6	12	35	NE	0512629;271	4	High	A
24821	0512634	293							0512634;293	4	High	A
24822	0512634	282							0512634;282	4	High	A
24823	0512634	292							0512634;292	4	High	A
24824	0512634	283							0512634;283	4	High	A
24825	0512634	291							0512634;291	4	High	A
24826	0512634	284							0512634;284	4	High	A
24827	0512634	290							0512634;290	4	High	A
24828	0512634	285							0512634;285	4	High	A
24829	0512634	289							0512634;289	4	High	A
24830	0512634	286							0512634;286	4	High	A
24831	0512634	287							0512634;287	4	High	A
24832	0512634	288							0512634;288	4	Very High	A
24833	0113531	6ER		4	6	12	35	NE	0113531;6ER	4	Very High	A
24834	388HH	B		4	6	12	35	NE	388HH;B	4	Very High	A
24835	8611310	CDE 8611310		4	6	12	35	NE	8611310;CDE 86113	4	Very High	A
24836	8110626	11	5MR	4	6	12	35	NE	8110626;11;5MR	4	Very High	A
24837	0512633	20	39	4	5	12	30	NE	0512633;20;39	2	High	B
24902		22	37PUL	4	6	12	13	NE	0312828;22;37PUL	3	Very High	A
24920	0412814	29	60	4	6	12	13	NW	0412814;29;60	2	Very High	B
24921	0412814	29	59	4	6	12	13	NW	0412814;29;59	2	Very High	B
24950	0111161	2	26	4	6	12	23	SE	0111161;2;26	4	Very High	A
25089	0312828	29	8PUL	4	6	12	24	13	0312828;29;8PUL	2	Very High	B
25104	3467AV	X		4	6	12	13	NW	3467AV;X	4	Very High	A
25106	0412811	29	33	4	6	12	13	NW	0412811;29;33	3	Moderate	B
25107	0412811	29	34	4	6	12	13	NW	0412811;29;34	3	High	B
25108	0412811	29	35	4	6	12	13	NW	0412811;29;35	3	High	B
25109	0412814	29	61	4	6	12	13	NW	0412814;29;61	2	Very High	B
25122		N.W.1/4 SEC.		4	6	12	13	NW	4;6;12;13;NW	3	Very High	A
25264	0910426	13	105	4	5	13	8	SE	0910426;13;105	3	Moderate	B
25266	0910426	13	107	4	5	13	8	SE	0910426;13;107	3	Moderate	B
25267	0910426	13	108	4	5	13	8	SE	0910426;13;108	3	Moderate	B
25268	0910426	13	109	4	5	13	8	SE	0910426;13;109	3	High	B
25269	0910426	13	110	4	5	13	8	SE	0910426;13;110	3	High	B
25270	0910426	13	111	4	5	13	8	SE	0910426;13;111	3	High	B
25272	0910426	13	134	4	5	13	8	SE	0910426;13;134	3	High	B
25273	0910426	13	132	4	5	13	8	SE	0910426;13;132	3	High	B
25276	0910426	13	131	4	5	13	8	SE	0910426;13;131	3	High	B
25277	0910426	13	135	4	5	13	8	SE	0910426;13;135	3	Very High	A
25280	0910426	13	130	4	5	13	8	SE	0910426;13;130	3	Moderate	B
25282	0910426	13	136	4	5	13	8	SE	0910426;13;136	3	Very High	A
25289	0910426	13	137	4	5	13	8	SE	0910426;13;137	3	Very High	A
25299	0910426	13	138	4	5	13	8	SE	0910426;13;138	3	Very High	A
25309	0910426	13	112	4	5	13	8	SE	0910426;13;112	3	High	B
25314	0910426	13	113	4	5	13	8	SE	0910426;13;113	3	High	B
25323	0910426	13	119MR	4	5	13	8	SE	0910426;13;119MR	3	High	B
25331	0910426	13	133	4	5	13	8	SE	0910426;13;133	3	High	B
25359	0910426	13	139	4	5	13	8	SE	0910426;13;139	3	High	B
25372	0910426	13	140	4	5	13	8	SE	0910426;13;140	3	High	B
25397	8210783	1	1	4	5	12	28	NW	8210783;1;1	4	High	A
25398	4774AV	Z		4	5	12	28	NW	4774AV;Z	4	Very High	A
25478		S.W.1/4 SEC.		4	5	13	8	SW	4;5;13;8;SW	4	Very High	A
25508	8210743	1	11	4	5	12	31	NW	8210743;1;11	2	High	B
25725	8310004			4	5	12	31	NE	8310004	2	Very High	B
25976	731642	A		4	6	12	24	NW	731642;A	4	Very High	A

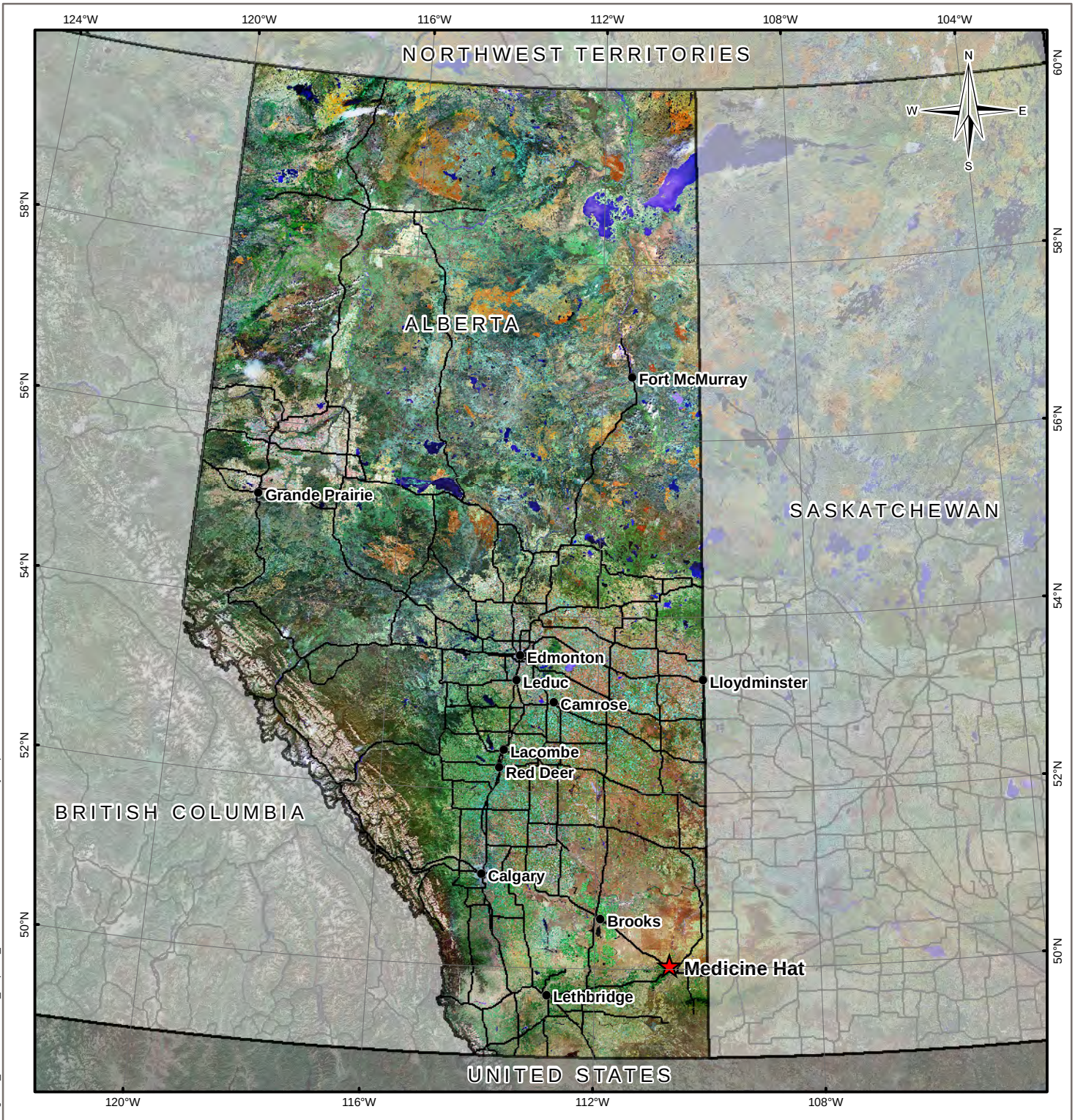
Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
26314	47JK	9	10	4	5	13	6	SE	47JK;9;10	2	Very High	B
26315	47JK	9	11	4	5	13	6	SE	47JK;9;11	2	Very High	B
26316	47JK	9	12	4	5	13	6	SE	47JK;9;12	2	Very High	B
26317	47JK	9	13	4	5	13	6	SE	47JK;9;13	2	Very High	B
26318	47JK	9	14	4	5	13	6	SE	47JK;9;14	2	Very High	B
26319	0813459	9	18ER	4	5	13	6	SE	0813459;9;18ER	2	Very High	B
26320	0813459	9	17	4	5	13	6	SE	0813459;9;17	2	Very High	B
26365	8211525	17MR		4	5	13	6	SE	8211525;17MR	3	Very High	A
26366	3953JK	R9		4	5	13	6	SE	3953JK;R9	2	Very High	B
26369	6099JK	A		4	5	12	30	SW	6099JK;A	2	Very High	B
26370	6099JK	R1		4	5	12	30	SE	6099JK;R1	2	Very High	B
26383	6160JK	R1		4	5	12	30	SE	6160JK;R1	3	Very High	A
26607	483M	13	9	4	5	12	30	NE	483M;13;9	4	Moderate	B
26608	483M	13	10	4	5	12	30	NE	483M;13;10	4	High	A
26616	483M	13	11	4	5	12	30	NE	483M;13;11	2	High	B
26650	8110695	D	2ER	4	6	12	25	SW	8110695;D;2ER	4	Very High	A
26652	8010570	5	3MR	4	6	12	24	NW	8010570;5;3MR	3	Very High	A
27357		RD ALLOWANCE		4	5	12	33	SW	4;5;12;33;SW	4	Very High	A
27358	4774AV	Z		4	5	12	28	NW	4774AV	4	Very High	A
27372	0812525	2	8	4	6	12	SE		0812525;2;8	4	High	A
27373	0812525	2	9	4	6	12	SE		0812525;2;9	4	High	A
27376	0812525	2	10	4	6	12	SE		0812525;2;10	4	High	A
27377	0812525	2	6	4	6	12	SE		0812525;2;6	4	High	A
27378	0812525	2	11	4	6	12	SE		0812525;2;11	4	High	A
27380	0812525	2	5ER	4	6	12	SE		0812525;2;5ER	4	Very High	A
27382	0812525	2	4	4	6	12	SE		0812525;2;4	4	Very High	A
27384	0514096	1	3	4	6	12	15	SE	0514096;1;3	4	Very High	A
27456	1595M	28	19	4	5	12	30	NE	1595M;28;19	2	Very High	B
27457	1595M	28	18	4	5	12	30	NE	1595M;28;18	2	High	B
27458	1595M	28	17	4	5	12	30	NE	1595M;28;17	2	High	B
27459	1595M	28	16	4	5	12	30	NE	1595M;28;16	2	High	B
27460	9511673	28	40	4	5	12	30	NE	9511673;28;40	2	High	B
27474	1595M	28	20	4	5	12	30	NE	1595M;28;20	2	High	B
27475	1595M	28	21	4	5	12	30	NE	1595M;28;21	2	High	B
27639	1132M	31	14	4	5	12	30	NW	1132M;31;14	3	Very High	A
27640	1132M	31	15	4	5	12	30	NW	1132M;31;15	3	Very High	A
27641	1132M	31	13	4	5	12	30	NW	1132M;31;13	3	Very High	A
27642	1132M	31	12	4	5	12	30	NW	1132M;31;12	3	High	B
27654	1132M	31	16	4	5	12	30	NW	1132M;31;16	3	Very High	A
27655	1132M	31	17	4	5	12	30	NW	1132M;31;17	3	Very High	A
27656	1132M	31	18	4	5	12	30	NW	1132M;31;18	3	Very High	A
27657	1132M	31	19	4	5	12	30	NW	1132M;31;19	4	Very High	A
27658	1132M	31	20	4	5	12	30	NW	1132M;31;20	4	High	A
27659	1132M	31	21	4	5	12	30	NW	1132M;31;21	4	High	A
27660	1132M	31	22	4	5	12	30	NW	1132M;31;22	4	Moderate	B
27661	1132M	31	23	4	5	12	30	NW	1132M;31;23	4	Moderate	B
27662	1132M	31	24	4	5	12	30	NW	1132M;31;24	4	Moderate	B
27663	1132M	31	25	4	5	12	30	NW	1132M;31;25	4	Moderate	B
27667	1110049	D		4	5	12	30	NW	1110049;D	3	Very High	A
27668	1132M	32	11	4	5	12	30	NW	1132M;32;11	4	Very High	A
27669	1132M	32	9	4	5	12	30	NW	1132M;32;9	4	Very High	A
27670	1132M	32	8	4	5	12	30	NW	1132M;32;8	4	Very High	A
27671	1132M	32	7	4	5	12	30	NW	1132M;32;7	4	Very High	A
27672	1132M	32	6	4	5	12	30	NW	1132M;32;6	4	Very High	A
27673	1132M	32	5	4	5	12	30	NW	1132M;32;5	4	Very High	A
27674	1132M	32	4	4	5	12	30	NW	1132M;32;4	4	Very High	A
27675	1132M	32	3	4	5	12	30	NW	1132M;32;3	4	High	A
27676	1132M	32	2	4	5	12	30	NW	1132M;32;2	4	High	A
27680		S.W.1/4 SEC.		4	6	12	14	SW	4;6;12;14;SW	4	Very High	A
27696	9710636	40	42	4	6	12	25	NE	9710336;40;42	3	Very High	A
27697	9710636	40	41	4	6	12	25	NE	9710636;40;41	3	High	B
27698	9710636	40	43ER	4	6	12	25	NE	9710636;40;43ER	3	Very High	A
27702	1132M	32	4	4	5	12	30	NW	1132M;32;4	4	High	A
27703	1110049	C		4	5	12	30	SW	1110049;C	4	Very High	A
27704	951BA	A		4	5	12	30	SW	951BA;A	4	Very High	A
27705		S.W.1/4 SEC		4	5	12	30	SW	4;5;12;30;SW	4	Very High	A
27706	2212EA	OT		4	5	12	30	SW	2212EA;OT	4	Very High	A
27707	8010301		1	4	5	12	30	SE	8010301;:1	4	Very High	A
27708	8010301		2	4	5	12	30	SE	8010301;LOT 2	4	Very High	A

Property										Terrain Hazard	Consequence	Partial Risk
OBJECTID_1	PLAN	BLOCK	LOT	MERIDIAN	RANGE	TOWNSHIP	SECTION	QUARTER	SHORT_LEGA	Hazard_ Class	CONSEQUENCE	PRisk_ Class
27709	1595M	C		4	5	12	30	NE	1595M;C	4	Very High	A
27710	1595M	32	1	4	5	12	30	NE	1595M;32;1	3	Very High	A
27743	2985AH			4	6	12	25	SE	2985AH	2	Very High	B
27751	1132M	33	5	4	5	12	30	NW	1132M;33;5	4	Very High	A
27752	1132M	33	4	4	5	12	30	NW	1132M;33;4	4	Very High	A
27753	1132M	33	3	4	5	12	30	NW	1132M;33;3	4	Very High	A
27754	1132M	33	1	4	5	12	30	NW	1132M;33;1	4	Very High	A
27755	1132M	34	10	4	5	12	30	NW	1132M;34;10	4	Very High	A
27756	1132M	34	9	4	5	12	30	NW	1132M;34;9	4	Very High	A
27757	1132M	34	8	4	5	12	30	NW	1132M;34;8	4	Very High	A
27758	1132M	34	7	4	5	12	30	NW	1132M;34;7	4	Very High	A
27759	1132M	34	6	4	5	12	30	NW	1132M;34;6	4	Very High	A
27760	1132M	34	5	4	5	12	30	NW	1132M;34;5	4	Very High	A
27761	1132M	34	4	4	5	12	30	NW	1132M;34;4	4	Very High	A
27767	1132M	33	2	4	5	12	30	NW	1132M;33;2	4	Very High	A
27768	1110049	B		4	5	12	30	SW	1110049;B	4	Very High	A
27829	190AN	16	8	4	5	12	30	SW	190AN;16;8	4	Very High	A
27830	3076IA	E		4	5	12	30	SW	3076IA;E	4	Very High	A
27832	3204M			4	5	12	31	NW	3204M	2	Very High	B
27833	3204M	18	11	4	5	12	31	NW	3204M	2	Very High	B
27853	1132M	29	25	4	5	12	30	NW	1132M;29;25	4	High	A
27854	1132M	29	26	4	5	12	30	NW	1132M;29;26	4	High	A
27855	1132M	29	27	4	5	12	30	NW	1132M;29;27	4	High	A
27856	1132M	29	28	4	5	12	30	NW	1132M;29;28	4	High	A
27857	1132M	29	29	4	5	12	30	NW	1132M;29;29	4	Very High	A
27858	1132M	29	30	4	5	12	30	NW	1132M;29;30	4	High	A
27859	1132M	29	31	4	5	12	30	NW	1132M;29;31	4	High	A
27860	1132M	29	32	4	5	12	30	NW	1132M;29;32	4	High	A
27861	1132M	29	33	4	5	12	30	NW	1132M;29;33	4	Very High	A
27862	1132M	29	34	4	5	12	30	NW	1132M;29;34	4	Very High	A
27863	1132M	29	35	4	5	12	30	NW	1132M;29;35	4	Very High	A
27864	1132M	29	36	4	5	12	30	NW	1132M;29;36	4	Very High	A
27865	1132M	29	37	4	5	12	30	NW	1132M;29;37	4	Very High	A
27866	1132M	29	38	4	5	12	30	NW	1132M;29;38	4	Very High	A
27867	1132M	29	39	4	5	12	30	NW	1132M;29;39	4	Very High	A
27868	1132M	29	40	4	5	12	30	NW	1132M;29;40	4	Very High	A
27869	1132M	28	21	4	5	12	30	NW	1132M;28;21	4	Very High	A
27870	1132M	28	22	4	5	12	30	NW	1132M;28;22	4	Very High	A
27871	1132M	28	23	4	5	12	30	NW	1132M;28;23	4	High	A
27872	1132M	28	24	4	5	12	30	NW	1132M;28;24	4	High	A
27873	1132M	28	25	4	5	12	30	NW	1132M;28;25	4	High	A
27874	1132M	28	26	4	5	12	30	NW	1132M;28;26	4	High	A
27875	1132M	28	27	4	5	12	30	NW	1132M;28;27	4	High	A
27876	1132M	28	28	4	5	12	30	NW	1132M;28;28	4	High	A
27877	1132M	28	29	4	5	12	30	NW	1132M;28;29	4	Moderate	B
27878	1132M	28	30	4	5	12	30	NW	1132M;28;30	4	Moderate	B
27879	1132M	28	31	4	5	12	30	NW	1132M;28;31	4	High	A
27880	1132M	28	32	4	5	12	30	NW	1132M;28;32	4	High	A
27881	1132M	28	33	4	5	12	30	NW	1132M;28;33	4	High	A
27882	1132M	28	34	4	5	12	30	NW	1132M;28;34	4	High	A
27895	1132M	29	21	4	5	12	30	NW	1132M;29;21	4	High	A
27903	1132M	33	11	4	5	12	30	NW	1132M;33;11	4	Very High	A
27904	1132M	33	11	4	5	12	30	NW	1132M;33;11	4	Very High	A
27905	1132M	33	10	4	5	12	30	NW	1132M;33;10	4	Very High	A
27906	1132M	33	9	4	5	12	30	NW	1132M;33;9	4	Very High	A
27907	1132M	33	8	4	5	12	30	NW	1132M;33;8	4	Very High	A
27908	1132M	33	7	4	5	12	30	NW	1132M;33;7	4	Very High	A
27909	1132M	33	6	4	5	12	30	NW	1132M;33;6	4	Very High	A
27911	6164JK	R1		4	5	13	8	SE	6164JK;R1	3	Very High	A
27912	9911333	9	1ER	4	5	13	8	SE	9911333;9;1ER	3	Very High	A
27913		SE 1/4 SEC		4	5	13	8	SE	4;5;13;8;SE	4	Very High	A
27914	6164JK	B		4	5	13	8	SE	6164JK;B	2	High	B
27976	5792JK	A		4	6	12	34	SE	5792JK;A	4	Very High	A
28070	0910426	13	141ER	4	5	13	8	SE	0910426;13;141ER	3	Very High	A
28424	0911363	2	29ER	4	6	12	23	SE	0911363;2;29ER	4	High	A
28425	8110690	2	13	4	6	12	23	SE	8110690;2;13	3	Very High	A
28426	8110690	2	12	4	6	12	23	SE	8110690;2;12	2	Very High	B
28427	0911363	2	30	4	6	12	23	SE	0911363;2;30	2	Very High	B
28429	0912993	2	29	4	6	12	23	SE	0912993;2;29	2	Very High	B

FIGURES

Figure 1	Site Location Plan
Figure 2	Detailed Site Location Plan
Figure 3	Elevation Map
Figure 4	Bedrock Geology
Figure 5	Surficial Geology
Figure 6	Bedrock Topography
Figure 7	Mine Workings in the Medicine Hat Area
Figure 8	Previous Borehole Location Plan
Figure 9	2011 Borehole Location Plan
Figure 10	Slope Gradient and Top/Toe of Escarpment Map
Figure 11	Ancient, Historic, and Recent Landslide Locations
Figure 12	Areas of Landslide Activity
Figure 13	Areas with Active Landslide Activity
Figure 14	Landslide Size and Type
Figure 15	Terrain Hazard Map
Figure 16	Areas with Class 3 and 4 Terrain Hazards
Figure 17	Case Study Location Plan
Figure 18	Landslide Regression Plan – Cypress County TWP Rd 130 Slide
Figure 19	Cross-Section Location Plan
Figure 20	Lateral Migration and Stream Reaches
Figure 21	Geological Sectors
Figure 22	Geotechnical Setback Sectors for Interior Slopes

Figure 23 Geotechnical Setback Sectors for the South Saskatchewan River
Figure 24 Geotechnical Setback Sectors for Seven Persons Creek
Figure 25 Geotechnical Setback Sectors for Ross Creek
Figure 26 Setback Lines for Top/Toe of Escarpment
Figure 27 Properties at Risk – Top and Toe of Escarpment



LEGEND

- Site Location
- City
- Major Road

NOTES
Base data source:
ESRI Data and Maps

STATUS
ISSUED FOR USE

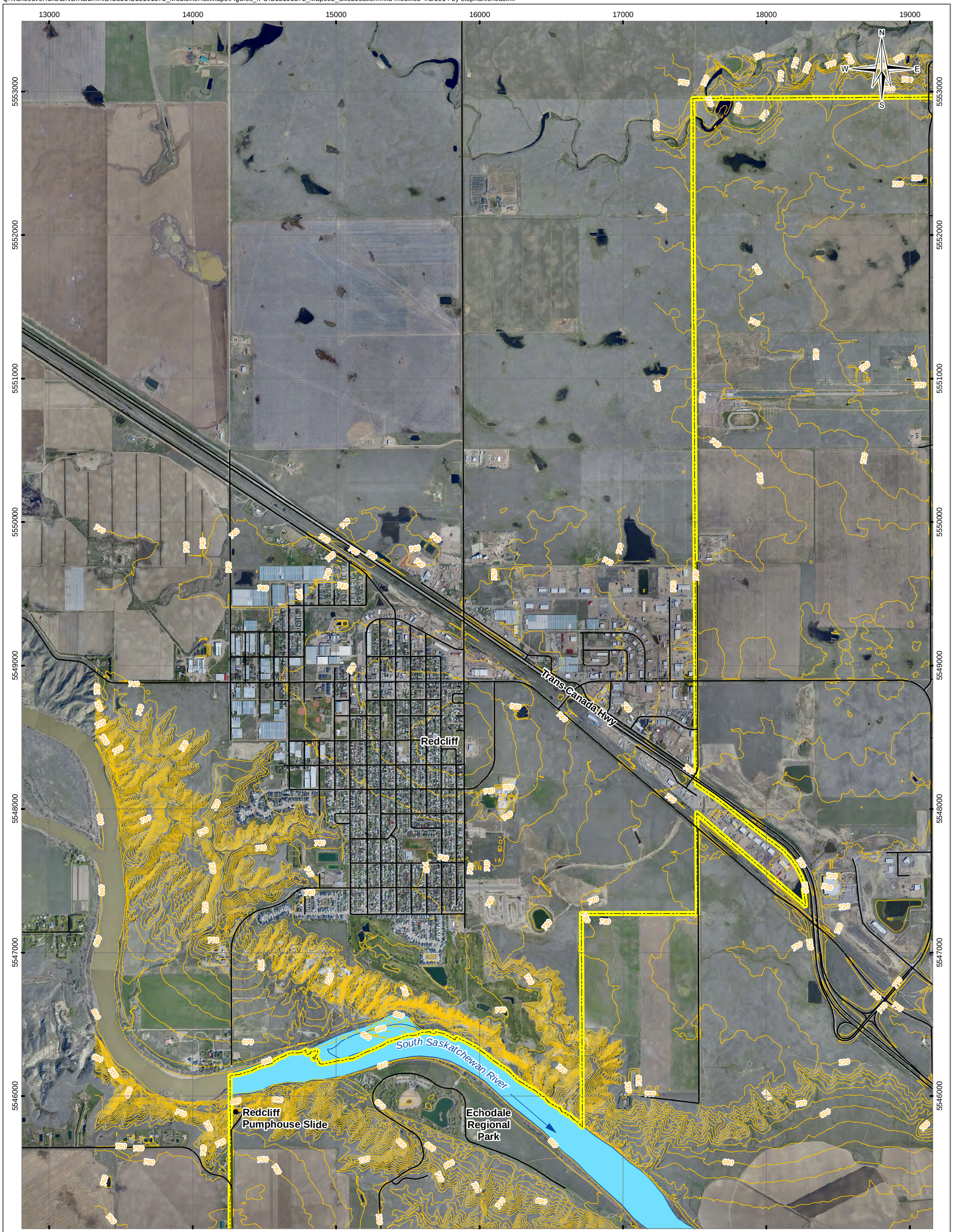
MEDICINE HAT SLOPE SETBACKS

Site Location Plan

PROJECTION UTM Zone 12		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:7,000,000 100 50 0 100 Kilometres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map001_Overview.mxd				
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** MG	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 1**

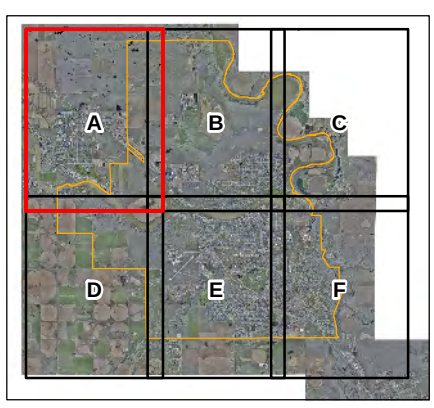
Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map001_Overview.mxd modified 4/3/2014 by stephanie.leusink

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map002_SiteLocation.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

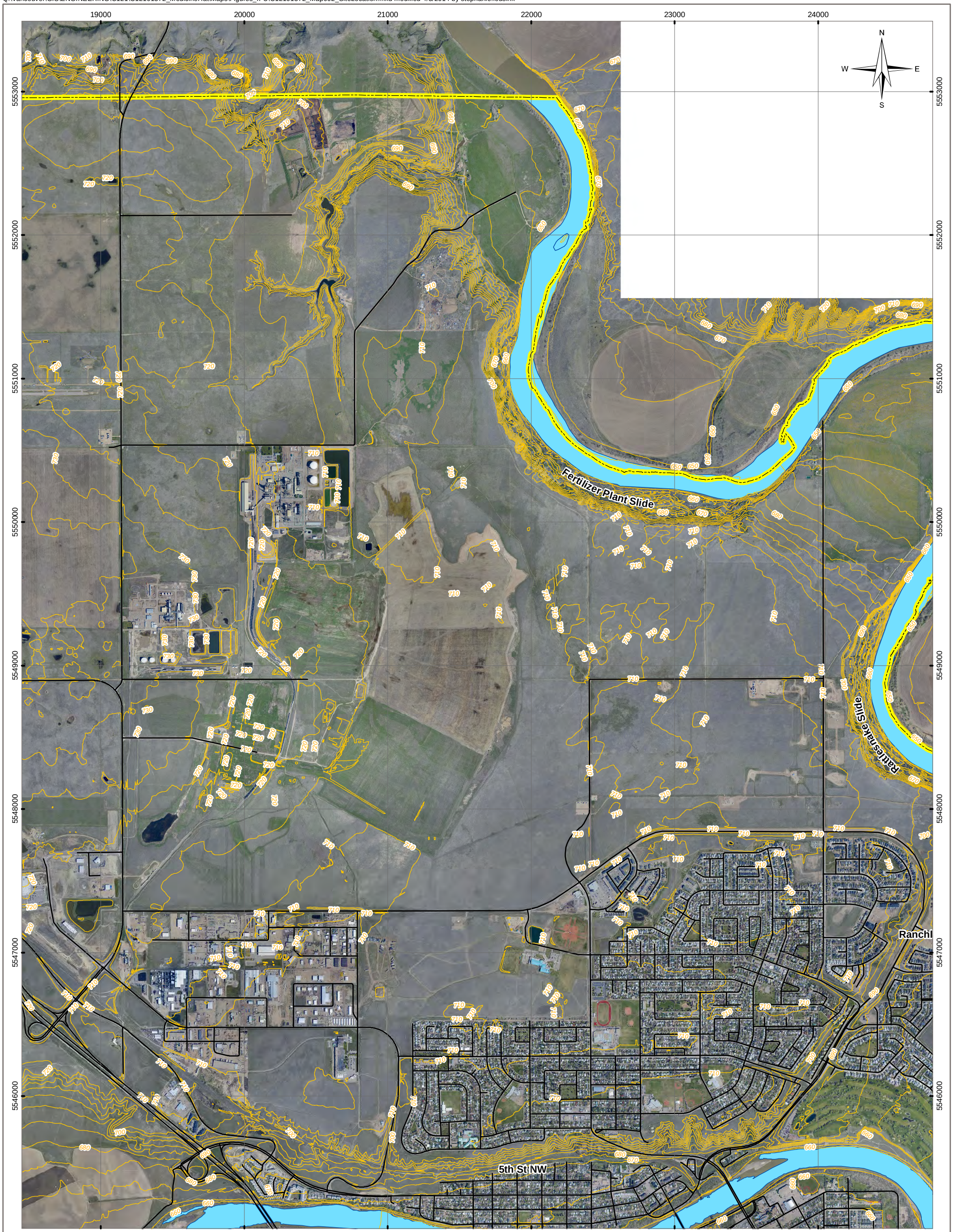
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Detailed Site Location Plan

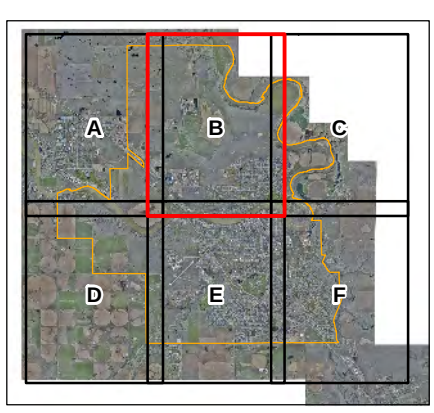
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map002_SiteLocation.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 2A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map002_SiteLocation.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Detailed Site Location Plan

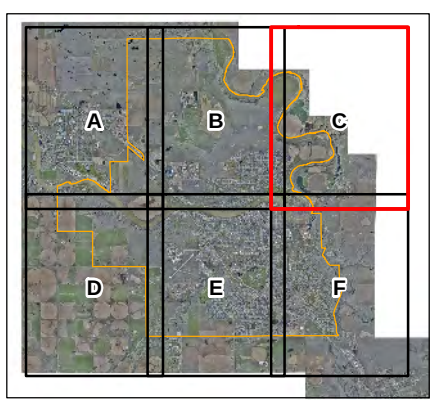
PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map002_SiteLocation.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 2B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map002_SiteLocation.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

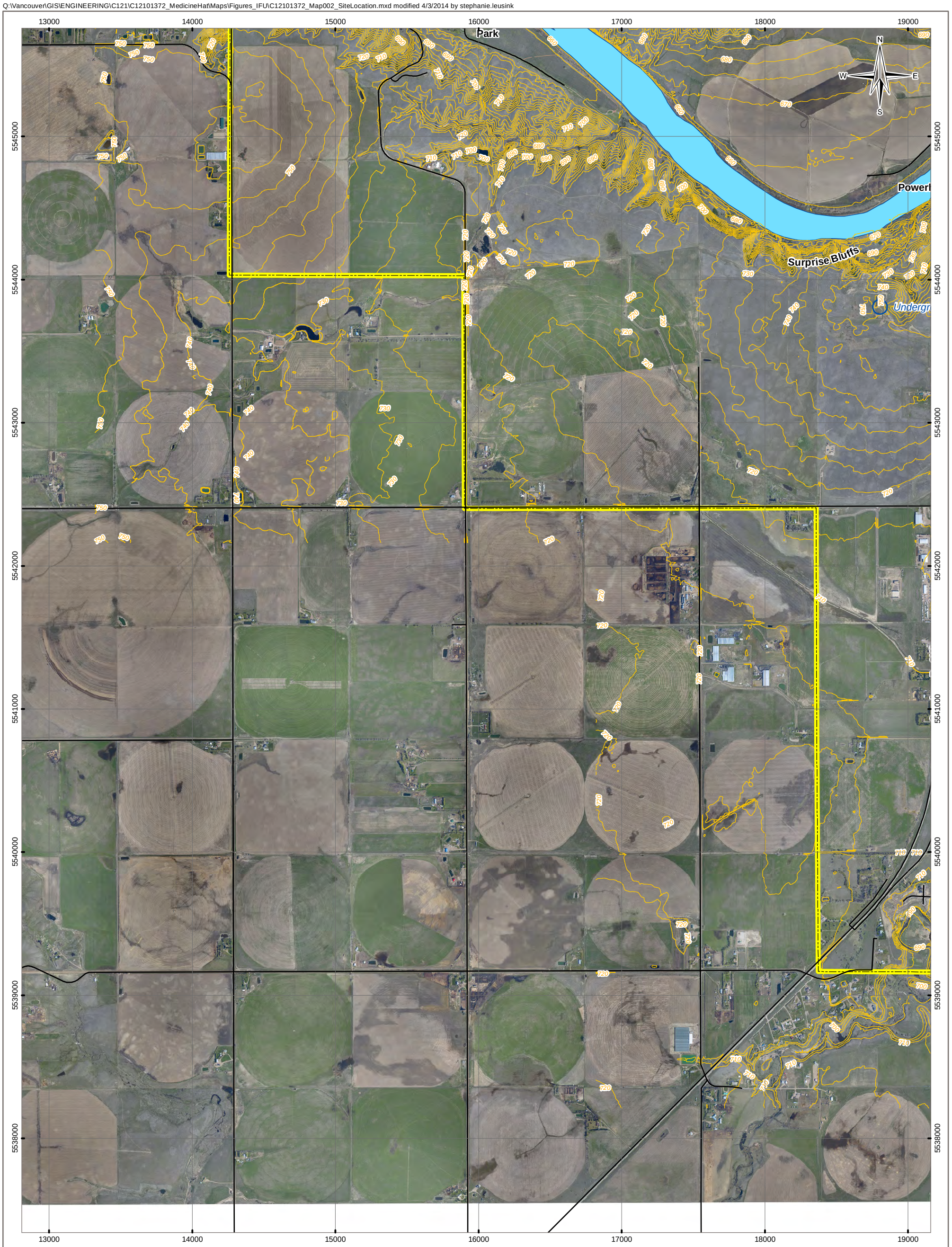
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Detailed Site Location Plan

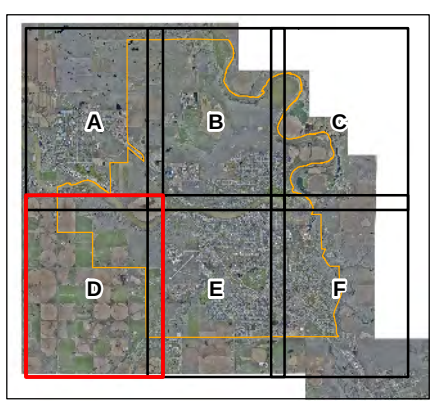
PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres			
FILE NO. C12101372_Map002_SiteLocation.mxd			A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ / **CKD** SL / **APVD** SH / **REV** 0		**Figure 2C**
OFFICE EBA-VANC	**DATE** April 3, 2014		

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map002_SiteLocation.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Detailed Site Location Plan

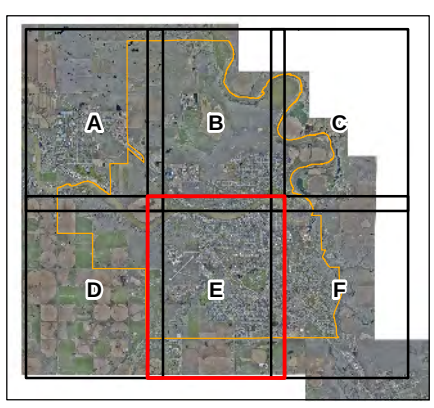
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map002_SiteLocation.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 2D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map002_SiteLocation.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

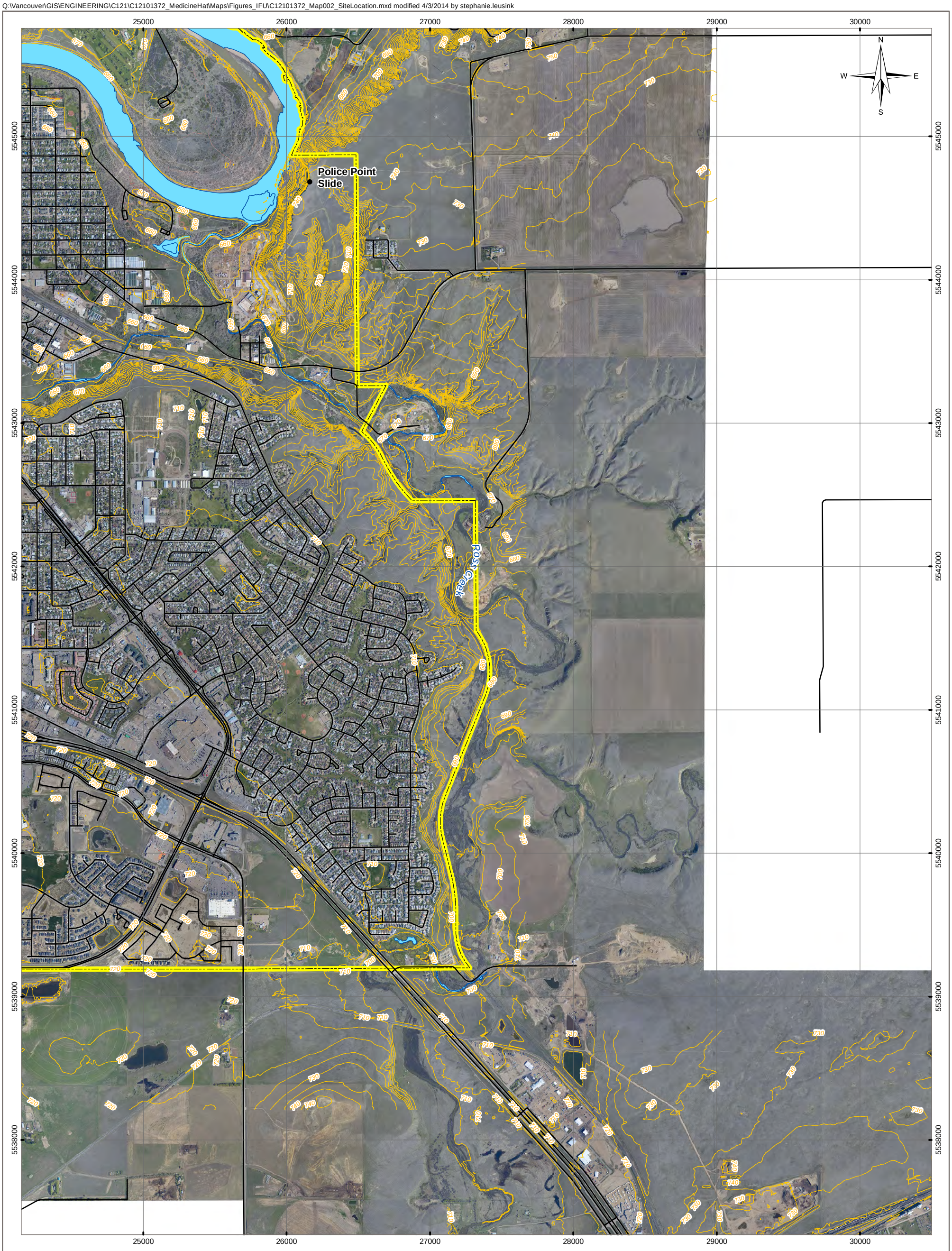
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Detailed Site Location Plan

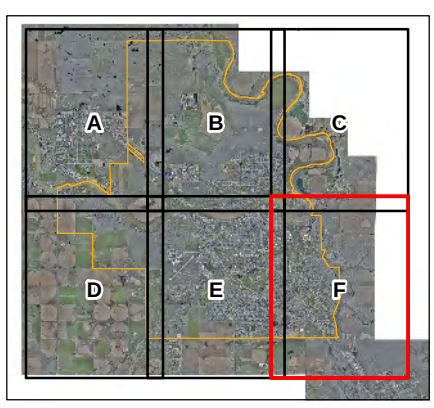
PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map002_SiteLocation.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 2E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map002_SiteLocation.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Detailed Site Location Plan

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map002_SiteLocation.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 2F**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map003_Elevation.mxd modified 4/3/2014 by stephanie.leusink

13000 14000 15000 16000 17000 18000 19000

5553000 5552000 5551000 5550000 5549000 5548000 5547000 5546000

N W E S

Trans-Canada Hwy

Redcliff

South Saskatchewan River

Redcliff Pumphouse Slide

Echodale Regional Park

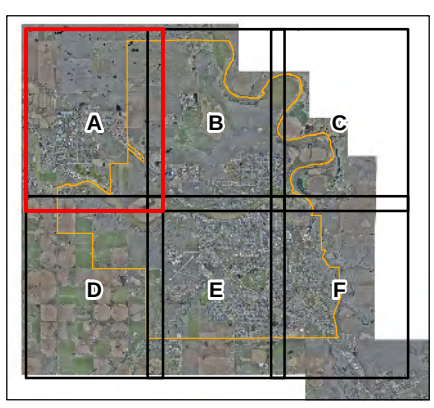
LEGEND

Elevation (m)

- 271 - 665
- 665 - 700
- 700 - 710
- 710 - 714
- 714 - 719
- 719 - 727
- 727 - 738
- 738 - 765

- Road
- City Boundary
- River / Creek

NOTES
Base data source: City of Medicine Hat



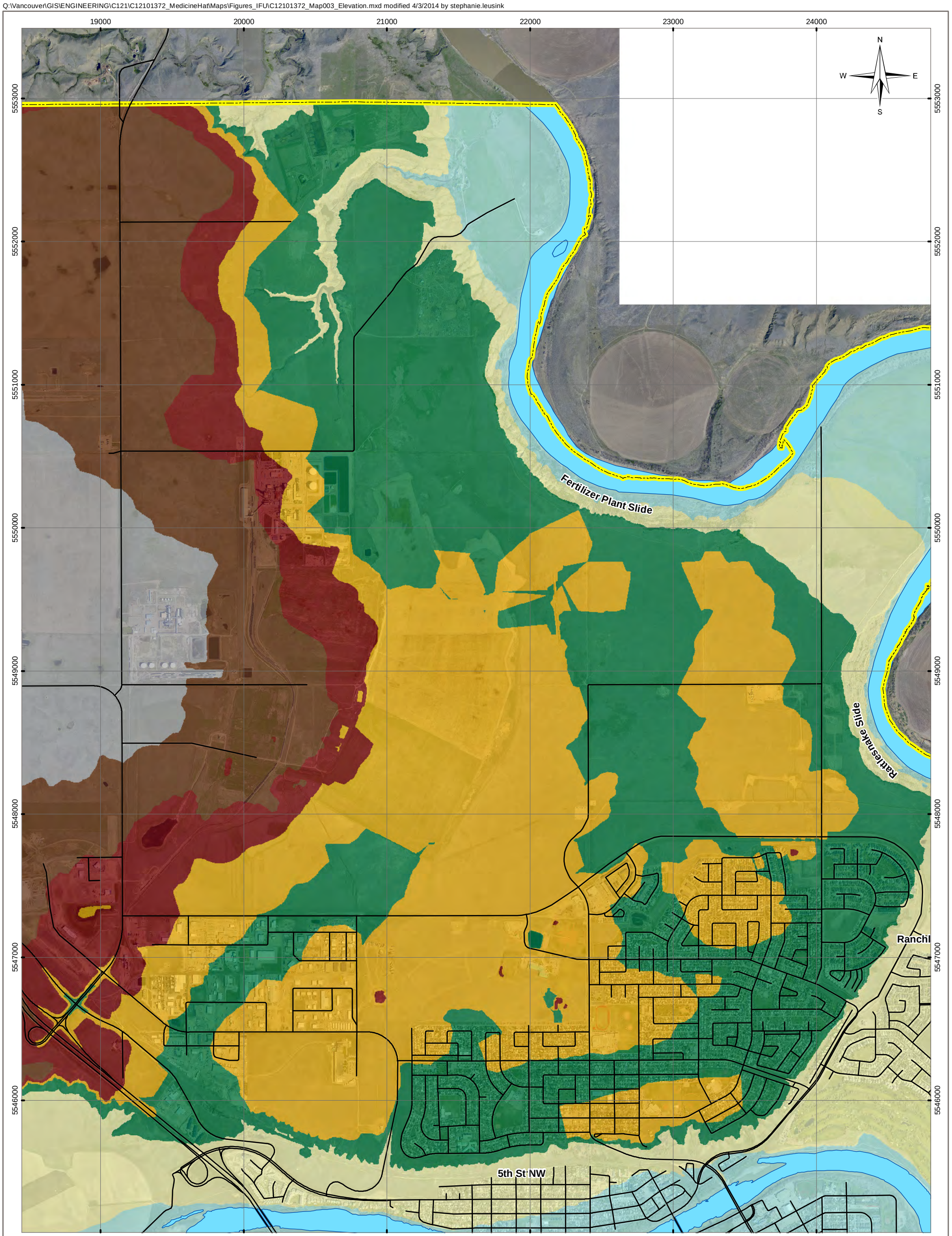
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Elevation Map

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map003_Elevation.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 3A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map003_Elevation.mxd modified 4/3/2014 by stephanie.leusink



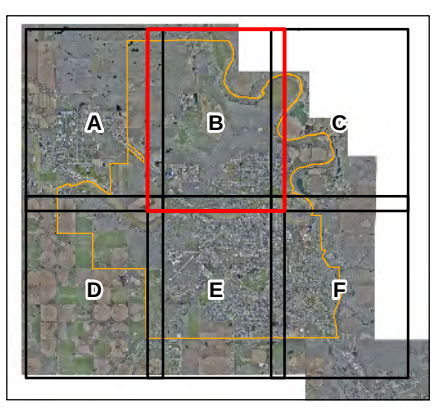
LEGEND

Elevation (m)

- 271 - 665
- 665 - 700
- 700 - 710
- 710 - 714
- 714 - 719
- 719 - 727
- 727 - 738
- 738 - 765

- Road
- City Boundary
- River / Creek

NOTES
Base data source: City of Medicine Hat



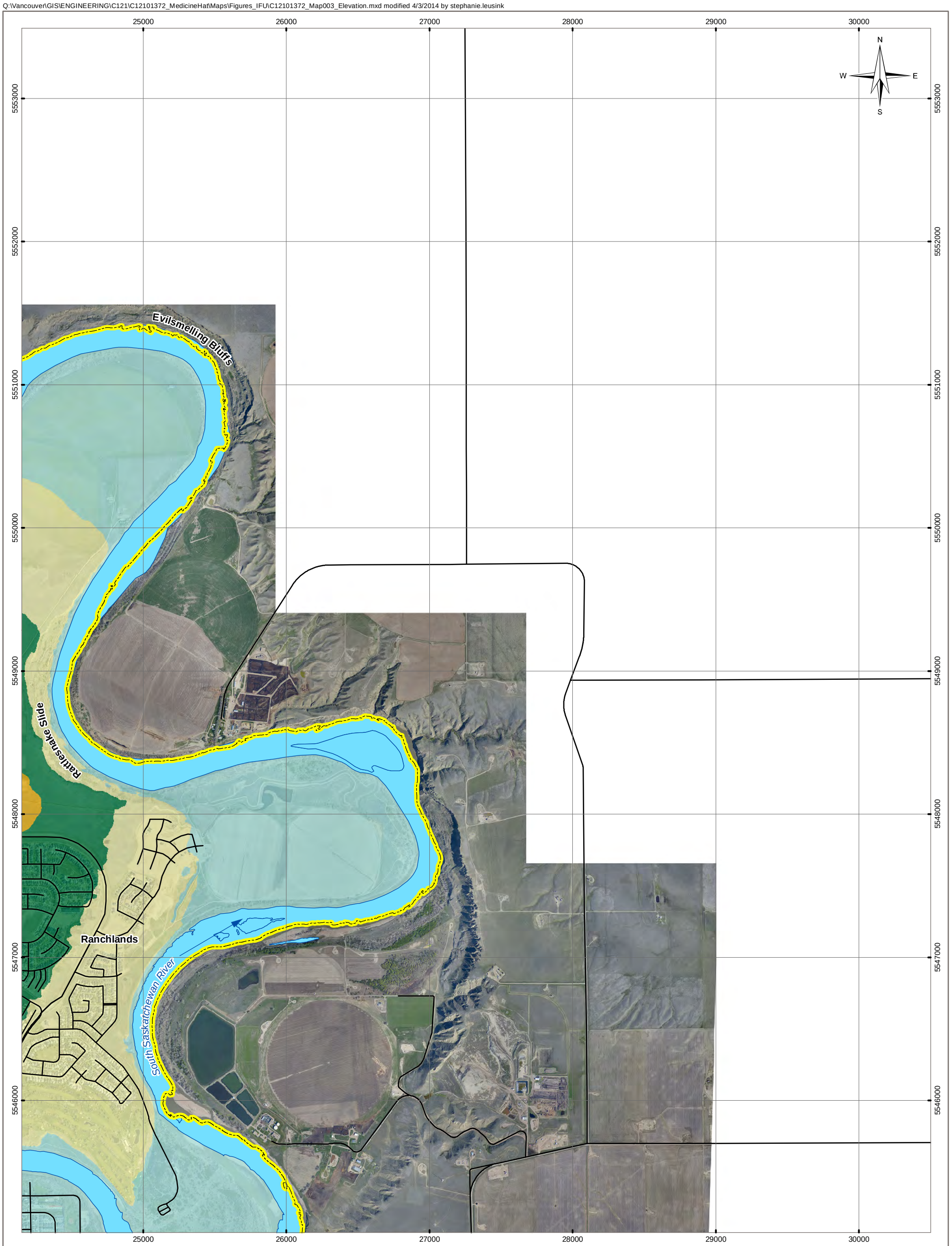
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Elevation Map

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map003_Elevation.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 3B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map003_Elevation.mxd modified 4/3/2014 by stephanie.leusink



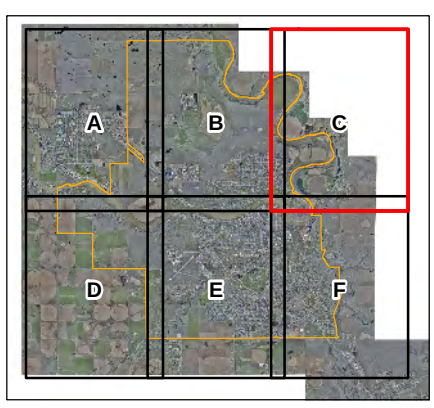
LEGEND

Elevation (m)

- 271 - 665
- 665 - 700
- 700 - 710
- 710 - 714
- 714 - 719
- 719 - 727
- 727 - 738
- 738 - 765

- Road
- City Boundary
- River / Creek

NOTES
Base data source: City of Medicine Hat



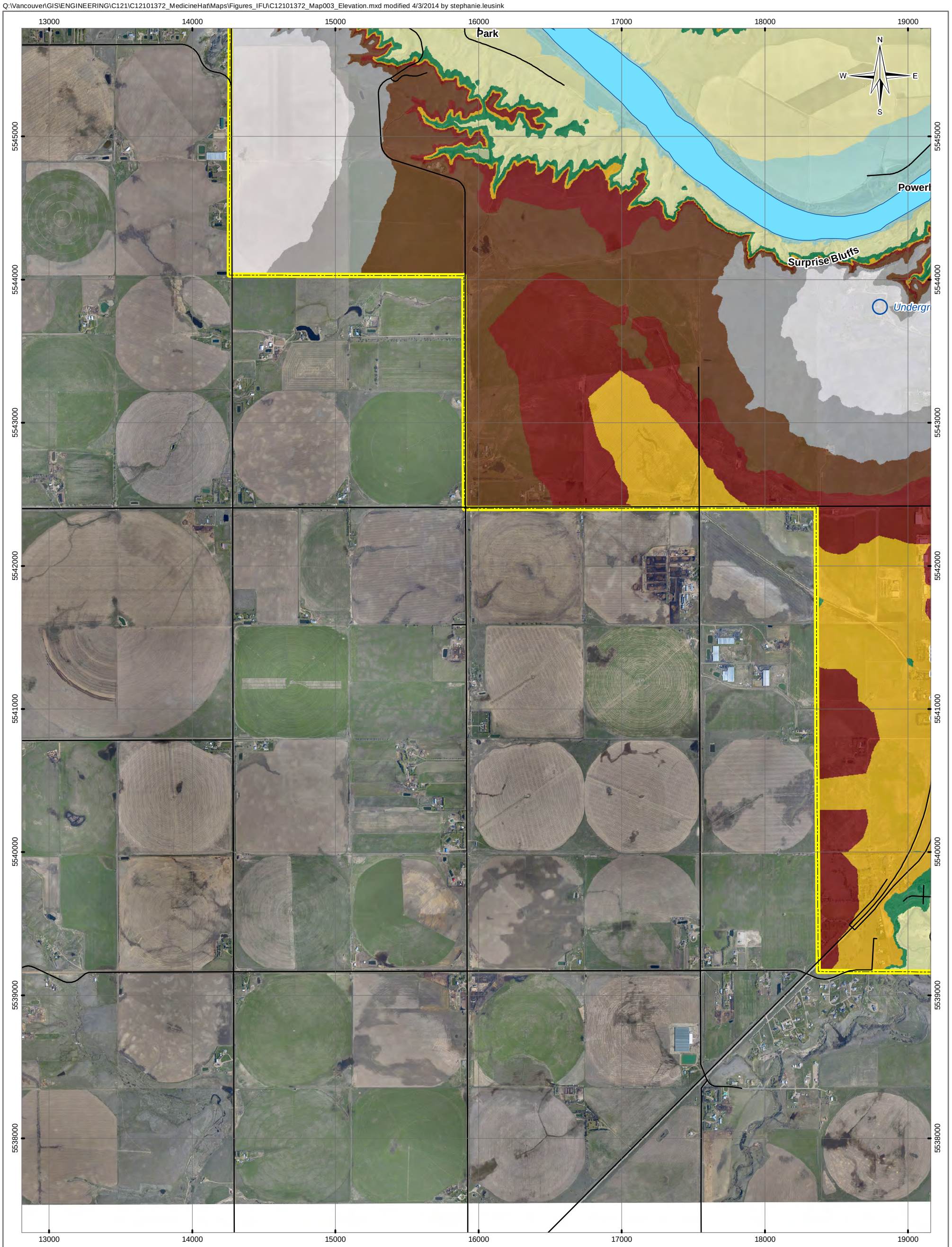
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Elevation Map

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Map003_Elevation.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 3C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map003_Elevation.mxd modified 4/3/2014 by stephanie.leusink

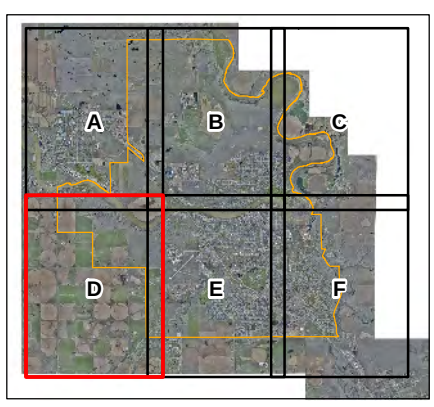


LEGEND

Elevation (m)

- 271 - 665
- 665 - 700
- 700 - 710
- 710 - 714
- 714 - 719
- 719 - 727
- 727 - 738
- 738 - 765

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

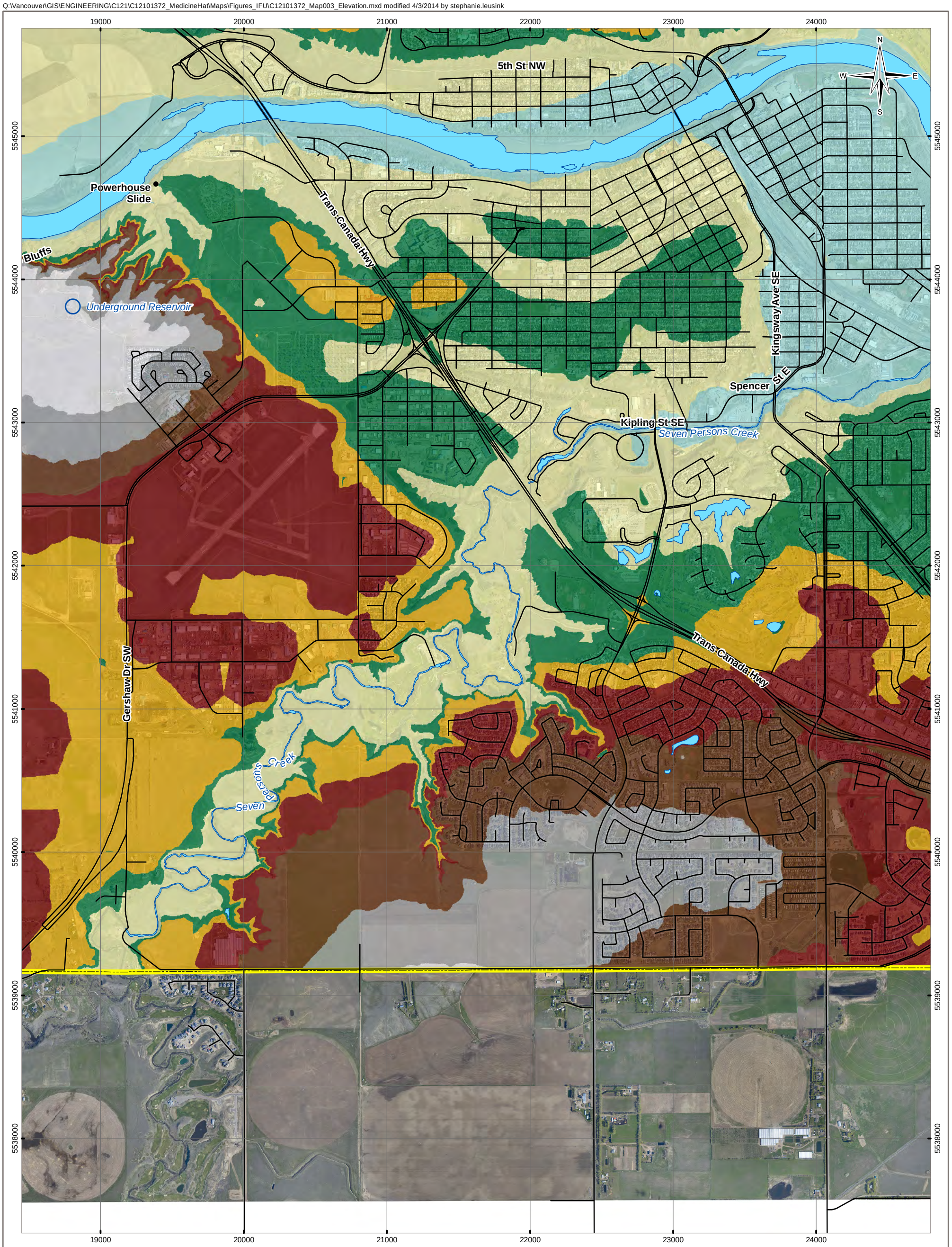
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Elevation Map

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map003_Elevation.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 3D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map003_Elevation.mxd modified 4/3/2014 by stephanie.leusink

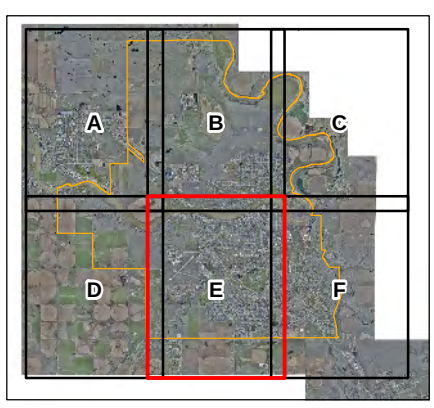


LEGEND

Elevation (m)

- 271 - 665
- 665 - 700
- 700 - 710
- 710 - 714
- 714 - 719
- 719 - 727
- 727 - 738
- 738 - 765

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

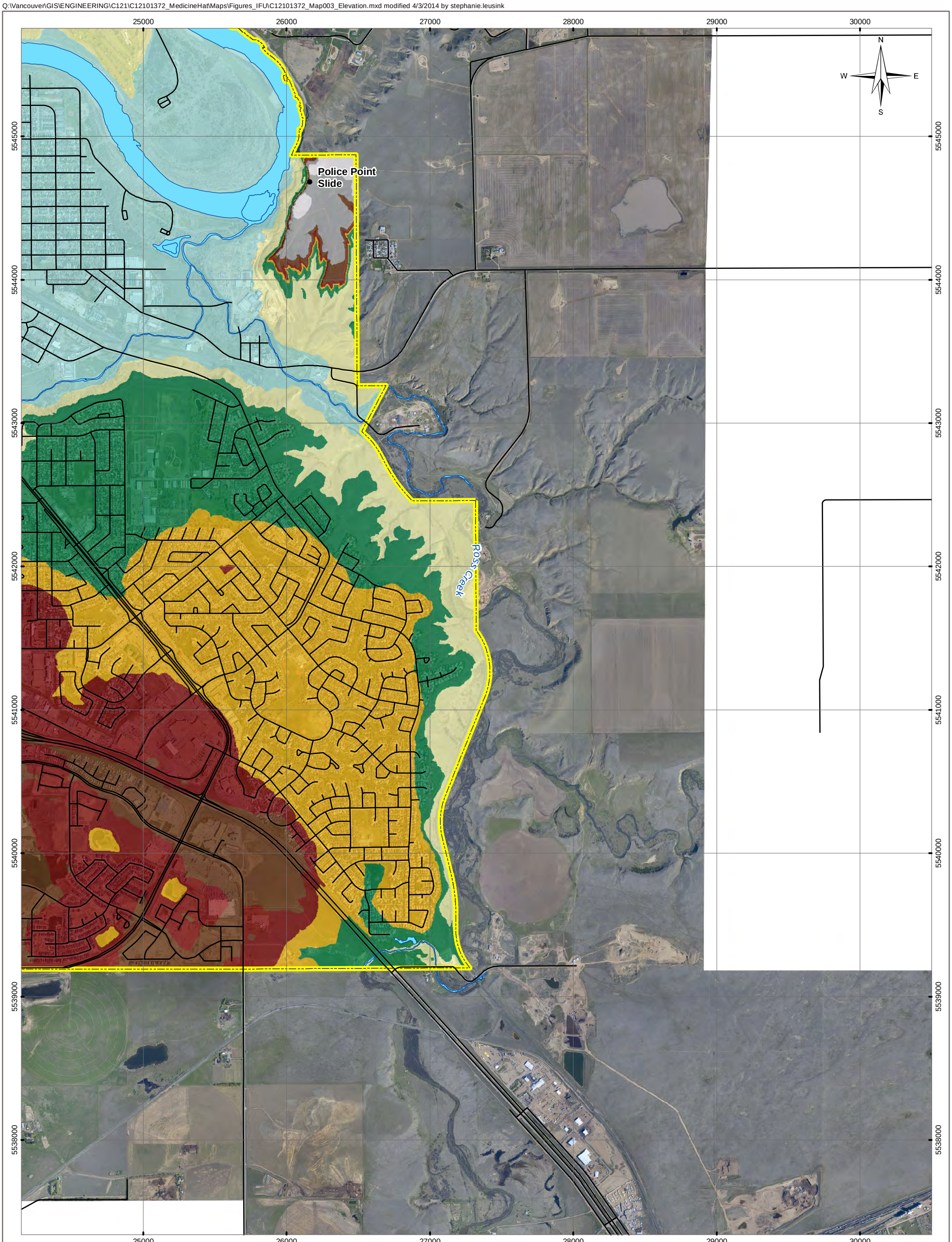
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Elevation Map

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map003_Elevation.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 3E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map003_Elevation.mxd modified 4/3/2014 by stephanie.leusink

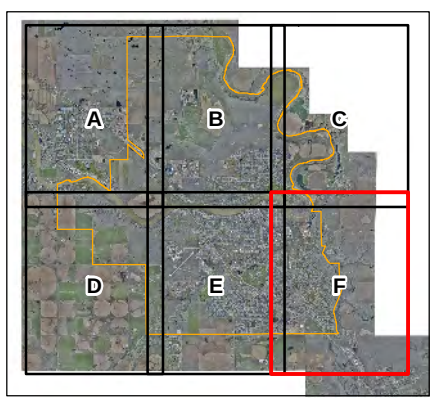


LEGEND

Elevation (m)

- 271 - 665
- 665 - 700
- 700 - 710
- 710 - 714
- 714 - 719
- 719 - 727
- 727 - 738
- 738 - 765

- Road
- City Boundary
- River / Creek



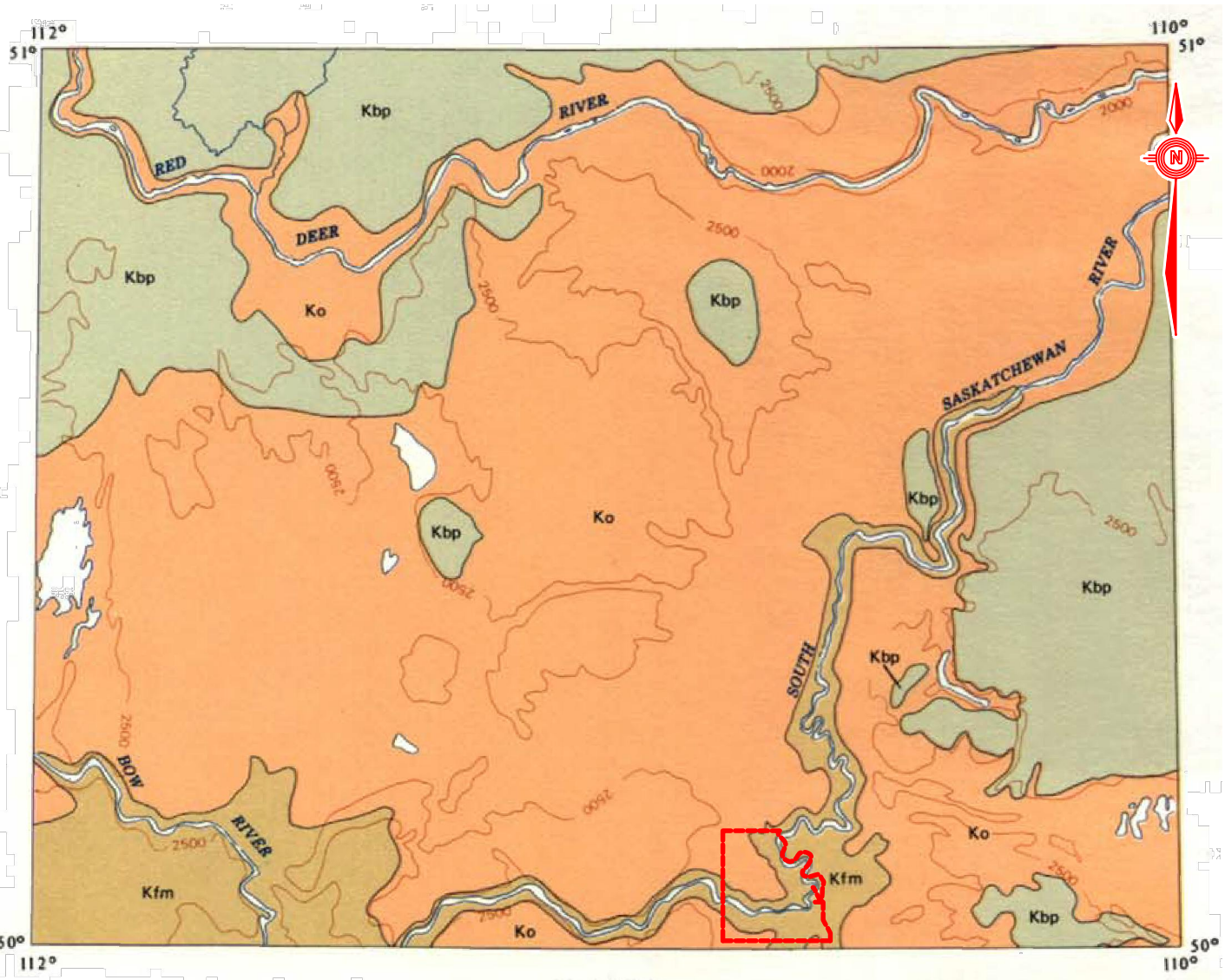
NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Elevation Map

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map003_Elevation.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 3F**



LEGEND

CRETACEOUS

Kbp — Bearpaw Formation: *dark grey bentonitic shale, silty shale, and argillaceous sandstone; thin concretionary ironstone and bentonite beds; marine*

Ko — Oldman Formation: *thick, crossbedded, pale grey sandstone, siltstone, and shale with concretionary ironstone beds; Lethbridge coal member near top; nonmarine*

Kfm — Foremost Formation: *pale grey sandstone, siltstone, and shale; thin coal seams and concretionary ironstone beds; nonmarine*

Geological boundary

Surface contour (contour interval 500 feet) 2500

STATUS
ISSUED FOR REVIEW

NOTES
BASE MAP FROM "SURFICIAL GEOLOGY, MEDICINE HAT, NTS 72L" PUBLISHED BY THE RESEARCH COUNCIL OF ALBERTA

STUDY AREA BOUNDARY

0 500

Scale: 1: 10 000 (metres)

CLIENT
CITY OF MEDICINE HAT

A TETRA TECH COMPANY

MEDICINE HAT SLOPE SETBACKS
MEDICINE HAT, ALBERTA

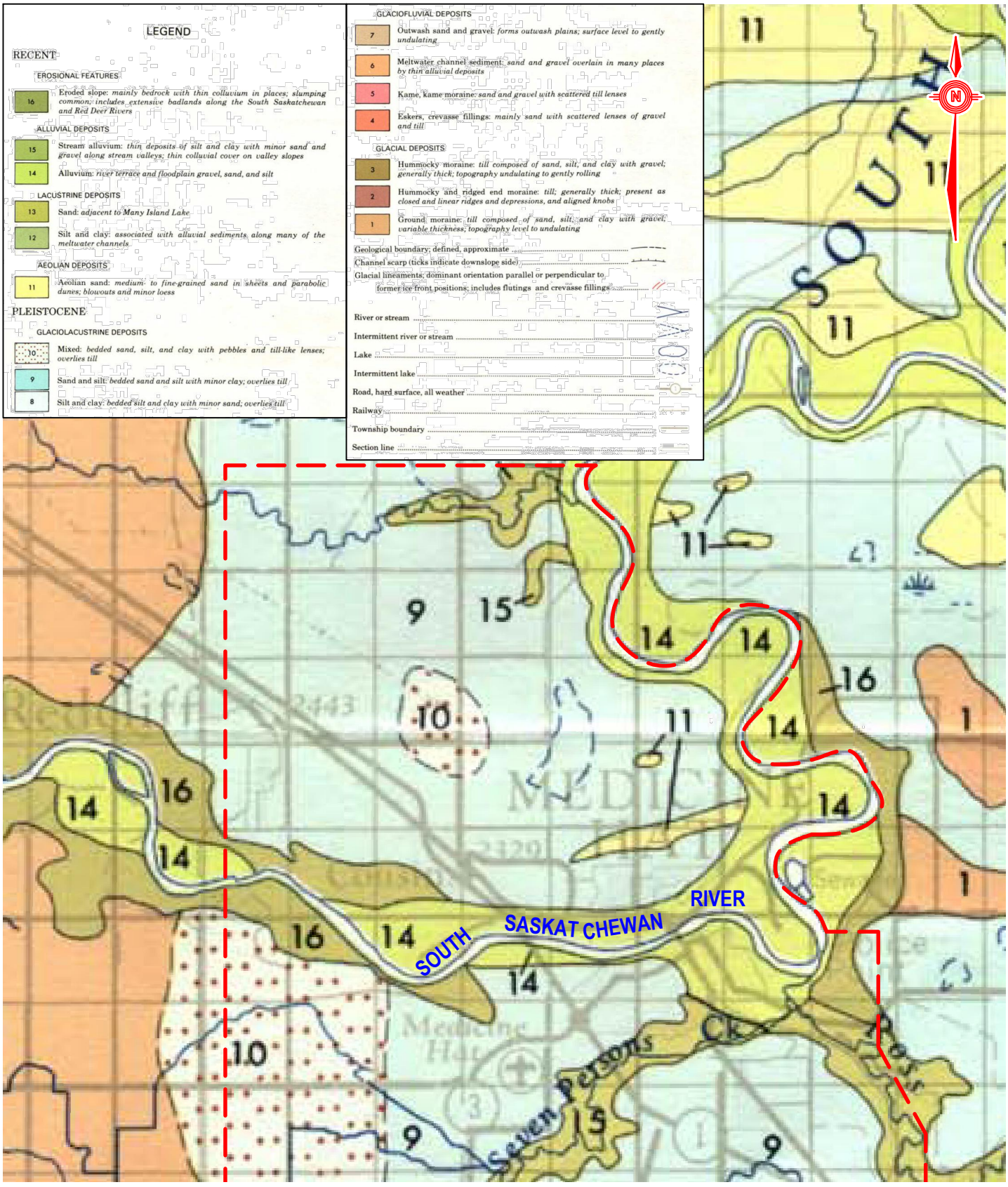
BEDROCK GEOLOGY

PROJECT NO.	DWN	CKD	REV
C12101372	DT	SH	1

OFFICE: NAN
DATE: January 12, 2012

Figure 4

Q:\Nanaimo\Environmental\N2311\Projects\2006 - Present\C12101372\Drafting\C12101372_FIG_4-5_R0.dwg [FIGURE 4] January 12, 2012 - 2:40:37 pm (BY: THOMAS, DARREN)



STATUS
ISSUED FOR REVIEW

NOTES
BASE MAP FROM "SURFICIAL GEOLOGY, MEDICINE HAT, NTS 72L" PUBLISHED BY THE RESEARCH COUNCIL OF ALBERTA

STUDY AREA BOUNDARY

0 5 000
Scale: 1: 100 000 (metres)

CLIENT
CITY OF MEDICINE HAT

eba
A TETRA TECH COMPANY

MEDICINE HAT SLOPE SETBACKS
MEDICINE HAT, ALBERTA

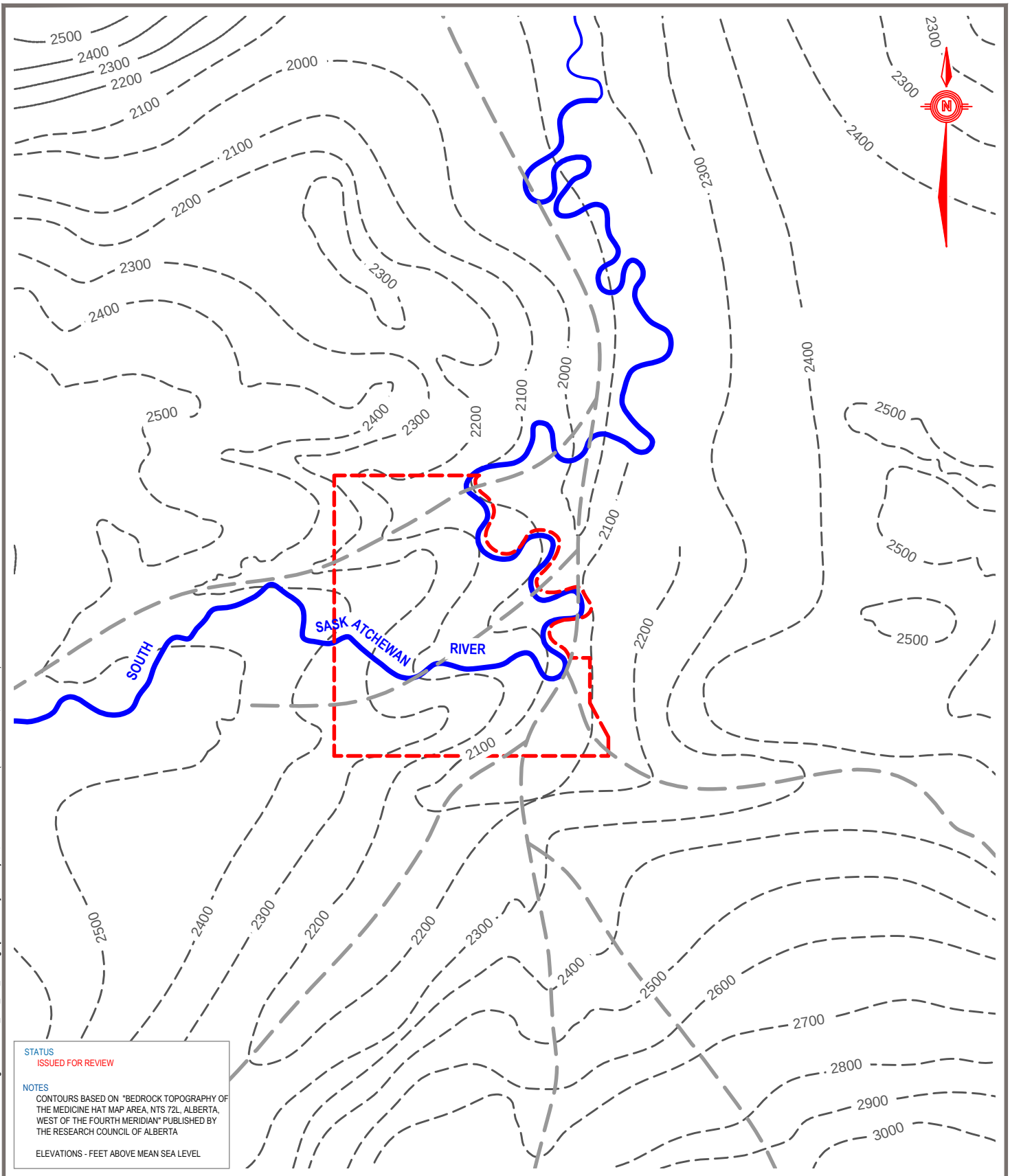
SURFICIAL GEOLOGY

PROJECT NO.	DWN	CKD	REV
C12101372	DT	SH	0

OFFICE	DATE
NAN	January 11, 2012

Figure 5

Q:\Nanaimo\Environmental\N2311\Projects\2006 - Present\C12101372\Drafting\C12101372_FIG_4-6_R1.dwg [FIGURE 5] January 16, 2012 - 9:01:36 am (BY: THOMAS, DARREN)



STATUS
ISSUED FOR REVIEW

NOTES
CONTOURS BASED ON "BEDROCK TOPOGRAPHY OF THE MEDICINE HAT MAP AREA, NTS 72L, ALBERTA, WEST OF THE FOURTH MERIDIAN" PUBLISHED BY THE RESEARCH COUNCIL OF ALBERTA

ELEVATIONS - FEET ABOVE MEAN SEA LEVEL

LEGEND:

STUDY AREA BOUNDARY

BEDROCK CONTOURS - APPROXIMATE

THALWEG OF PREGLACIAL MEDICINE HAT VALLEY

0 100

Scale: 1: 2 500 (metres)

CLIENT

CITY OF MEDICINE HAT

MEDICINE HAT SLOPE SETBACKS
MEDICINE HAT, ALBERTA

BEDROCK TOPOGRAPHY

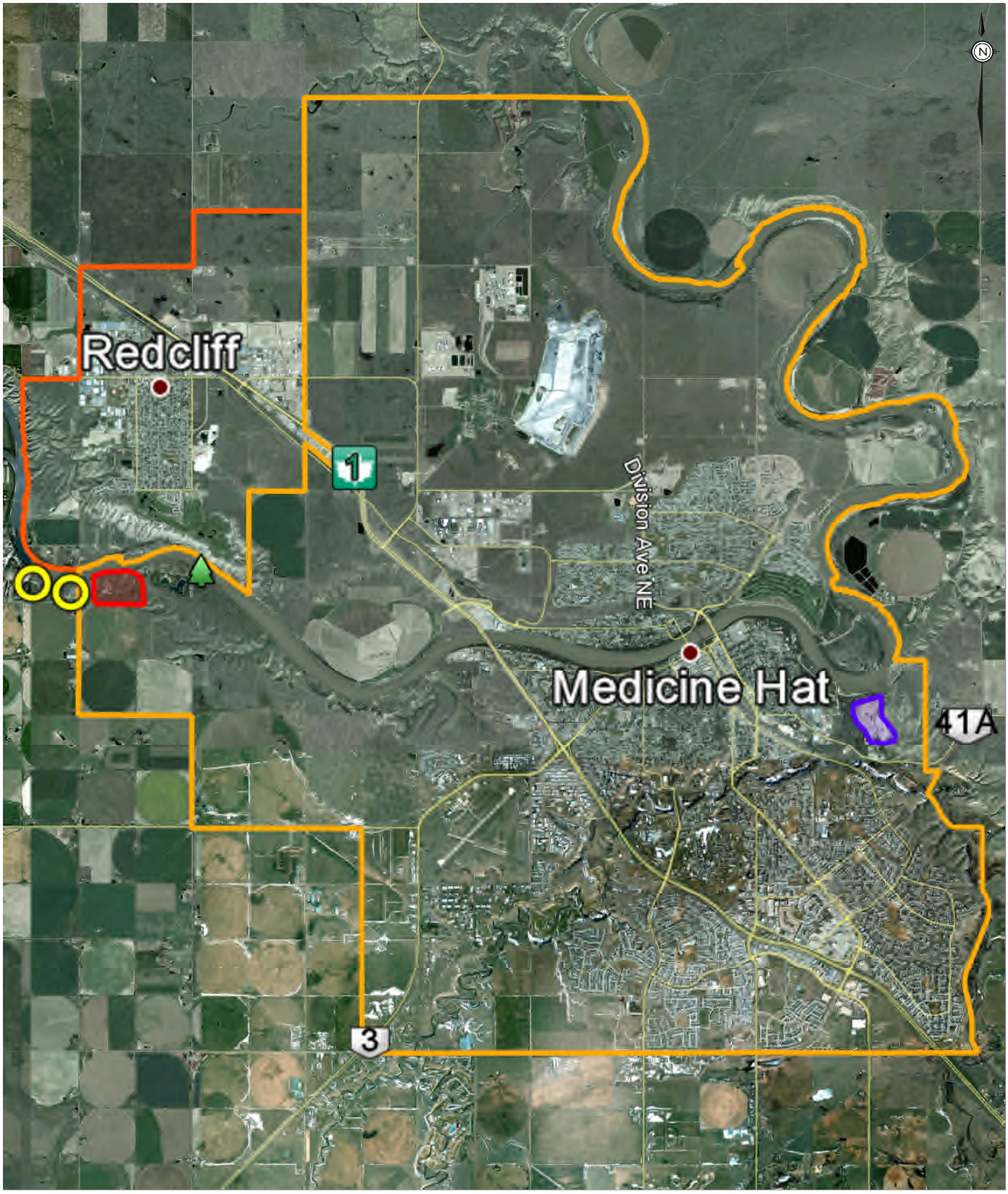
PROJECT NO.	DWN	CKD	REV
C12101372	DT	SH	1

OFFICE	DATE
NAN	January 12, 2012

Figure 6

A TETRA TECH COMPANY

Q:\Nanaimo\Environmental\N231\Projects\2006 - Present\C12101372\Drafting\C12101372_FIG_4-6_R1.dwg [FIGURE 6] January 16, 2012 - 9:01:22 am (BY: THOMAS, DARREN)



LEGEND

- Sinkholes Observed in 2011
- Open Pit Clay Mine
- Underground Coal Mine Workings
- Medicine Hat City Limits
- Redcliff City Limits
- Echodale Regional Park

NOTES
2010 Image from Google Earth Pro.

STATUS
ISSUED FOR USE

CLIENT
CITY OF MEDICINE HAT

A TETRA TECH COMPANY

MEDICINE HAT SLOPE SETBACKS

MINE WORKINGS IN THE MEDICINE HAT AREA

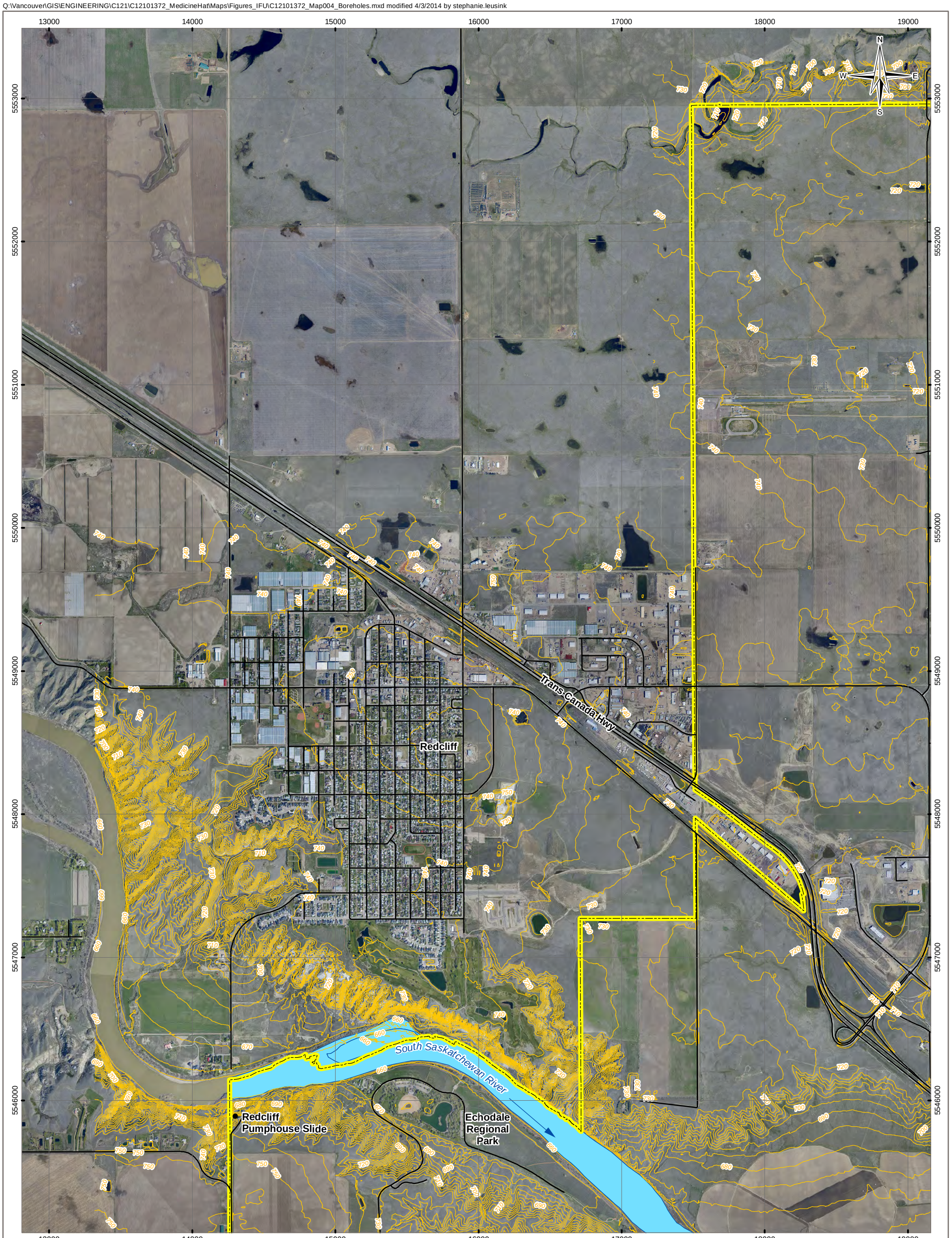
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	RG	SH	SH	1

OFFICE	DATE
EBA-NAN	April 3, 2014

Figure 7

C:\Users\becky.wohlgemuth\Desktop\C12101372 Figures\C12101372 Figure 7.doc

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map004_Boreholes.mxd modified 4/3/2014 by stephanie.leusink



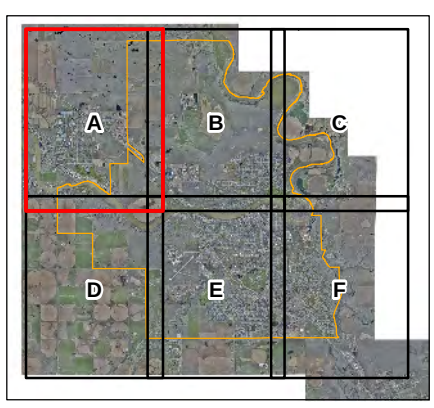
LEGEND

Borehole Location by Consultant

- AEE
- AMEC
- Agra
- EBA
- EGT
- Golder
- PGE
- Thurber
- UMA

- Road
- City Boundary
- Contour (5 m)
- River / Creek

NOTES
Base data source: City of Medicine Hat



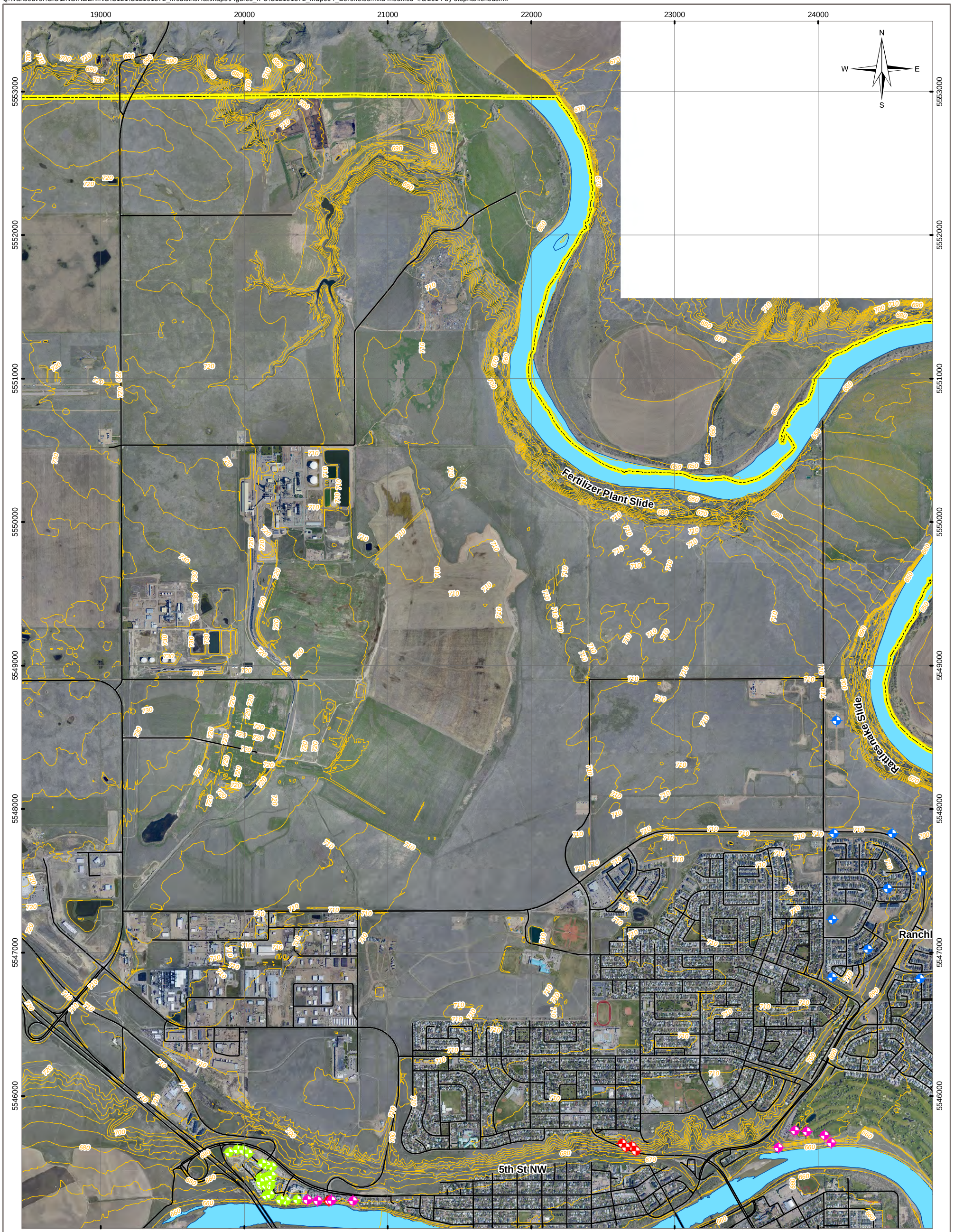
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Previous Borehole Location Plan

PROJECTION: UTM Zone 12 (3TM)			DATUM: NAD83	CLIENT: City of Medicine Hat
Scale: 1:25,000 (500 250 0 500 Metres)				
FILE NO.: C12101372_Map004_Boreholes.mxd				A TETRA TECH COMPANY
PROJECT NO.: C12101372	DWN: MEZ	CKD: SL	APVD: SH	REV: 0
OFFICE: EBA-VANC	DATE: April 3, 2014			Figure 8A

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map004_Boreholes.mxd modified 4/3/2014 by stephanie.leusink

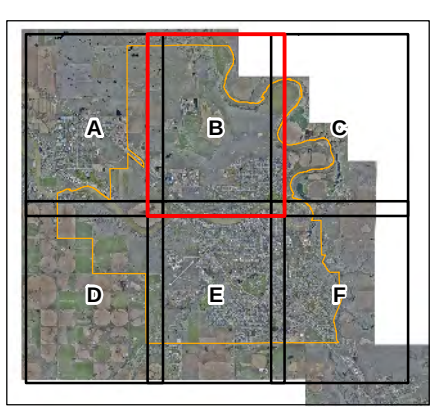


LEGEND

Borehole Location by Consultant

- AEE
- AMEC
- Agra
- EBA
- EGT
- Golder
- PGE
- Thurber
- UMA

- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Previous Borehole Location Plan

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map004_Boreholes.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 8B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map004_Boreholes.mxd modified 4/3/2014 by stephanie.leusink

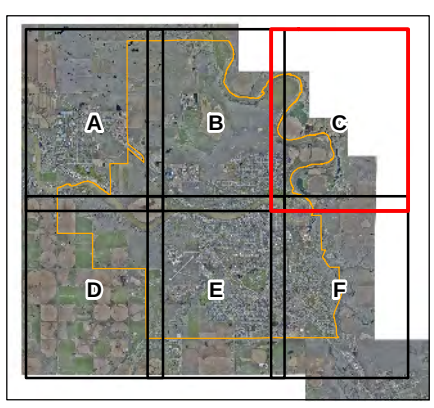


LEGEND

Borehole Location by Consultant

- AEE
- AMEC
- Agra
- EBA
- EGT
- Golder
- PGE
- Thurber
- UMA

- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

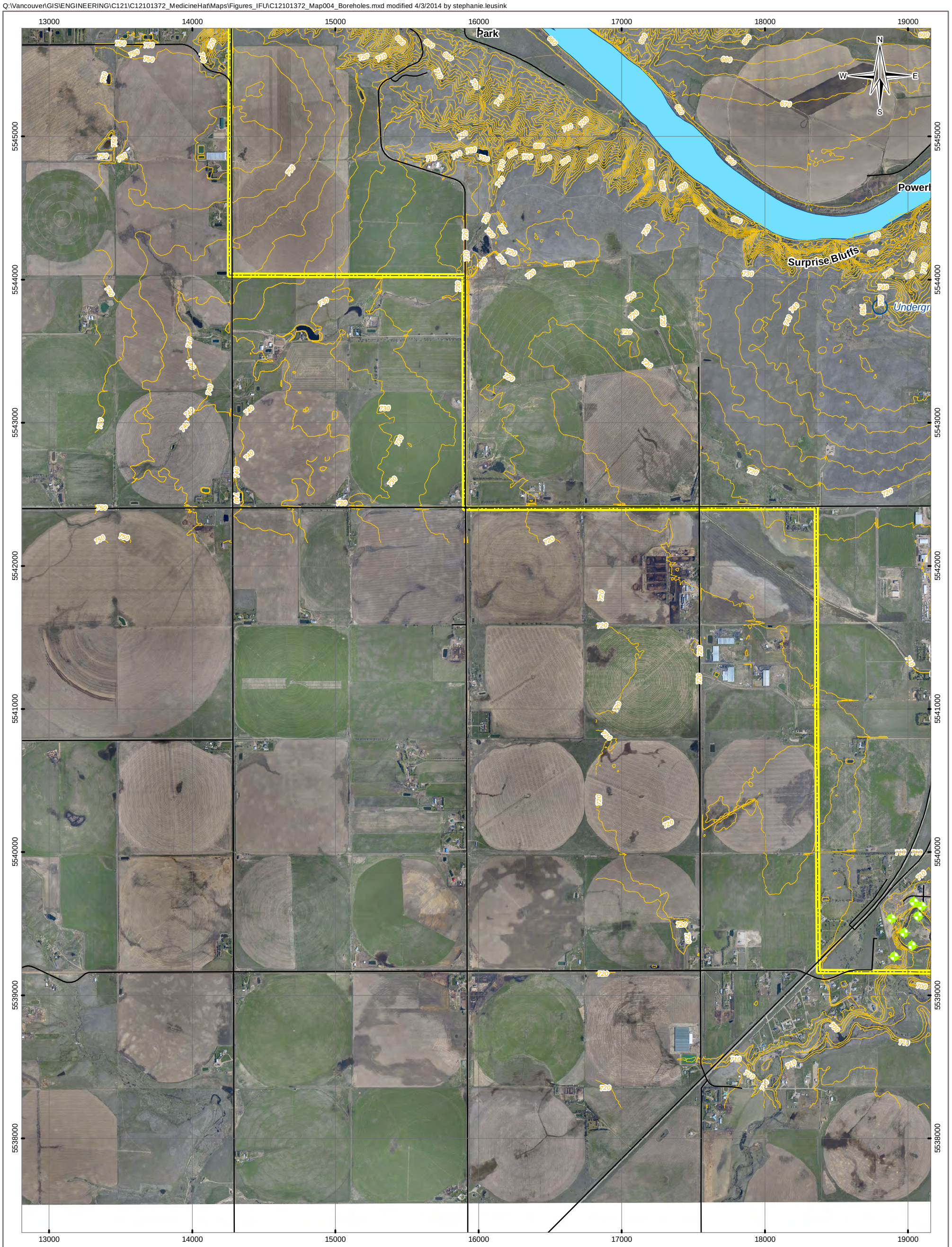
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Previous Borehole Location Plan

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres			
FILE NO. C12101372_Map004_Boreholes.mxd			A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ / **CKD** SL / **APVD** SH / **REV** 0		**Figure 8C**
OFFICE EBA-VANC	**DATE** April 3, 2014		

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map004_Boreholes.mxd modified 4/3/2014 by stephanie.leusink



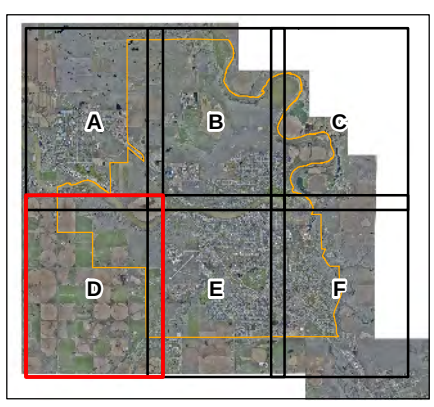
LEGEND

Borehole Location by Consultant

- AEE
- AMEC
- Agra
- EBA
- EGT
- Golder
- PGE
- Thurber
- UMA

- Road
- City Boundary
- Contour (5 m)
- River / Creek

NOTES
Base data source: City of Medicine Hat



STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Previous Borehole Location Plan

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map004_Boreholes.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 8D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map004_Boreholes.mxd modified 4/3/2014 by stephanie.leusink



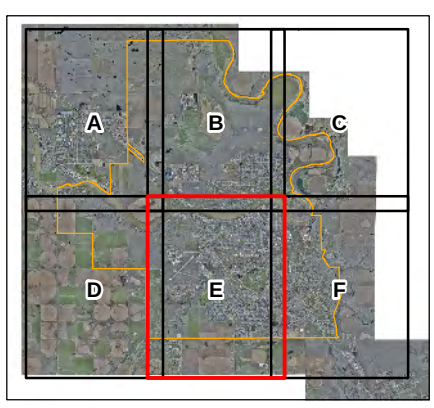
LEGEND

Borehole Location by Consultant

- AEE
- AMEC
- Agra
- EBA
- EGT
- Golder
- PGE
- Thurber
- UMA

- Road
- City Boundary
- Contour (5 m)
- River / Creek

NOTES
Base data source: City of Medicine Hat



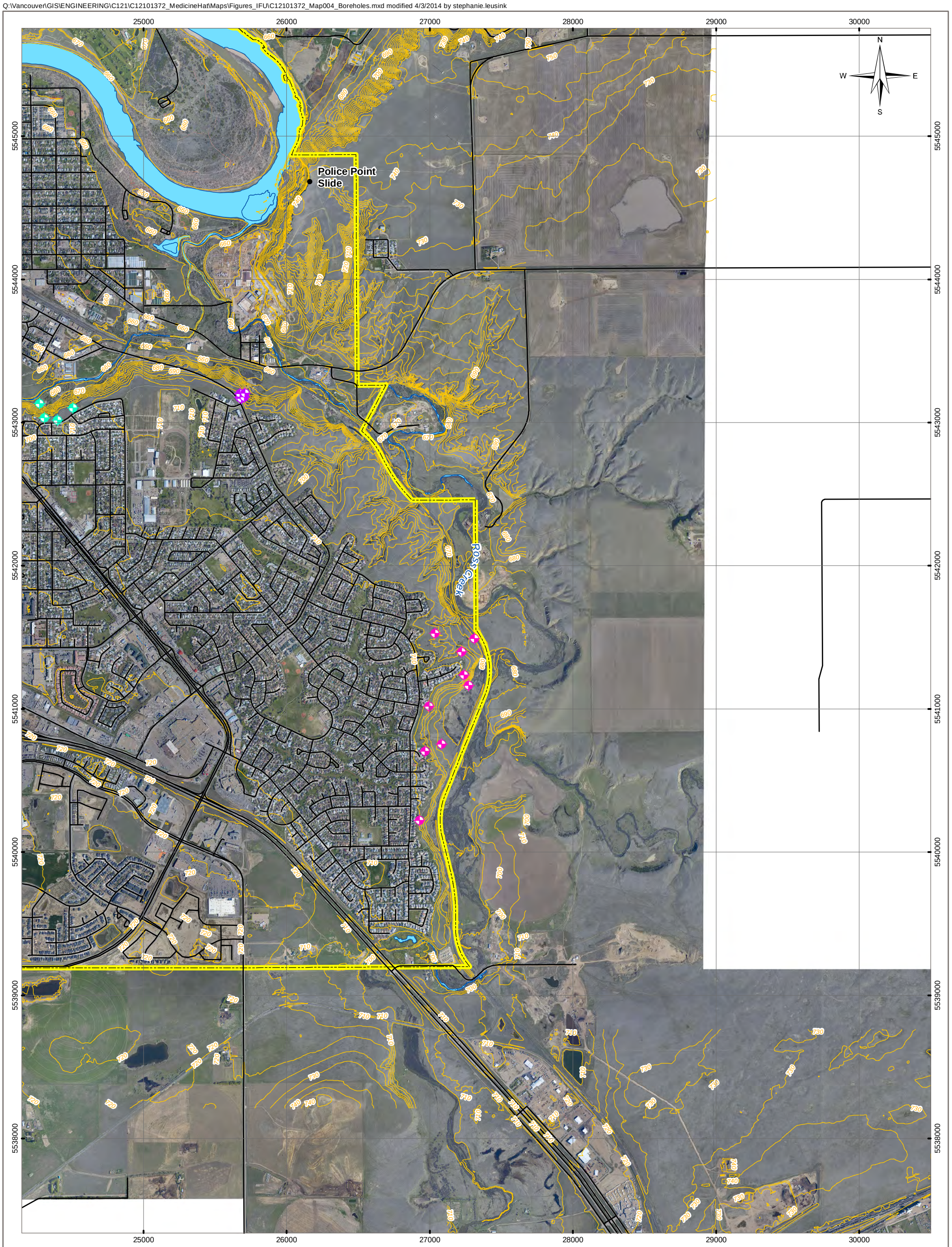
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Previous Borehole Location Plan

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map004_Boreholes.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 8E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map004_Boreholes.mxd modified 4/3/2014 by stephanie.leusink



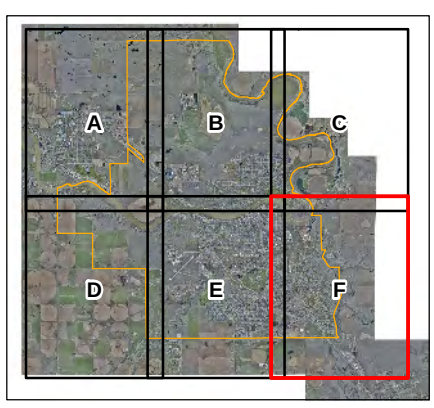
LEGEND

Borehole Location by Consultant

- AEE
- AMEC
- Agra
- EBA
- EGT
- Golder
- PGE
- Thurber
- UMA

- Road
- City Boundary
- Contour (5 m)
- River / Creek

NOTES
Base data source: City of Medicine Hat



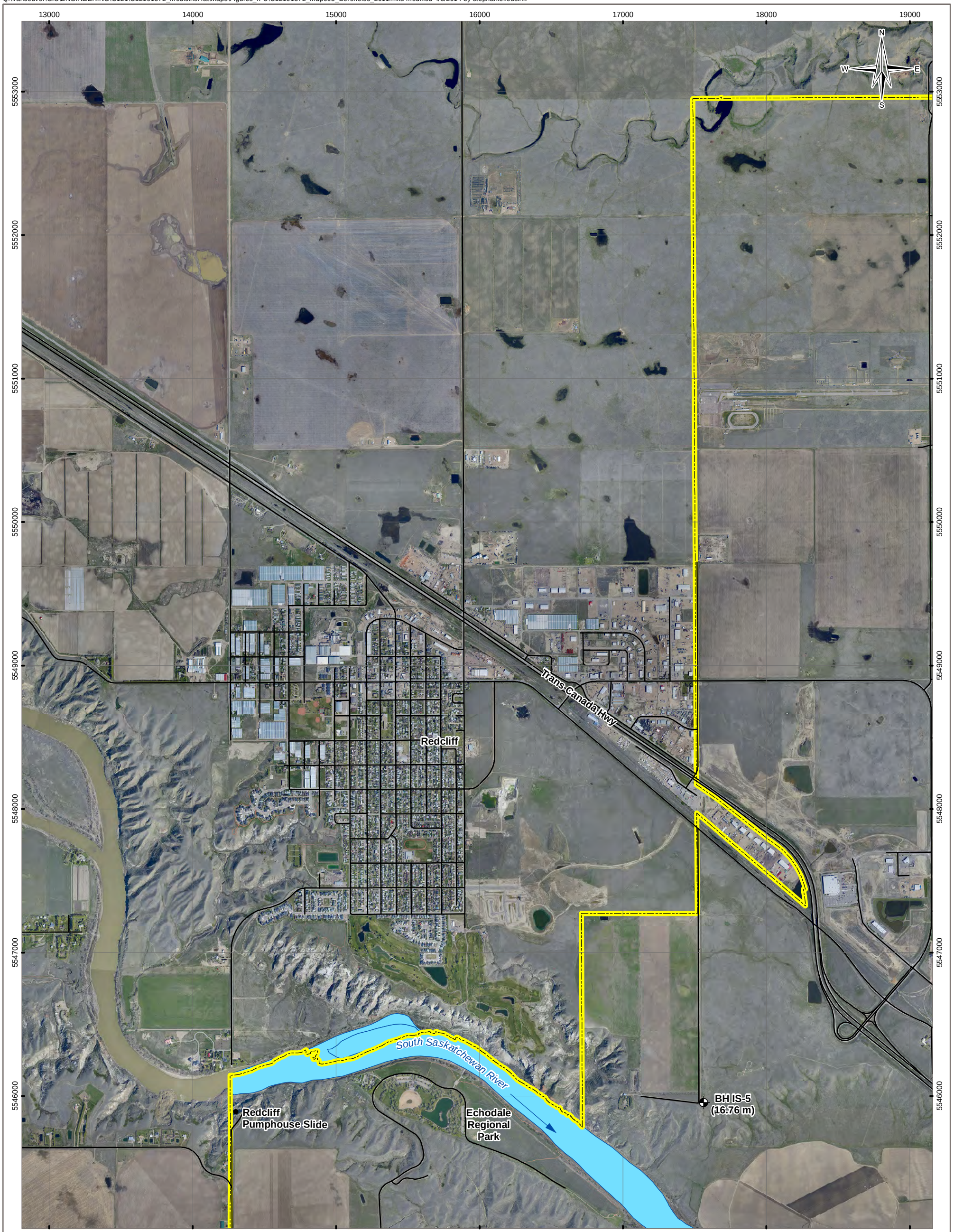
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Previous Borehole Location Plan

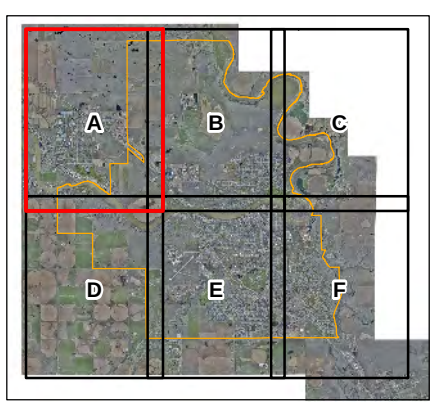
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map004_Boreholes.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 8F**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map005_Boreholes_2011.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- EBA 2011 Borehole (Depth)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

2011 Borehole Location Plan

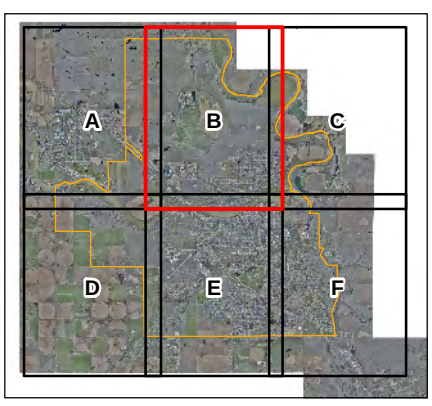
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map005_Boreholes_2011.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 9A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map005_Boreholes_2011.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- EBA 2011 Borehole (Depth)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

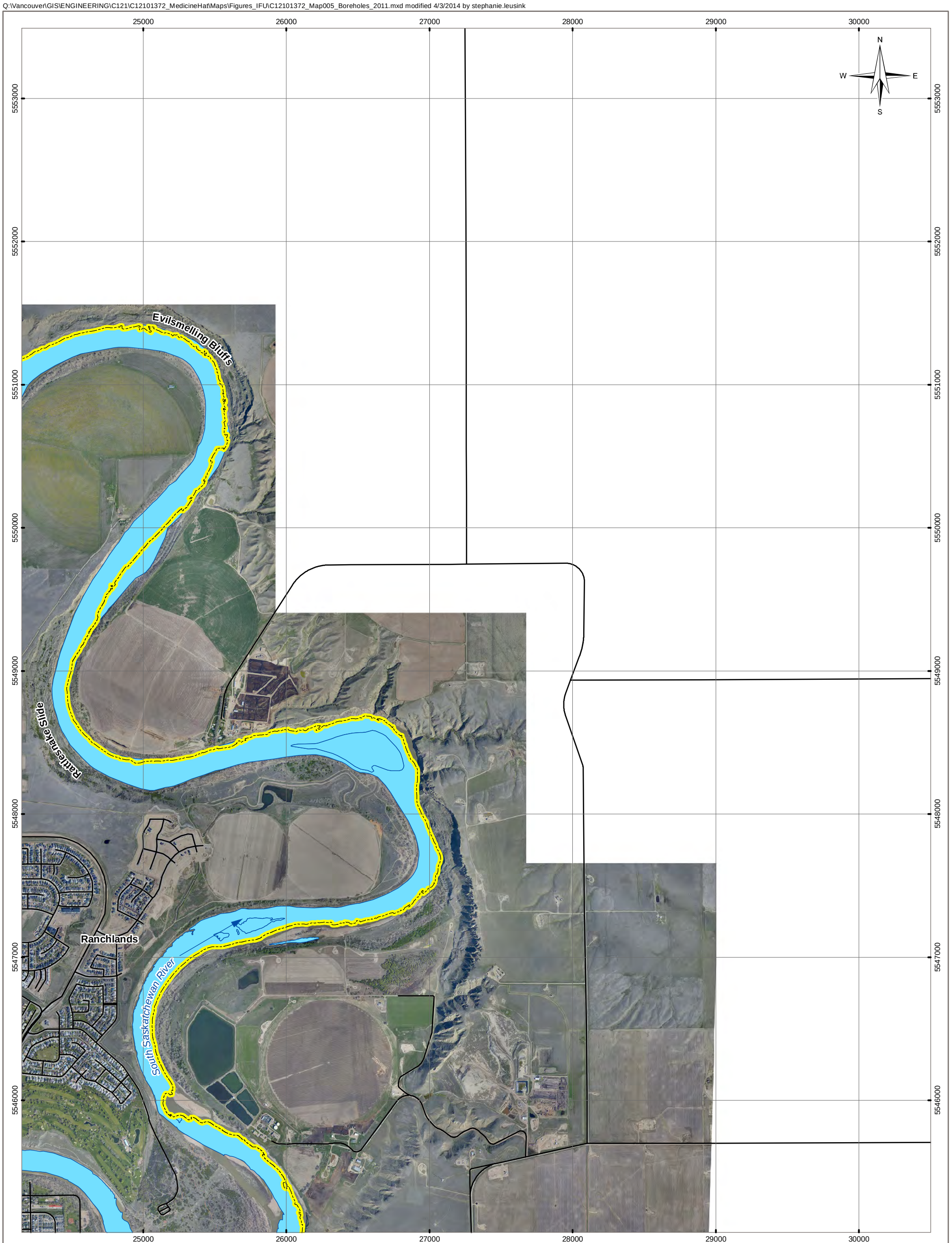
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

2011 Borehole Location Plan

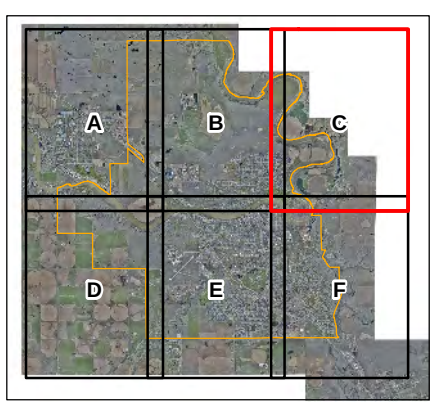
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map005_Boreholes_2011.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 9B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map005_Boreholes_2011.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- EBA 2011 Borehole (Depth)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

2011 Borehole Location Plan

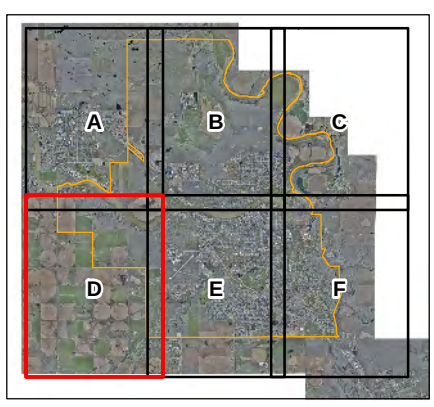
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Map005_Boreholes_2011.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 9C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map005_Boreholes_2011.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- EBA 2011 Borehole (Depth)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

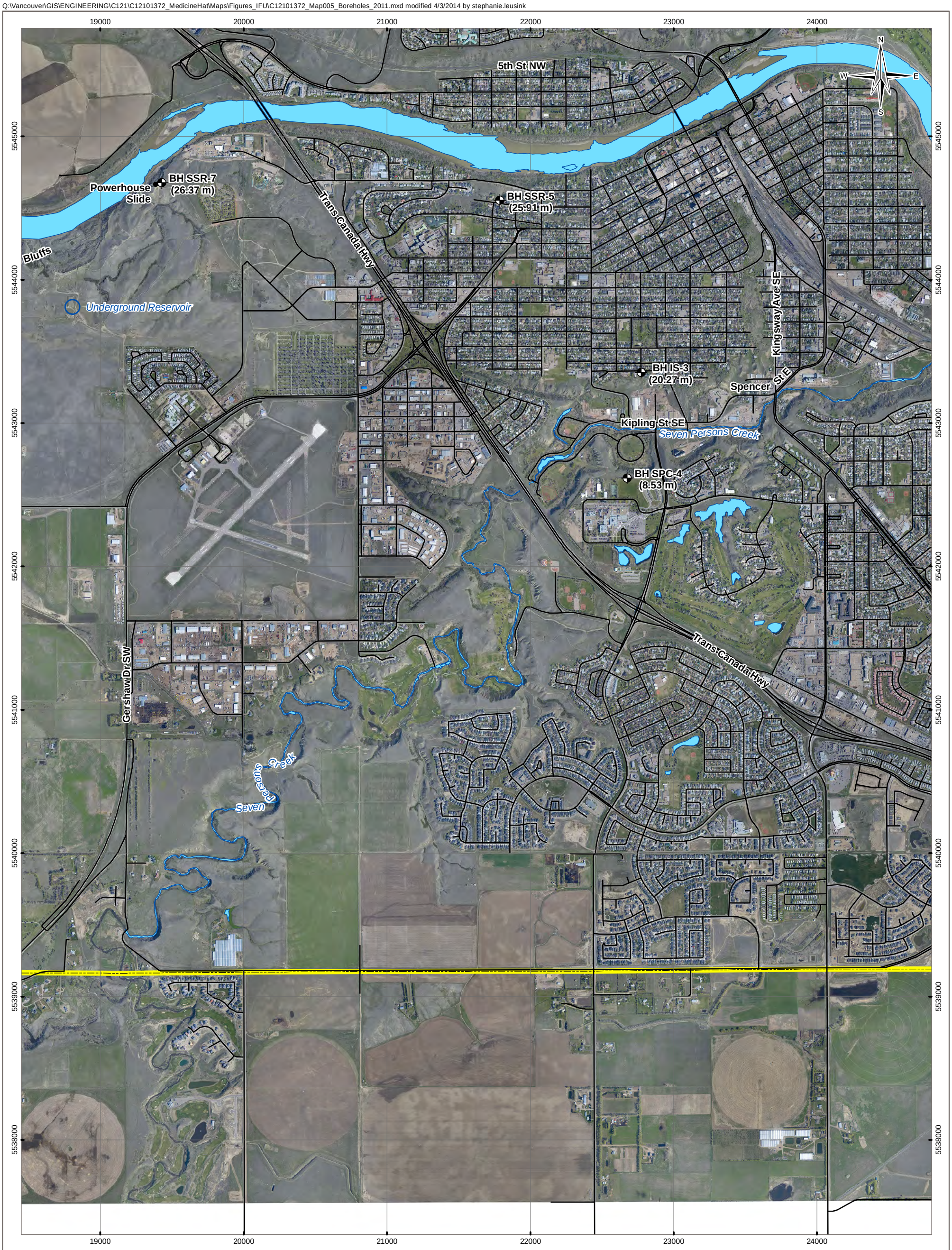
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

2011 Borehole Location Plan

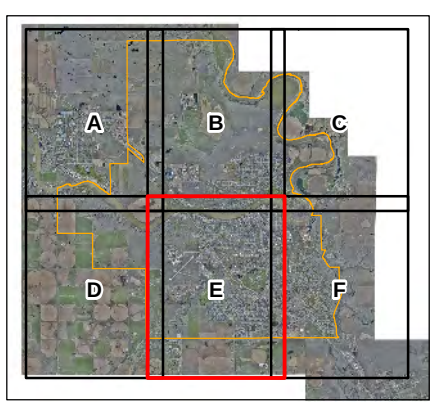
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map005_Boreholes_2011.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 9D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map005_Boreholes_2011.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- EBA 2011 Borehole (Depth)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

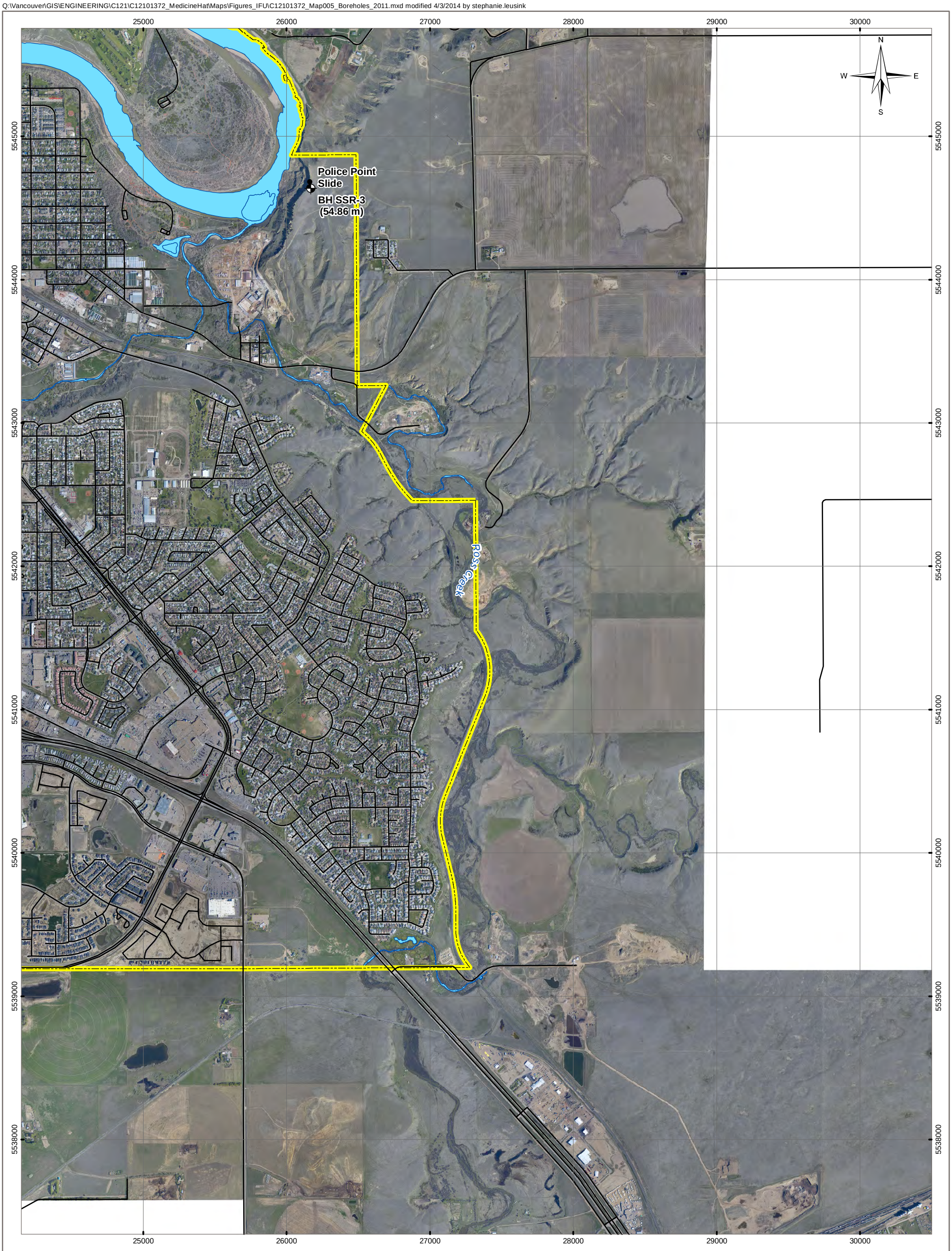
MEDICINE HAT SLOPE SETBACKS

2011 Borehole Location Plan

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Map005_Boreholes_2011.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 9E**

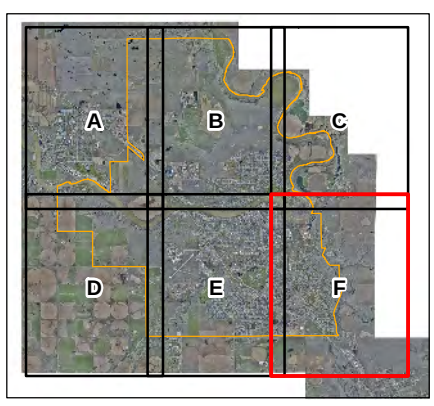
eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map005_Boreholes_2011.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- EBA 2011 Borehole (Depth)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

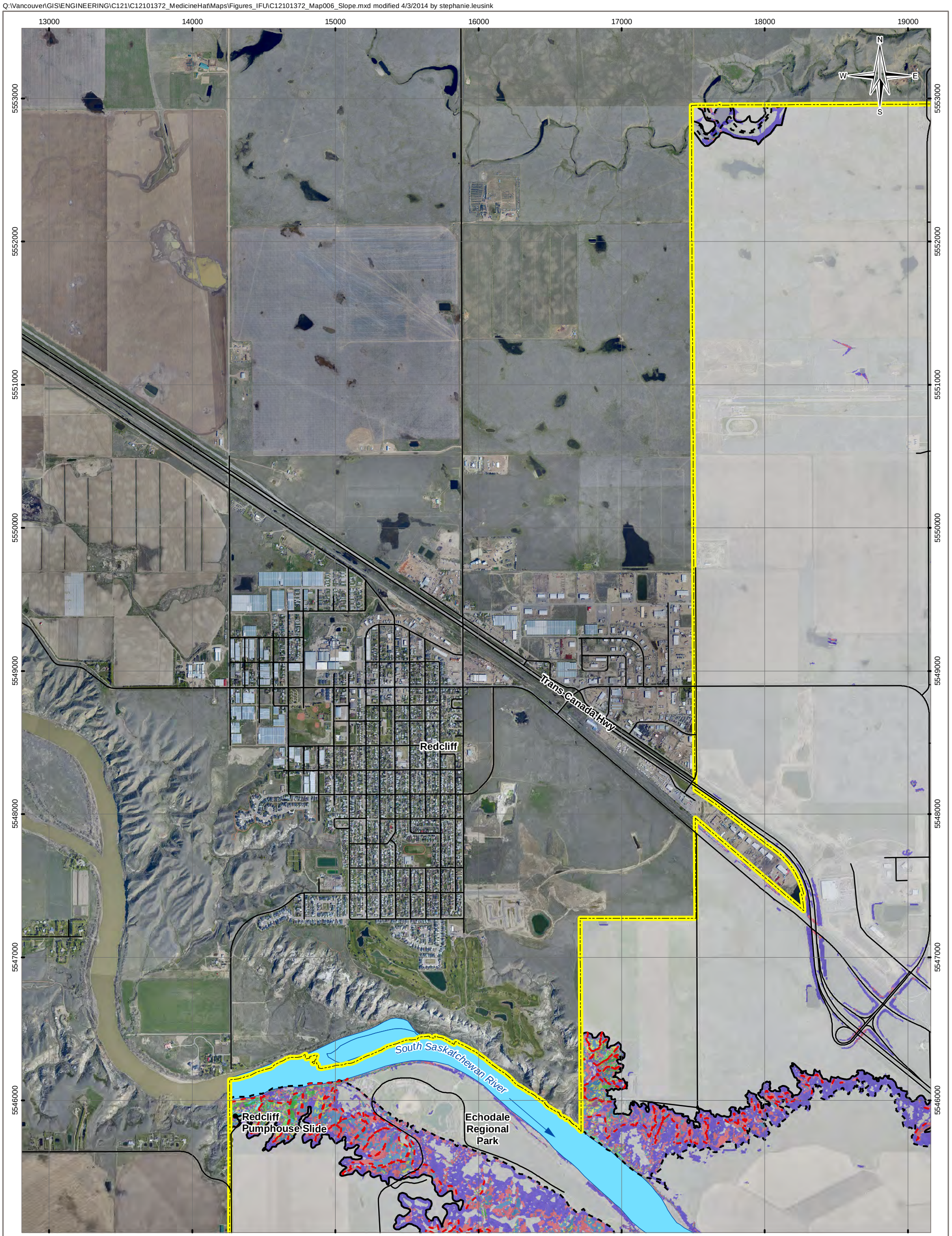
MEDICINE HAT SLOPE SETBACKS

2011 Borehole Location Plan

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres			
FILE NO. C12101372_Map005_Boreholes_2011.mxd			
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL / **APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014		**Figure 9F**

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map006_Slope.mxd modified 4/3/2014 by stephanie.leusink

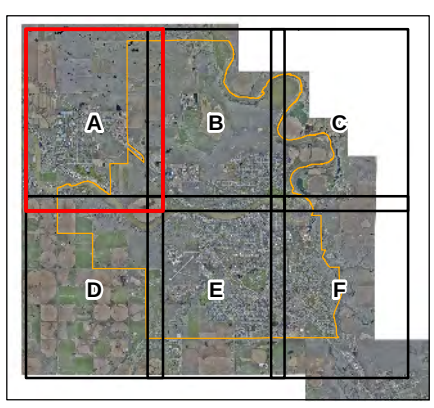


LEGEND

Slope

- 0-14% (0-8°)
- 15-32% (8.5-17.74°)
- 33-44% (18.3-23.75°)
- 45-59% (24.23-30.54°)
- 60-69% (30.96-34.61°)
- 70-79% (34.99-38.31°)
- 80-99% (38.66-44.71°)
- >100% (>45°)

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

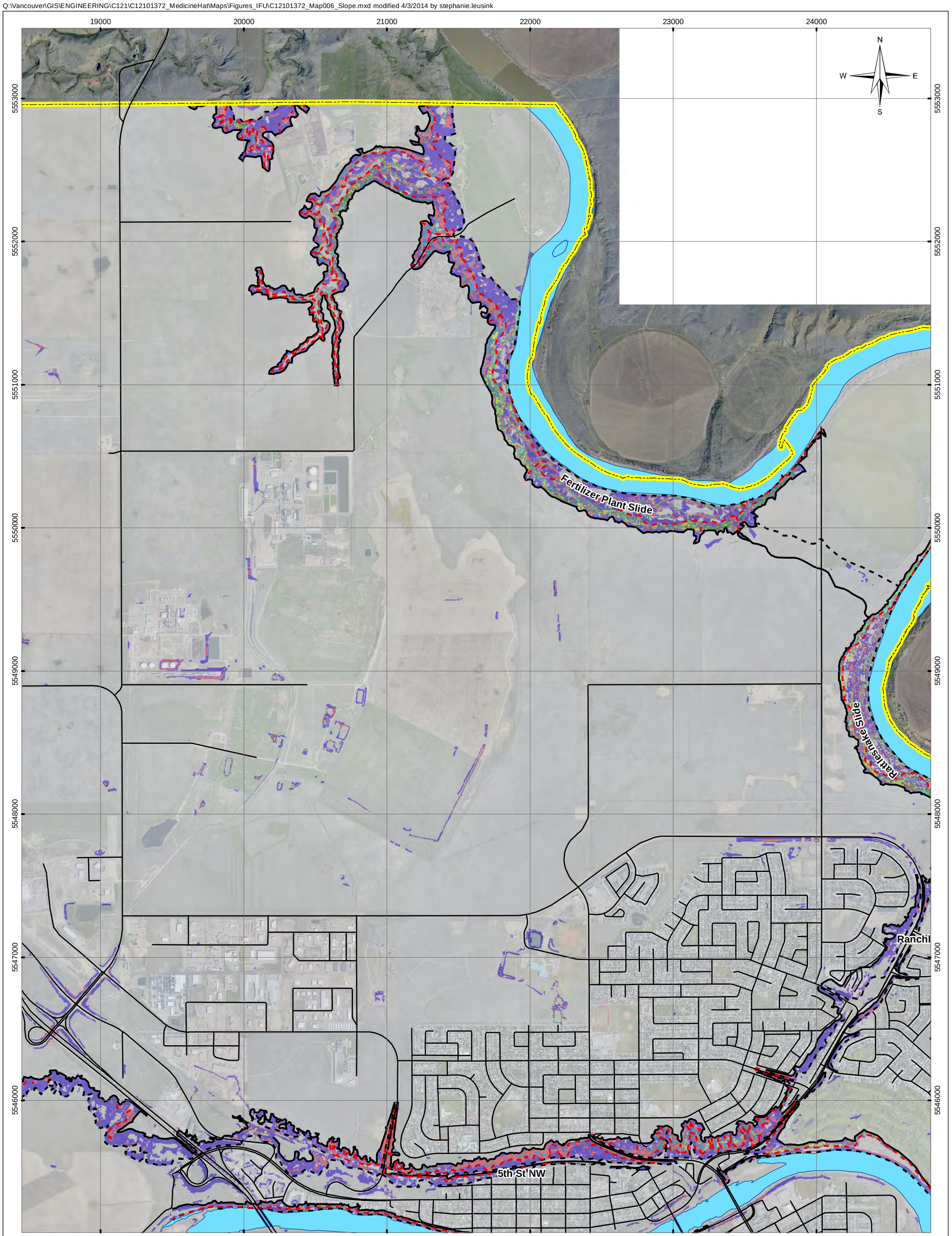
STATUS
ISSUED FOR REVIEW

MEDICINE HAT SLOPE SETBACKS

Slope Gradient Map

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map006_Slope.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 10A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map006_Slope.mxd modified 4/3/2014 by stephanie.leusink

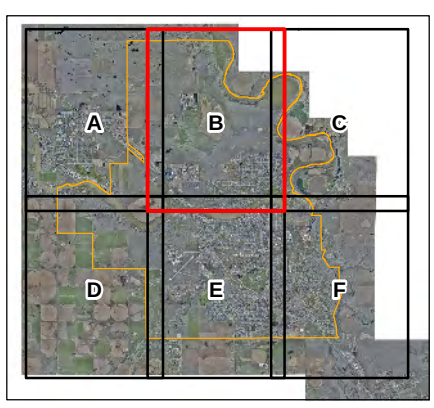


LEGEND

Slope

- 0-14% (0-8°)
- 15-32% (8.5-17.74°)
- 33-44% (18.3-23.75°)
- 45-59% (24.23-30.54°)
- 60-69% (30.96-34.61°)
- 70-79% (34.99-38.31°)
- 80-99% (38.66-44.71°)
- >100% (>45°)

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

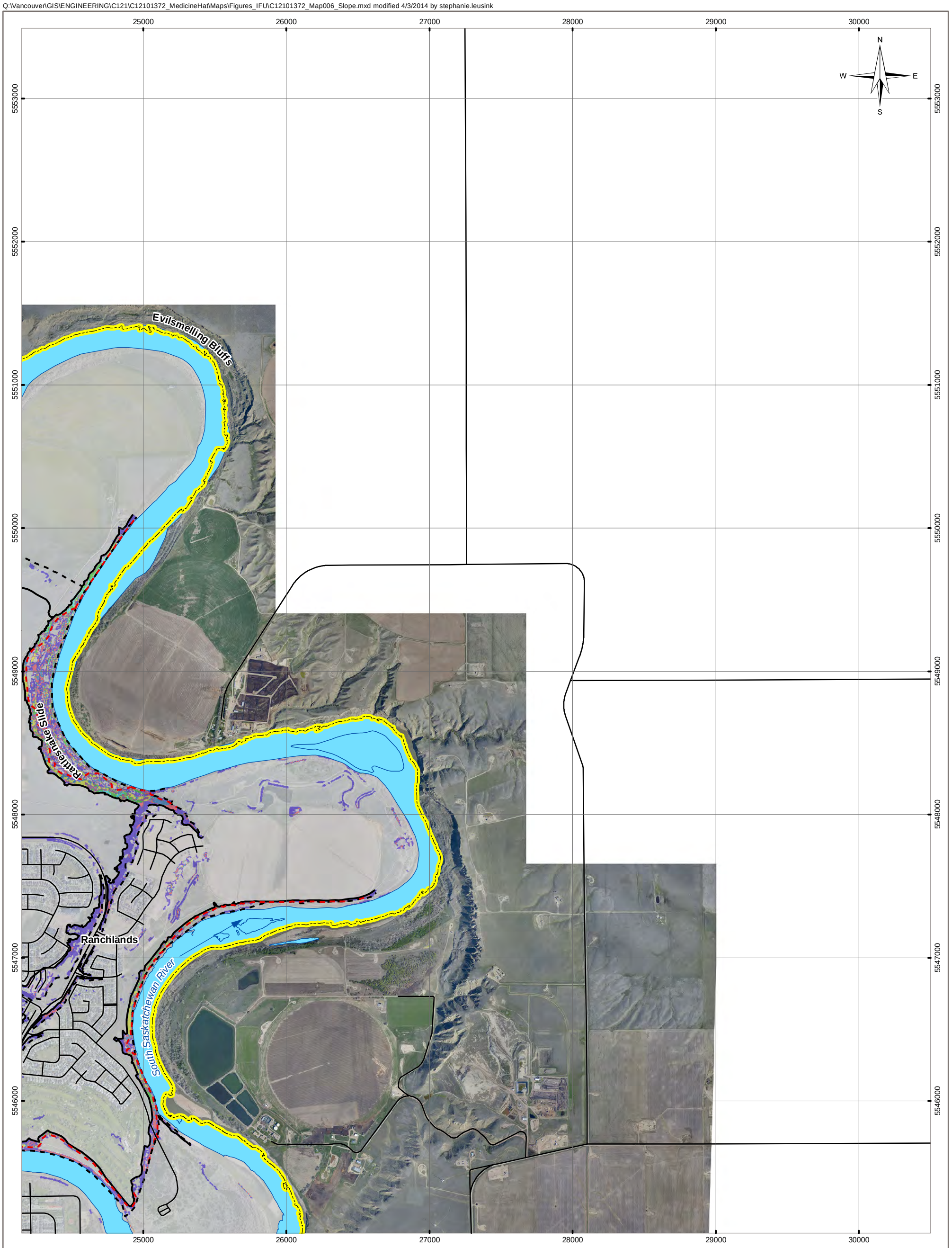
STATUS
ISSUED FOR REVIEW

MEDICINE HAT SLOPE SETBACKS

Slope Gradient Map

PROJECTION: UTM Zone 12 (3TM)	DATUM: NAD83			CLIENT: City of Medicine Hat
Scale: 1:25,000 (500 250 0 500 Metres)				
FILE NO.: C12101372_Map006_Slope.mxd				A TETRA TECH COMPANY
PROJECT NO.: C12101372	DWN: MEZ	CKD: SL	APVD: SH	REV: 0
OFFICE: EBA-VANC	DATE: April 3, 2014			Figure 10B

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map006_Slope.mxd modified 4/3/2014 by stephanie.leusink



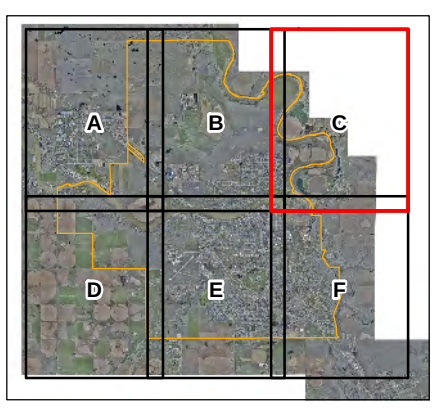
LEGEND

Slope

- 0-14% (0-8°)
- 15-32% (8.5-17.74°)
- 33-44% (18.3-23.75°)
- 45-59% (24.23-30.54°)
- 60-69% (30.96-34.61°)
- 70-79% (34.99-38.31°)
- 80-99% (38.66-44.71°)
- >100% (>45°)

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek

NOTES
Base data source: City of Medicine Hat



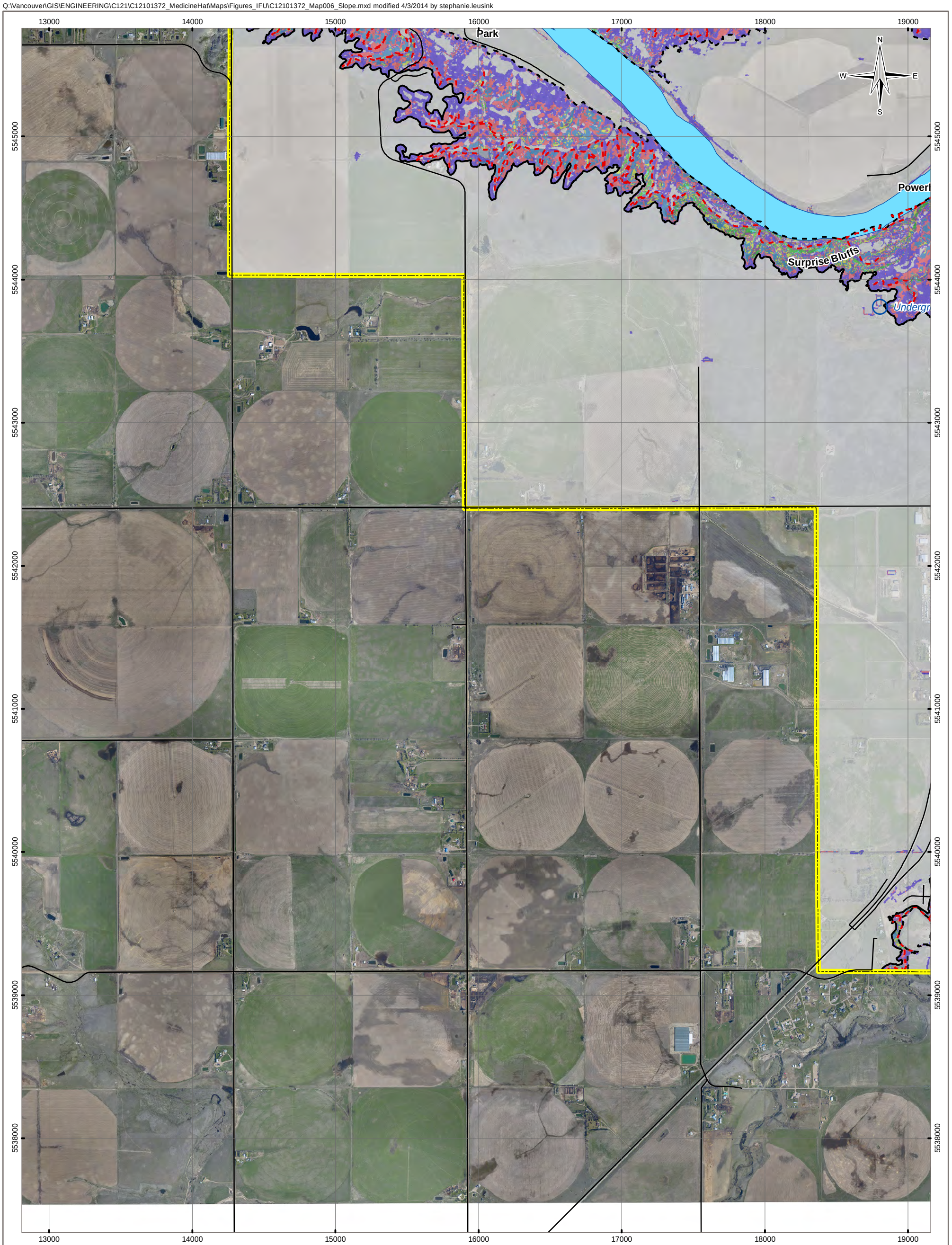
STATUS
ISSUED FOR REVIEW

MEDICINE HAT SLOPE SETBACKS

Slope Gradient Map

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map006_Slope.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 10C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map006_Slope.mxd modified 4/3/2014 by stephanie.leusink

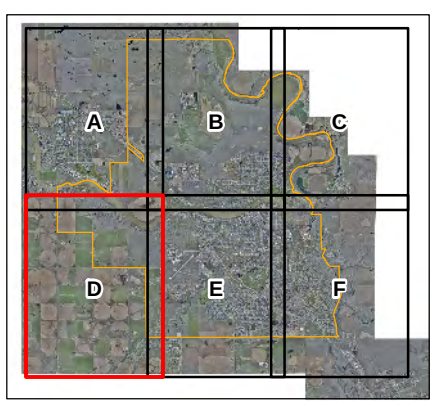


LEGEND

Slope

- 0-14% (0-8°)
- 15-32% (8.5-17.74°)
- 33-44% (18.3-23.75°)
- 45-59% (24.23-30.54°)
- 60-69% (30.96-34.61°)
- 70-79% (34.99-38.31°)
- 80-99% (38.66-44.71°)
- >100% (>45°)

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR REVIEW

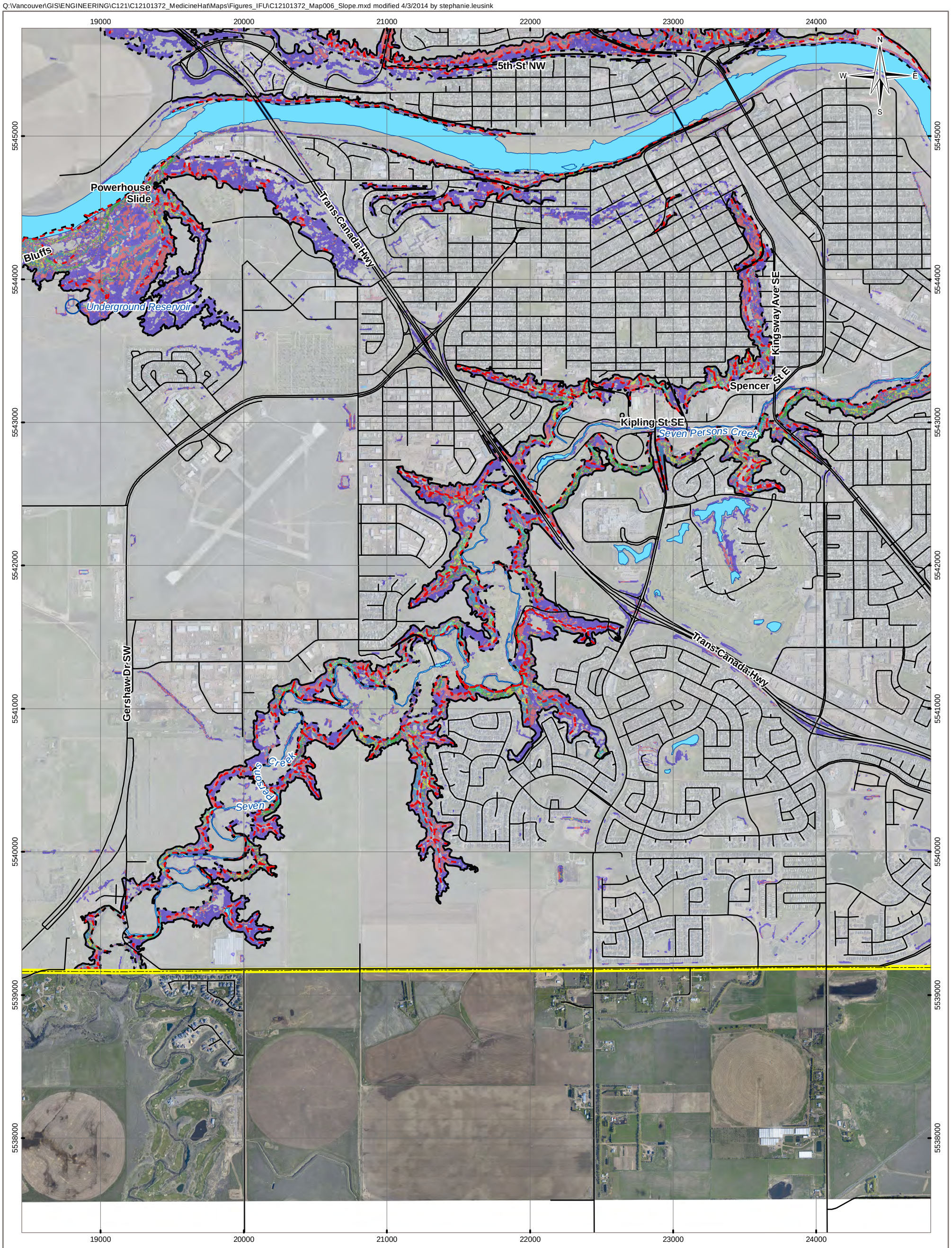
MEDICINE HAT SLOPE SETBACKS

Slope Gradient Map

PROJECTION: UTM Zone 12 (3TM)	DATUM: NAD83			CLIENT: City of Medicine Hat
Scale: 1:25,000 (500 250 0 500 Metres)				
FILE NO.: C12101372_Map006_Slope.mxd				
PROJECT NO.: C12101372	DWN: MEZ	CKD: SL	APVD: SH	REV: 0
OFFICE: EBA-VANC	DATE: April 3, 2014			Figure 10D

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map006_Slope.mxd modified 4/3/2014 by stephanie.leusink

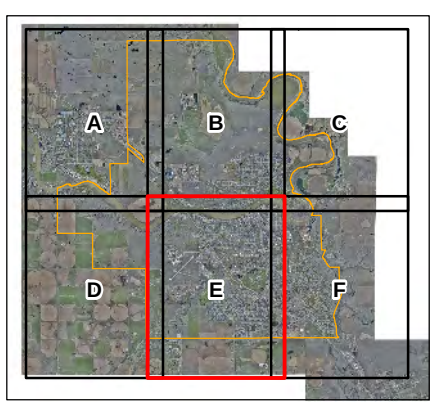


LEGEND

Slope

- 0-14% (0-8°)
- 15-32% (8.5-17.74°)
- 33-44% (18.3-23.75°)
- 45-59% (24.23-30.54°)
- 60-69% (30.96-34.61°)
- 70-79% (34.99-38.31°)
- 80-99% (38.66-44.71°)
- >100% (>45°)

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR REVIEW

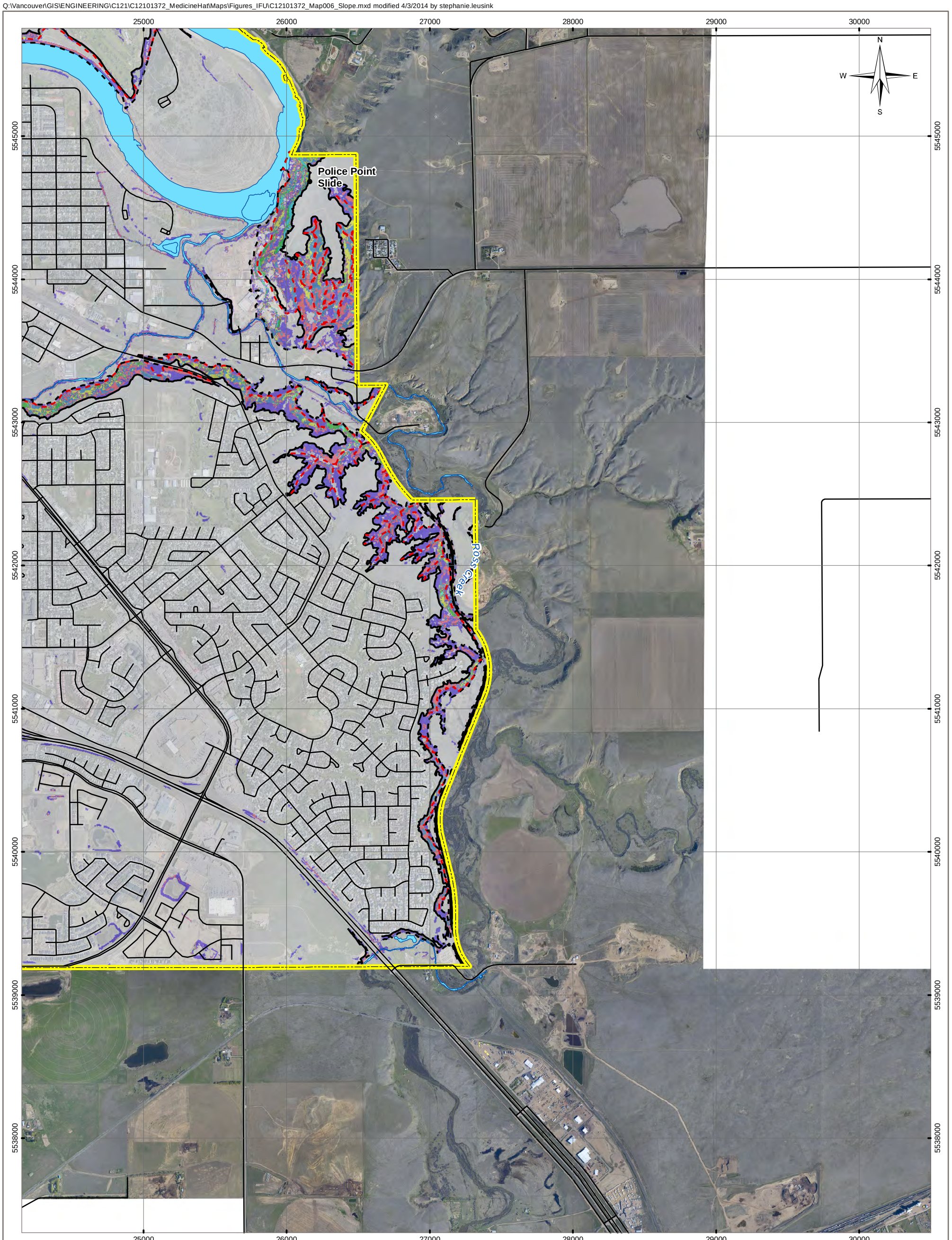
MEDICINE HAT SLOPE SETBACKS

Slope Gradient Map

PROJECTION: UTM Zone 12 (3TM)	DATUM: NAD83			CLIENT: City of Medicine Hat
Scale: 1:25,000 (500 250 0 500 Metres)				
FILE NO.: C12101372_Map006_Slope.mxd				
PROJECT NO.: C12101372	DWN: MEZ	CKD: SL	APVD: SH	REV: 0
OFFICE: EBA-VANC	DATE: April 3, 2014			Figure 10E

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map006_Slope.mxd modified 4/3/2014 by stephanie.leusink



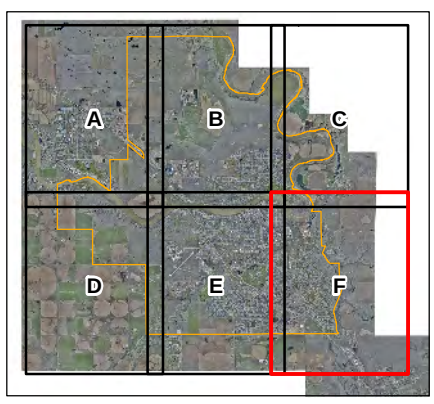
LEGEND

Slope

- 0-14% (0-8°)
- 15-32% (8.5-17.74°)
- 33-44% (18.3-23.75°)
- 45-59% (24.23-30.54°)
- 60-69% (30.96-34.61°)
- 70-79% (34.99-38.31°)
- 80-99% (38.66-44.71°)
- >100% (>45°)

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek

NOTES
Base data source: City of Medicine Hat



STATUS
ISSUED FOR REVIEW

MEDICINE HAT SLOPE SETBACKS

Slope Gradient Map

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map006_Slope.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 10F**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map007_Landslides.mxd modified 4/3/2014 by stephanie.leusink

13000 14000 15000 16000 17000 18000 19000

5553000 5552000 5551000 5550000 5549000 5548000 5547000 5546000

N W E S

Trans-Canada Hwy

Redcliff

South Saskatchewan River

L30 L31 L32 L33 L34 L35 L36 L44 L37

Redcliff Pumphouse Slide

Echodale Regional Park

LEGEND

Landslide Age[2]

- Ancient (A)
- Historic (H)
- Recent (R)
- Ancient / Historic (A-H)
- Ancient / Recent (A-R)
- Historic / Recent (H-R)

- Road
- City Boundary
- River / Creek

A B C D E F

NOTES
1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide ID, where applicable.

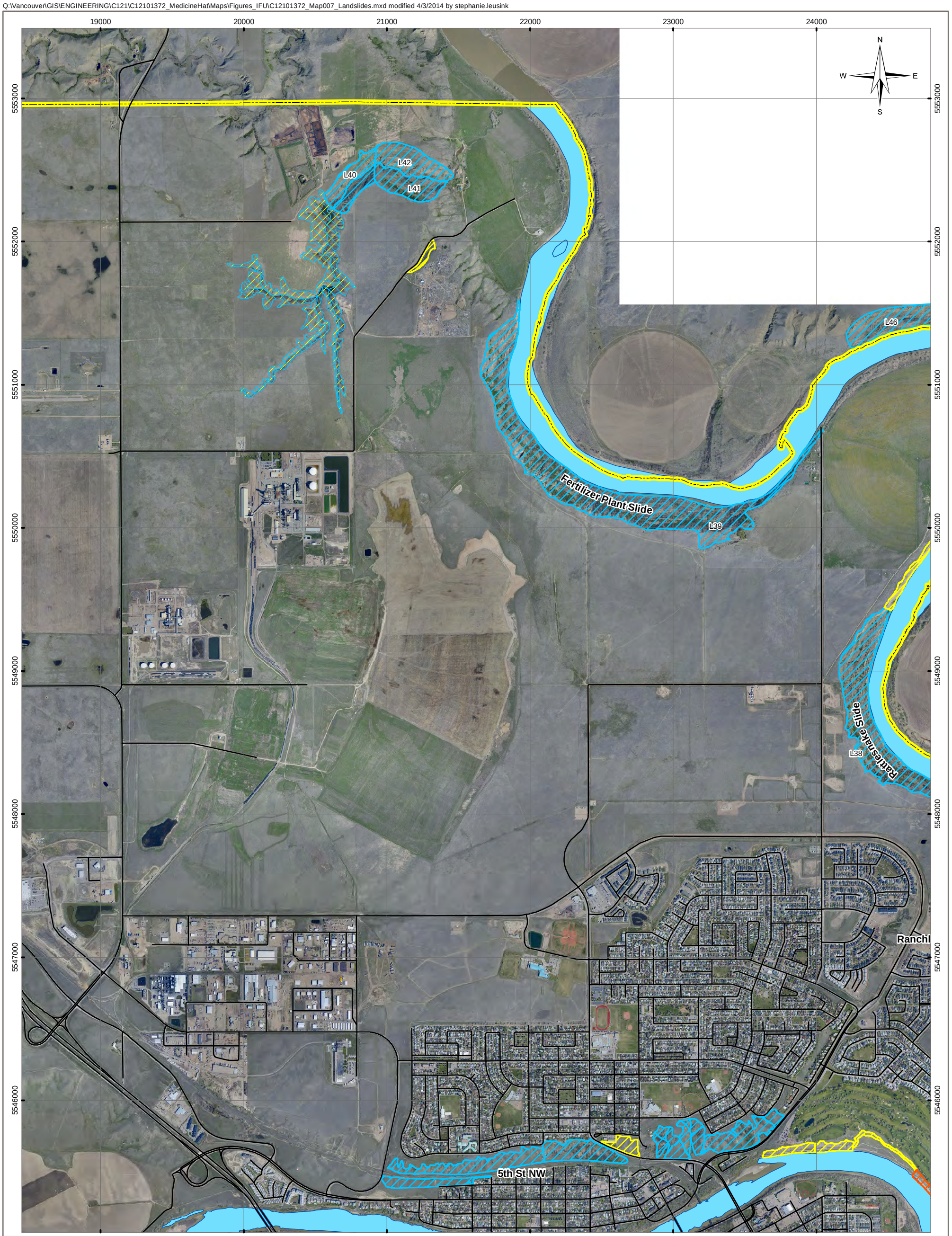
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Ancient, Historic and Recent Landslides

PROJECTION: UTM Zone 12 (3TM)	DATUM: NAD83			CLIENT: City of Medicine Hat
Scale: 1:25,000 (500 250 0 500 Metres)				
FILE NO.: C12101372_Map007_Landslides.mxd				eba A TETRA TECH COMPANY
PROJECT NO.: C12101372	DWN: MEZ	CKD: SL	APVD: SH	REV: 0
OFFICE: EBA-VANC	DATE: April 3, 2014			Figure 11A

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map007_Landslides.mxd modified 4/3/2014 by stephanie.leusink

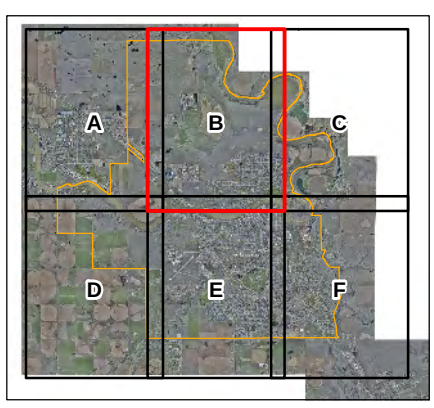


LEGEND

Landslide Age[2]

- Ancient (A)
- Historic (H)
- Recent (R)
- Ancient / Historic (A-H)
- Ancient / Recent (A-R)
- Historic / Recent (H-R)

- Road
- City Boundary
- River / Creek



NOTES
1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide ID, where applicable.

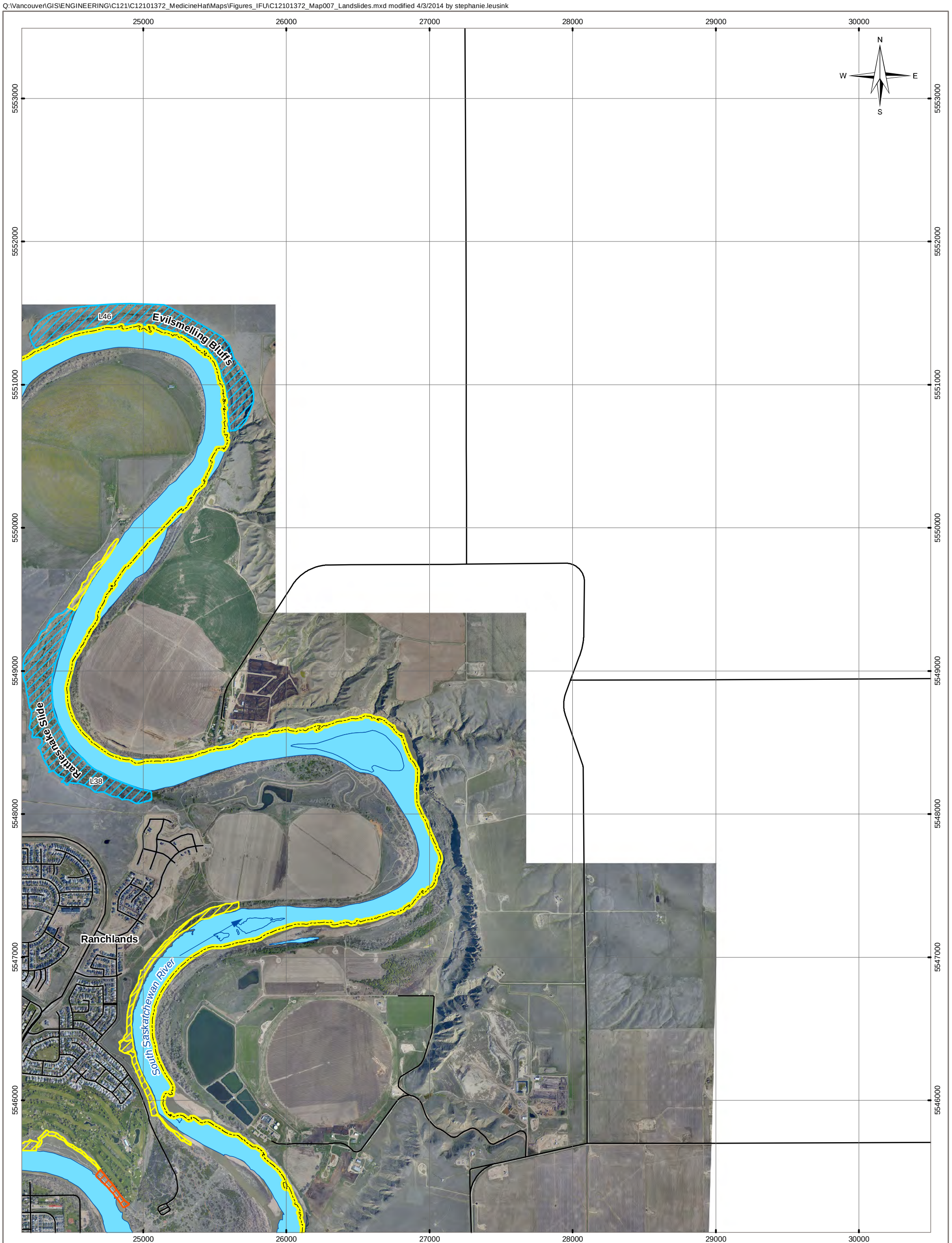
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Ancient, Historic and Recent Landslides

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map007_Landslides.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 11B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map007_Landslides.mxd modified 4/3/2014 by stephanie.leusink

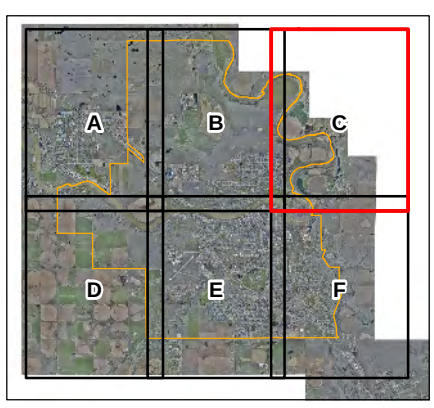


LEGEND

Landslide Age[2]

- Ancient (A)
- Historic (H)
- Recent (R)
- Ancient / Historic (A-H)
- Ancient / Recent (A-R)
- Historic / Recent (H-R)

- Road
- City Boundary
- River / Creek



NOTES
1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide ID, where applicable.

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Ancient, Historic and Recent Landslides

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map007_Landslides.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 11C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map007_Landslides.mxd modified 4/3/2014 by stephanie.leusink

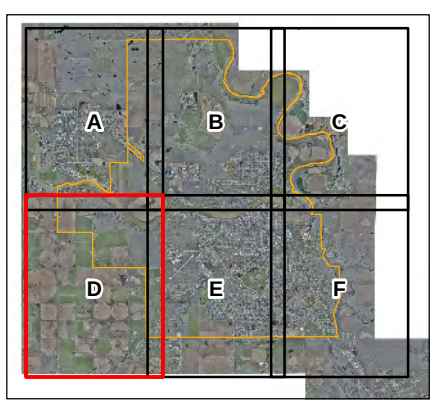


LEGEND

Landslide Age[2]

- Ancient (A)
- Historic (H)
- Recent (R)
- Ancient / Historic (A-H)
- Ancient / Recent (A-R)
- Historic / Recent (H-R)

- Road
- City Boundary
- River / Creek



NOTES
1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide ID, where applicable.

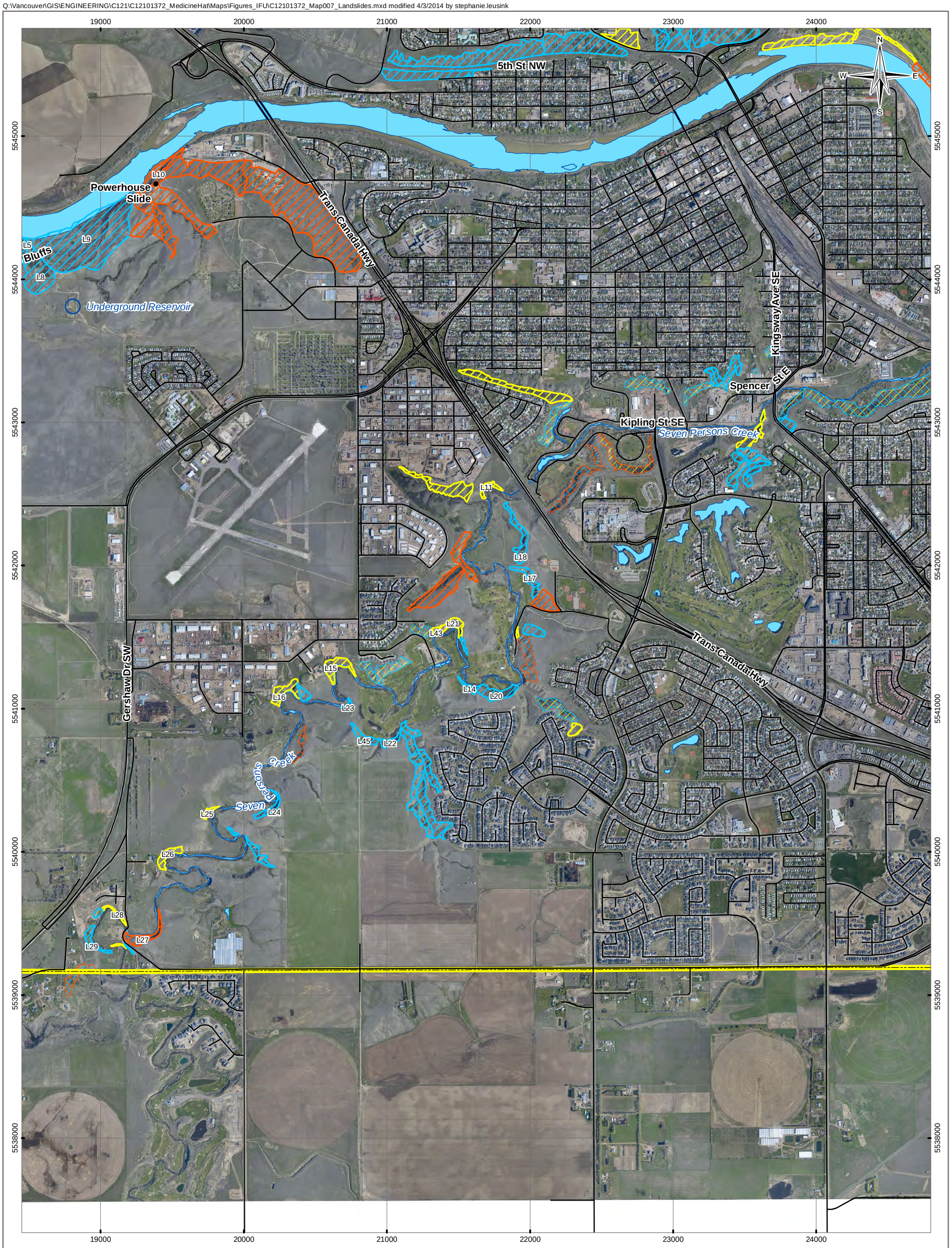
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Ancient, Historic and Recent Landslides

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map007_Landslides.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 11D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map007_Landslides.mxd modified 4/3/2014 by stephanie.leusink

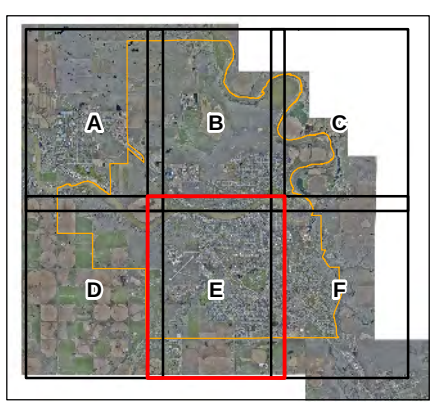


LEGEND

Landslide Age[2]

- Ancient (A)
- Historic (H)
- Recent (R)
- Ancient / Historic (A-H)
- Ancient / Recent (A-R)
- Historic / Recent (H-R)

- Road
- City Boundary
- River / Creek



NOTES
1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide ID, where applicable.

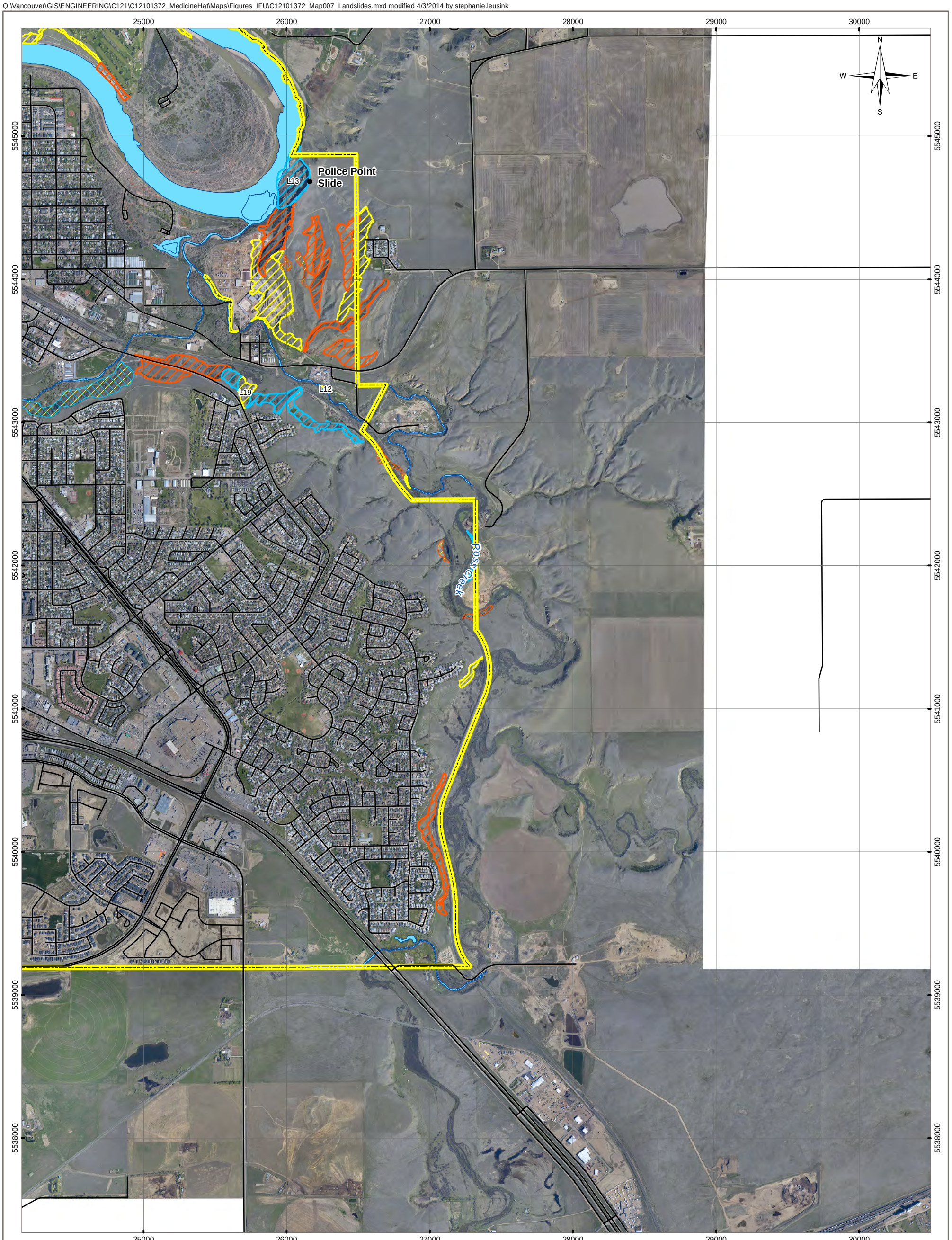
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Ancient, Historic and Recent Landslides

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map007_Landslides.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 11E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map007_Landslides.mxd modified 4/3/2014 by stephanie.leusink

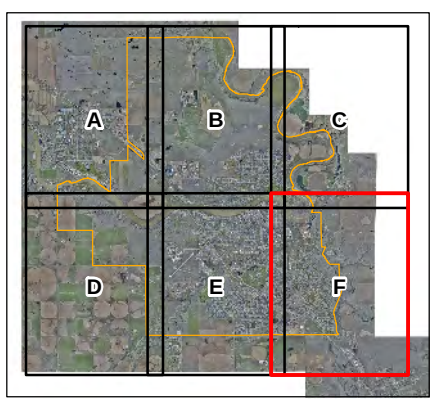


LEGEND

Landslide Age[2]

- Ancient (A)
- Historic (H)
- Recent (R)
- Ancient / Historic (A-H)
- Ancient / Recent (A-R)
- Historic / Recent (H-R)

- Road
- City Boundary
- River / Creek



NOTES
1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide ID, where applicable.

STATUS
ISSUED FOR USE

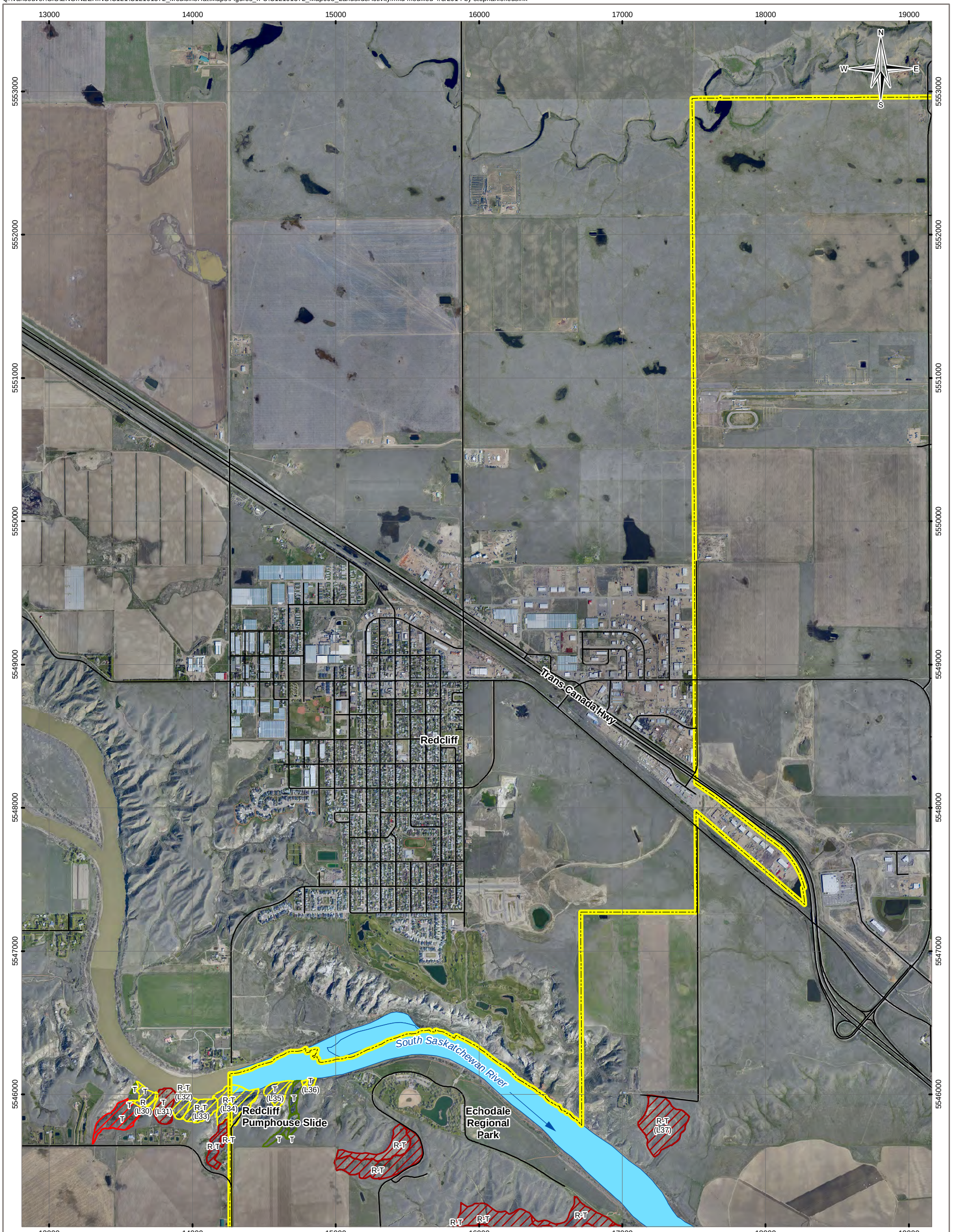
MEDICINE HAT SLOPE SETBACKS

Ancient, Historic and Recent Landslides

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Map007_Landslides.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 11F**

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map008_LandslideActivity.mxd modified 4/3/2014 by stephanie.leusink



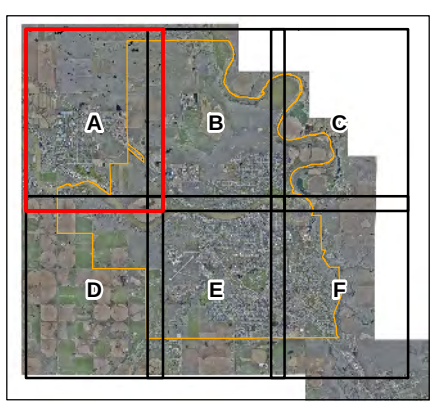
LEGEND

Degree of Landslide Activity[2]

- Active (A)
- Reactivated (R)
- Suspended (S)
- Inactive - Dormant (I-D)
- Inactive - Relict (I-R)

- Road
- City Boundary
- River / Creek

NOTES
1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide Type where
   R = Earth/Rock Slump
   T = Earth/Rock Slide
   R-T = Compound
   and by Landslide ID in parentheses, where applicable.



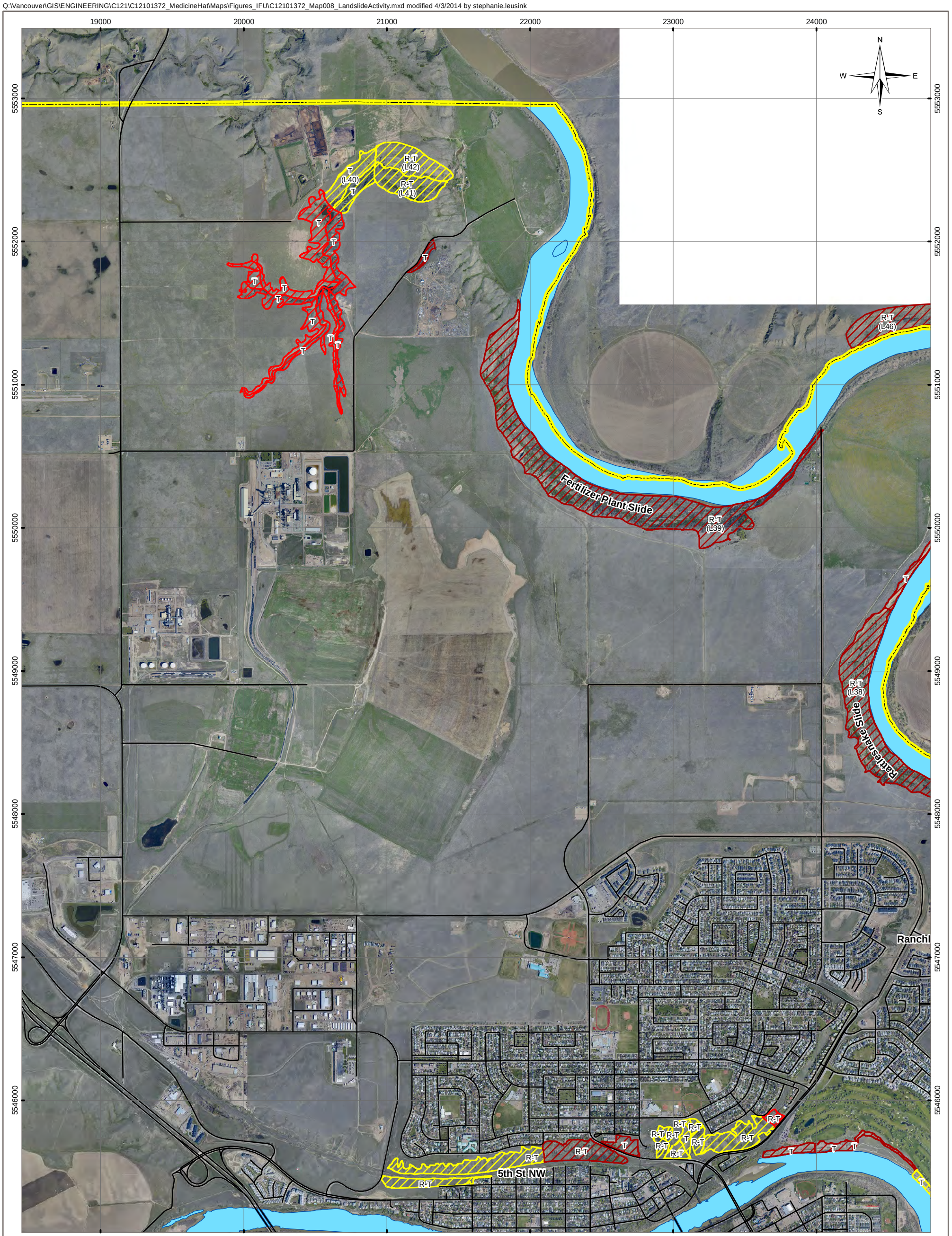
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas of Landslide Activity

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Map008_LandslideActivity.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 12A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map008_LandslideActivity.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

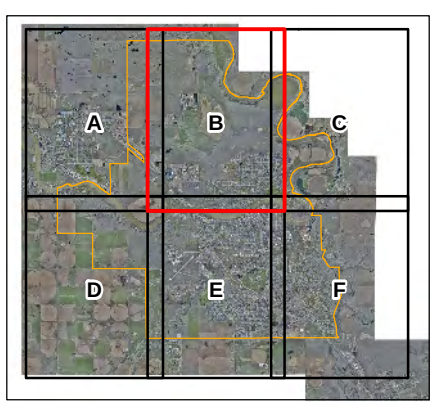
Degree of Landslide Activity[2]

- Active (A)
- Reactivated (R)
- Suspended (S)
- Inactive - Dormant (I-D)
- Inactive - Relict (I-R)

- Road
- City Boundary
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide Type where
   R = Earth/Rock Slump
   T = Earth/Rock Slide
   R-T = Compound
   and by Landslide ID in parentheses, where applicable.



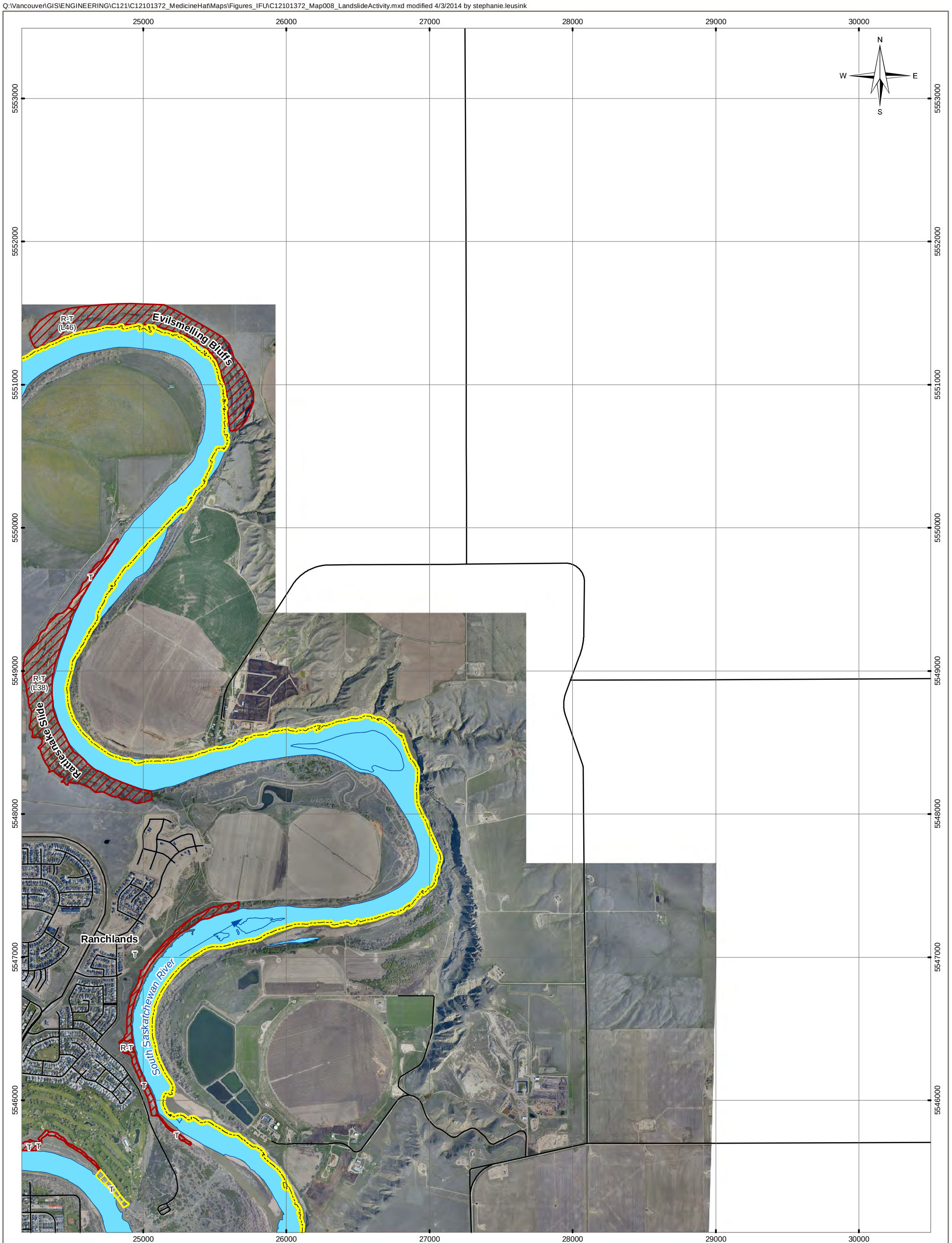
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas of Landslide Activity

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map008_LandslideActivity.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 12B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map008_LandslideActivity.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

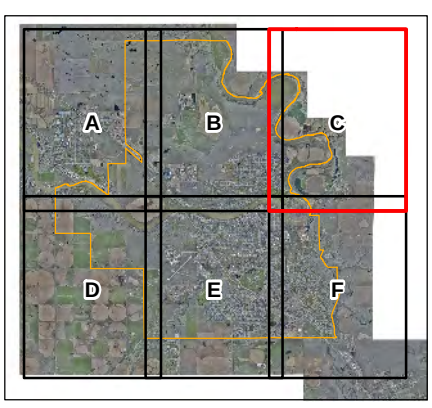
Degree of Landslide Activity[2]

- Active (A)
- Reactivated (R)
- Suspended (S)
- Inactive - Dormant (I-D)
- Inactive - Relict (I-R)

- Road
- City Boundary
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide Type where
   R = Earth/Rock Slump
   T = Earth/Rock Slide
   R-T = Compound
   and by Landslide ID in parentheses, where applicable.



STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas of Landslide Activity

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Map008_LandslideActivity.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 12C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map008_LandslideActivity.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

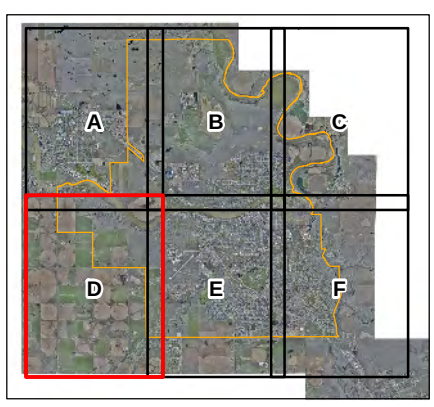
Degree of Landslide Activity[2]

- Active (A)
- Reactivated (R)
- Suspended (S)
- Inactive - Dormant (I-D)
- Inactive - Relict (I-R)

- Road
- City Boundary
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide Type where
   R = Earth/Rock Slump
   T = Earth/Rock Slide
   R-T = Compound
   and by Landslide ID in parentheses, where applicable.



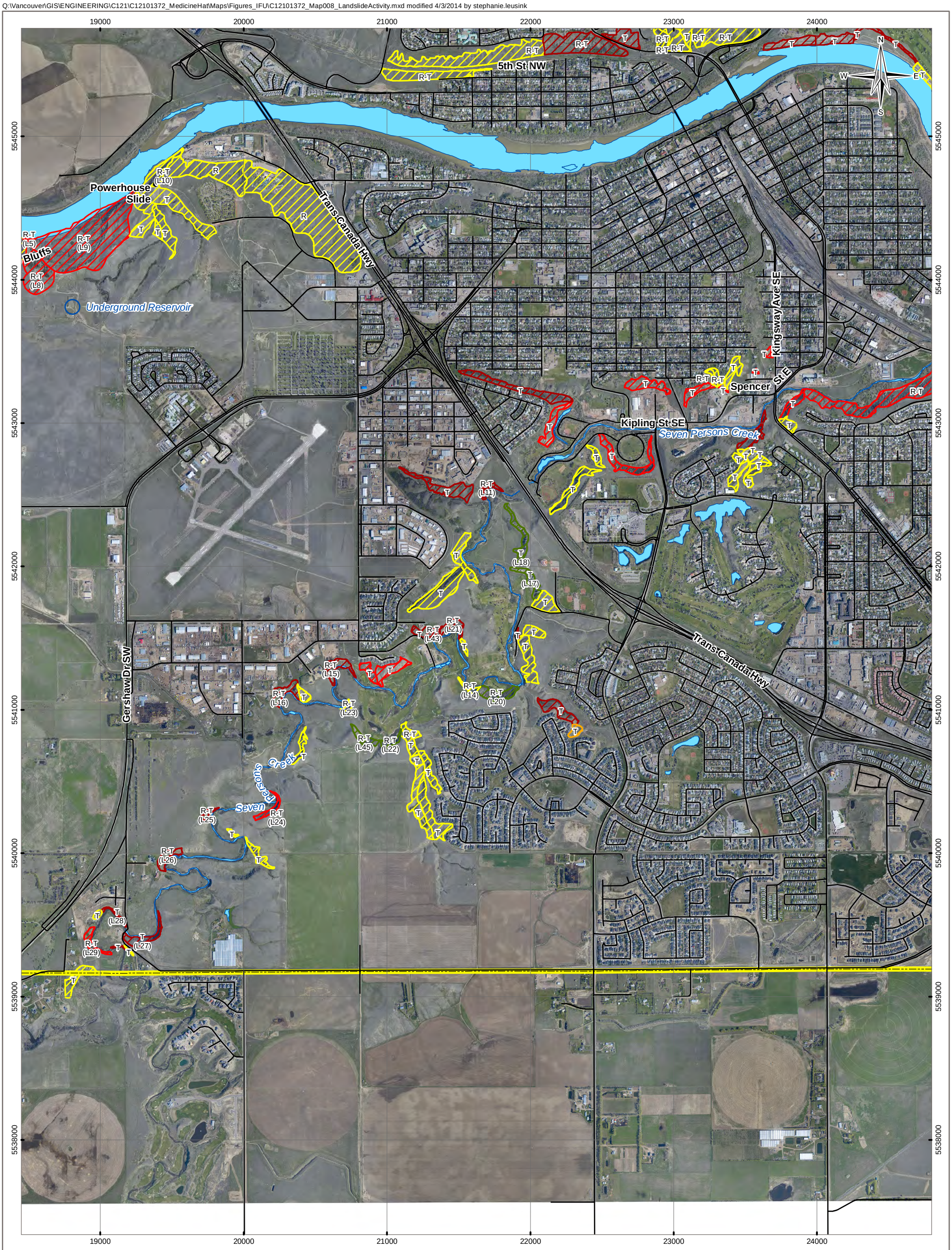
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas of Landslide Activity

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map008_LandslideActivity.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 12D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map008_LandslideActivity.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

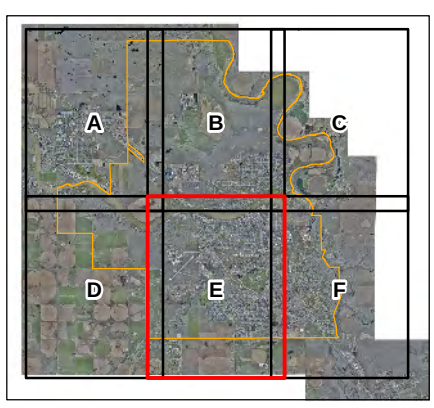
Degree of Landslide Activity[2]

- Active (A)
- Reactivated (R)
- Suspended (S)
- Inactive - Dormant (I-D)
- Inactive - Relict (I-R)

- Road
- City Boundary
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide Type where
   R = Earth/Rock Slump
   T = Earth/Rock Slide
   R-T = Compound
   and by Landslide ID in parentheses, where applicable.



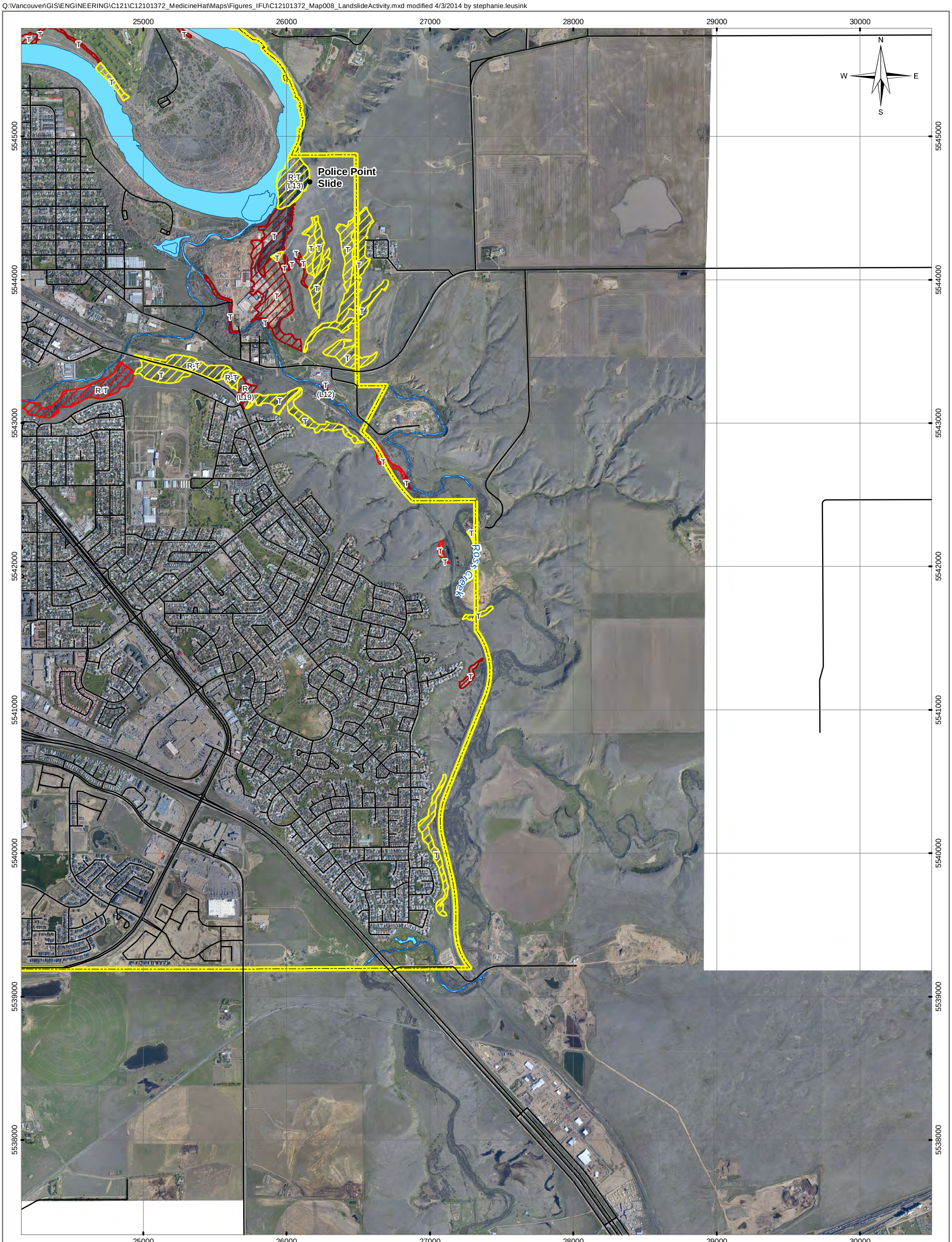
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas of Landslide Activity

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map008_LandslideActivity.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 12E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map008_LandslideActivity.mxd modified 4/3/2014 by stephanie.leusink



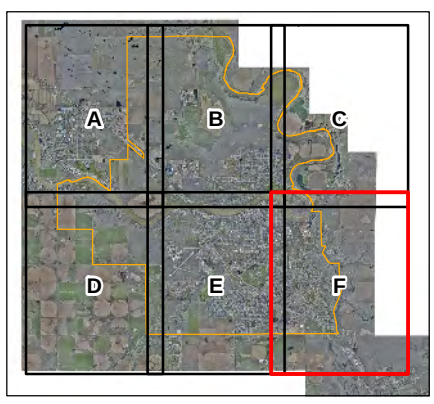
LEGEND

Degree of Landslide Activity[2]

- Active (A)
- Reactivated (R)
- Suspended (S)
- Inactive - Dormant (I-D)
- Inactive - Relict (I-R)

- Road
- City Boundary
- River / Creek

NOTES
1. Base data source: City of Medicine Hat
2. Landslide polygons are labelled by Landslide Type where
   R = Earth/Rock Slump
   T = Earth/Rock Slide
   R-T = Compound
   and by Landslide ID in parentheses, where applicable.



STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas of Landslide Activity

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map008_LandslideActivity.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 12F**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map009_ActiveLandslide.mxd modified 4/3/2014 by stephanie.leusink

13000 14000 15000 16000 17000 18000 19000

5553000 5552000 5551000 5550000 5549000 5548000 5547000 5546000

N W E S

Trans-Canada Hwy

Redcliff

South Saskatchewan River

Redcliff Pumphouse Slide

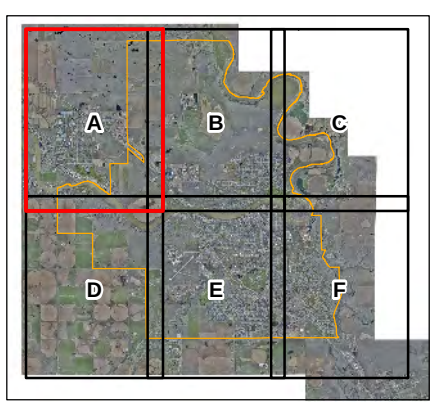
Echodale Regional Park

LEGEND

Active Landslide by Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

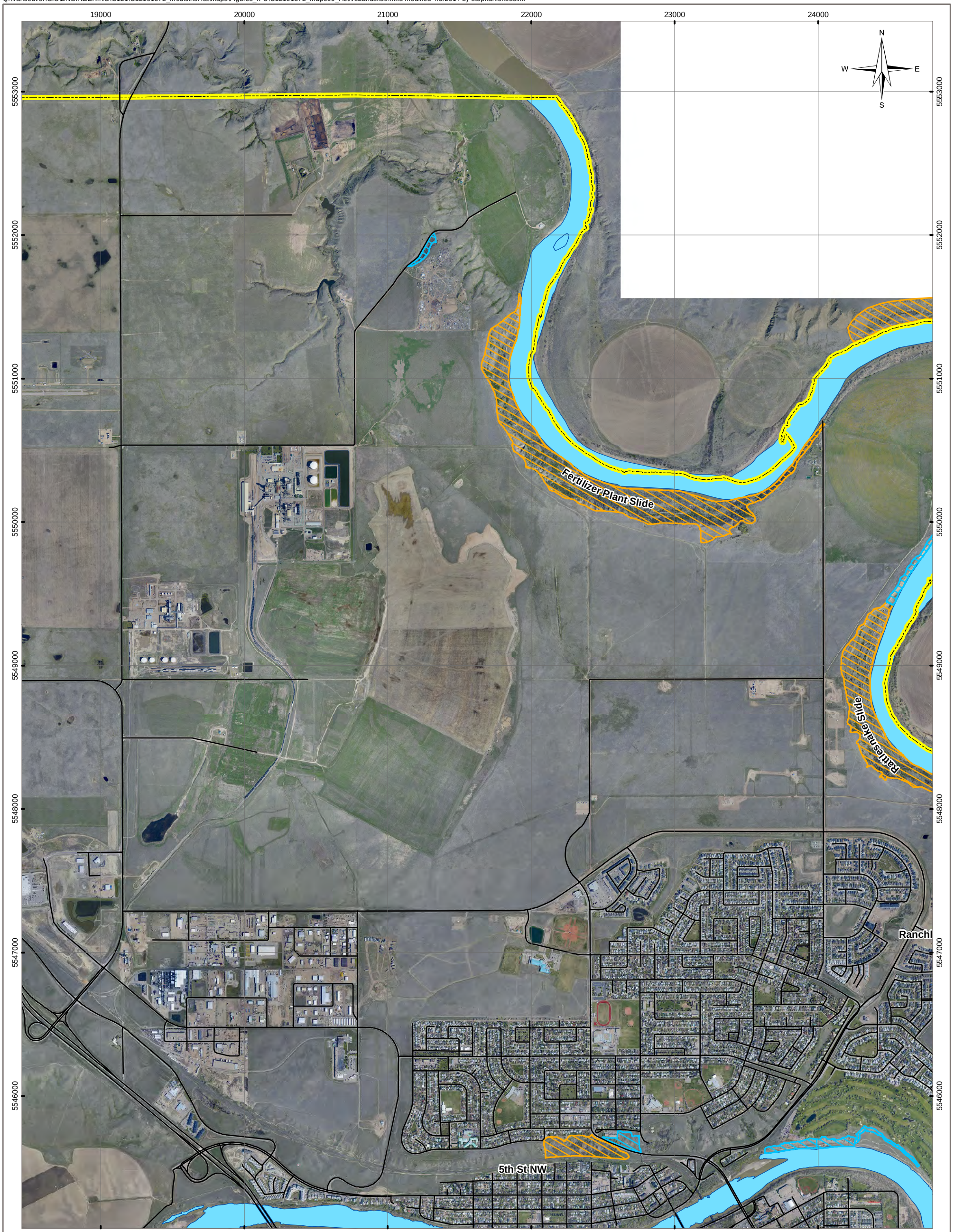
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas with Active Landslide Activity and Landslide Type

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map009_ActiveLandslide.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 13A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map009_ActiveLandslide.mxd modified 4/3/2014 by stephanie.leusink

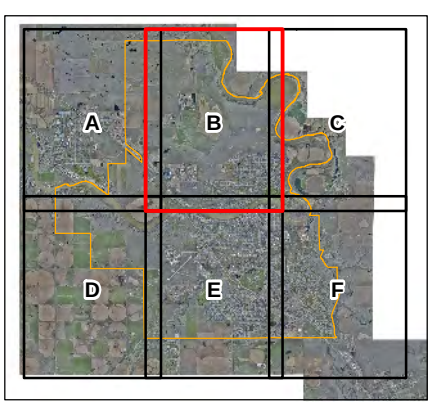


LEGEND

Active Landslide by Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

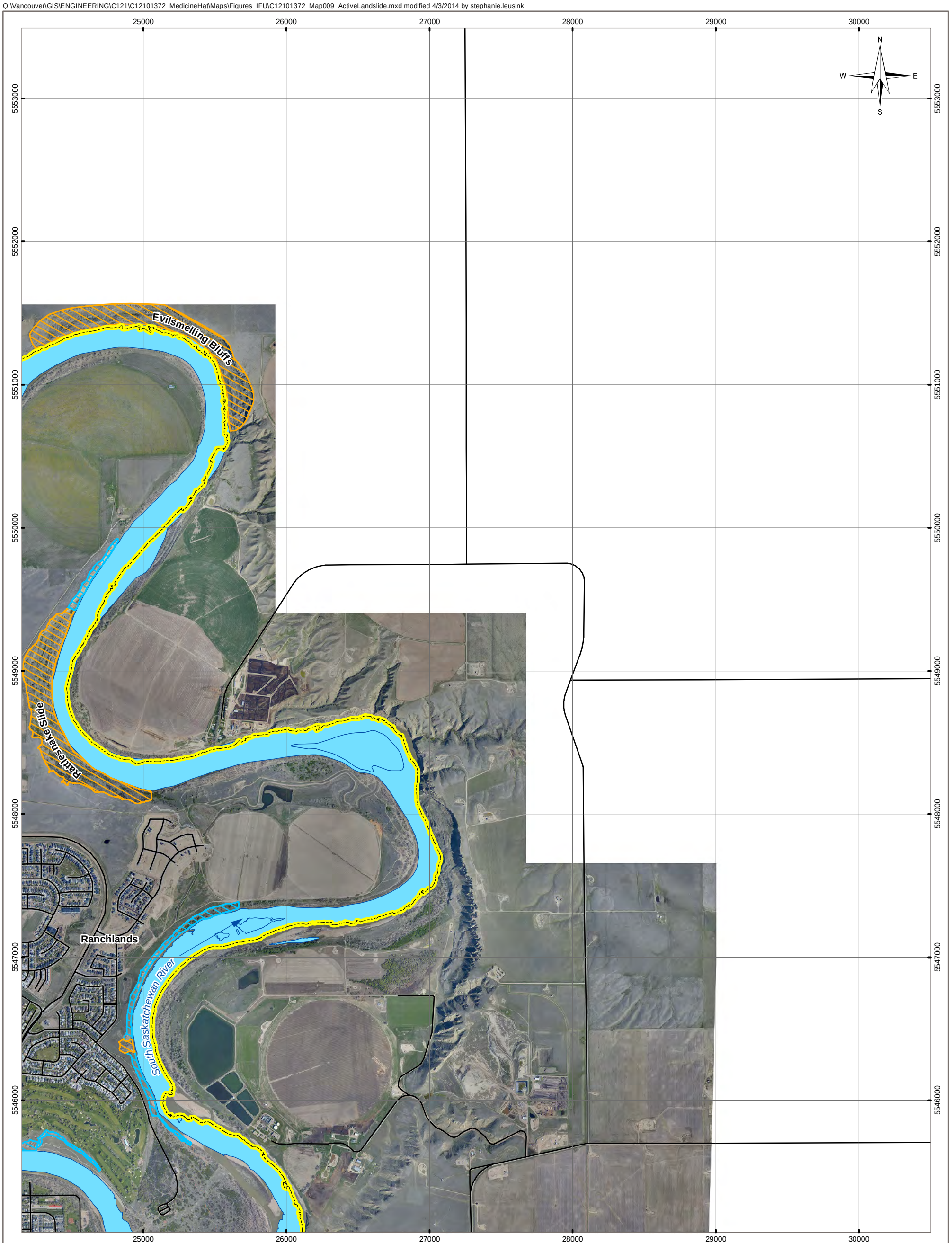
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas with Active Landslide Activity and Landslide Type

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map009_ActiveLandslide.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 13B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map009_ActiveLandslide.mxd modified 4/3/2014 by stephanie.leusink

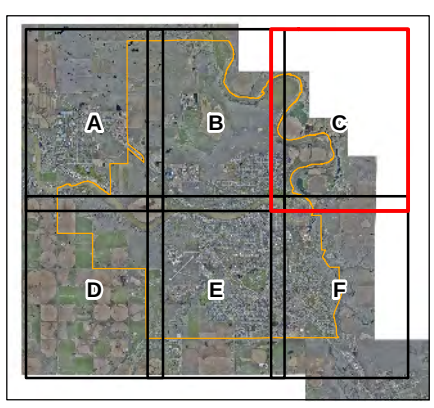


LEGEND

Active Landslide by Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas with Active Landslide Activity and Landslide Type

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map009_ActiveLandslide.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 13C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map009_ActiveLandslide.mxd modified 4/3/2014 by stephanie.leusink

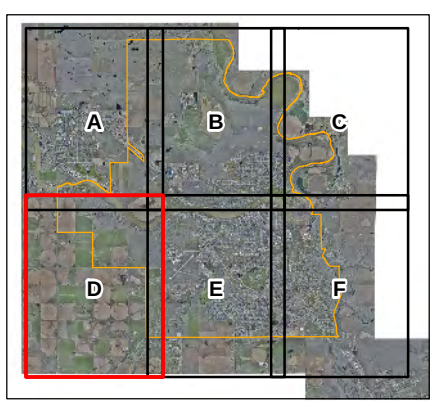


LEGEND

Active Landslide by Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas with Active Landslide Activity and Landslide Type

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map009_ActiveLandslide.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 13D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map009_ActiveLandslide.mxd modified 4/3/2014 by stephanie.leusink

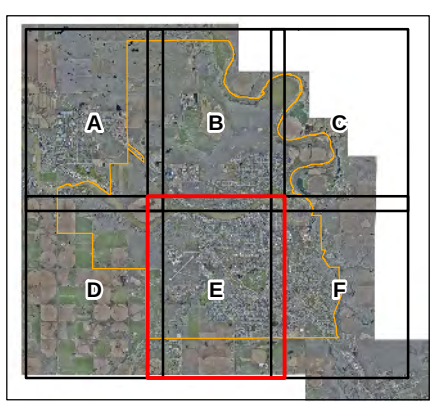


LEGEND

Active Landslide by Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

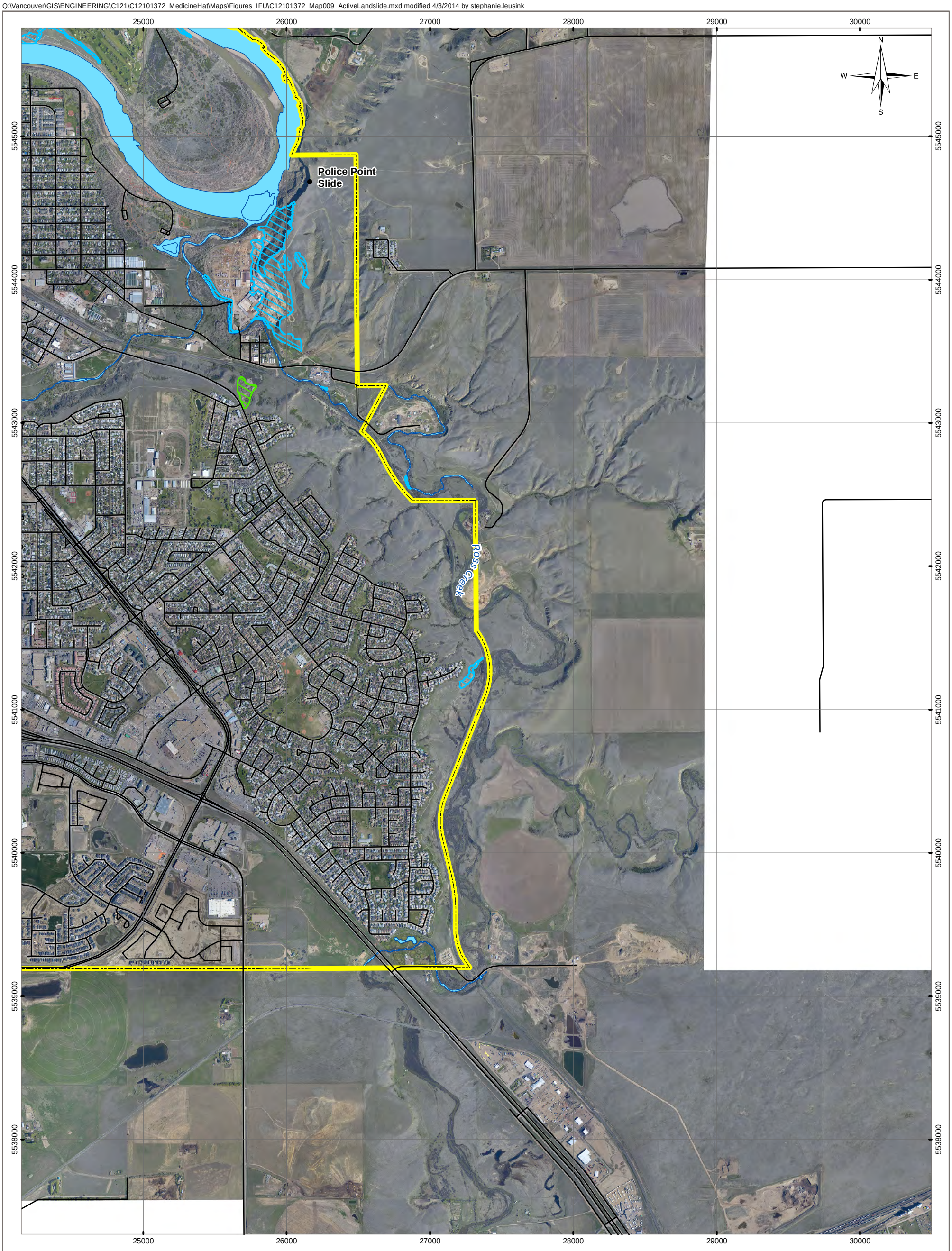
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas with Active Landslide Activity and Landslide Type

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map009_ActiveLandslide.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 13E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map009_ActiveLandslide.mxd modified 4/3/2014 by stephanie.leusink

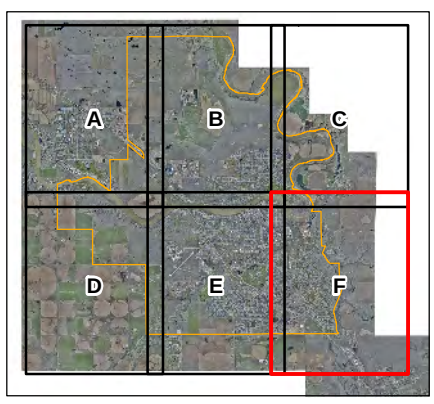


LEGEND

Active Landslide by Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas with Active Landslide Activity and Landslide Type

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres			eba A TETRA TECH COMPANY
FILE NO. C12101372_Map009_ActiveLandslide.mxd			
PROJECT NO. C12101372	**DWN** MEZ / **CKD** SL / **APVD** SH / **REV** 0		**Figure 13F**
OFFICE EBA-VANC	**DATE** April 3, 2014		

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map010_LandslideSize.mxd modified 4/3/2014 by stephanie.leusink

13000 14000 15000 16000 17000 18000 19000

5553000 5552000 5551000 5550000 5549000 5548000 5547000 5546000

N W E S

Trans-Canada Hwy

Redcliff

South Saskatchewan River

L30 L31 L32 L33 L34 L35 L36 L44

Redcliff Pumphouse Slide

Echodale Regional Park

L37

LEGEND

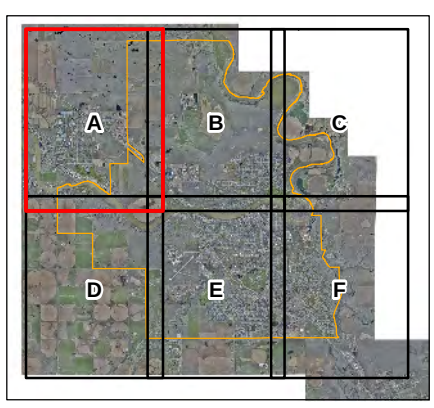
Landslide Size Class

- Very Small (1)
- Small (2)
- Moderately Small (3)
- Moderate (4)
- Moderately Large (5)
- Large (6)
- Very Large (7)

Landslide Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

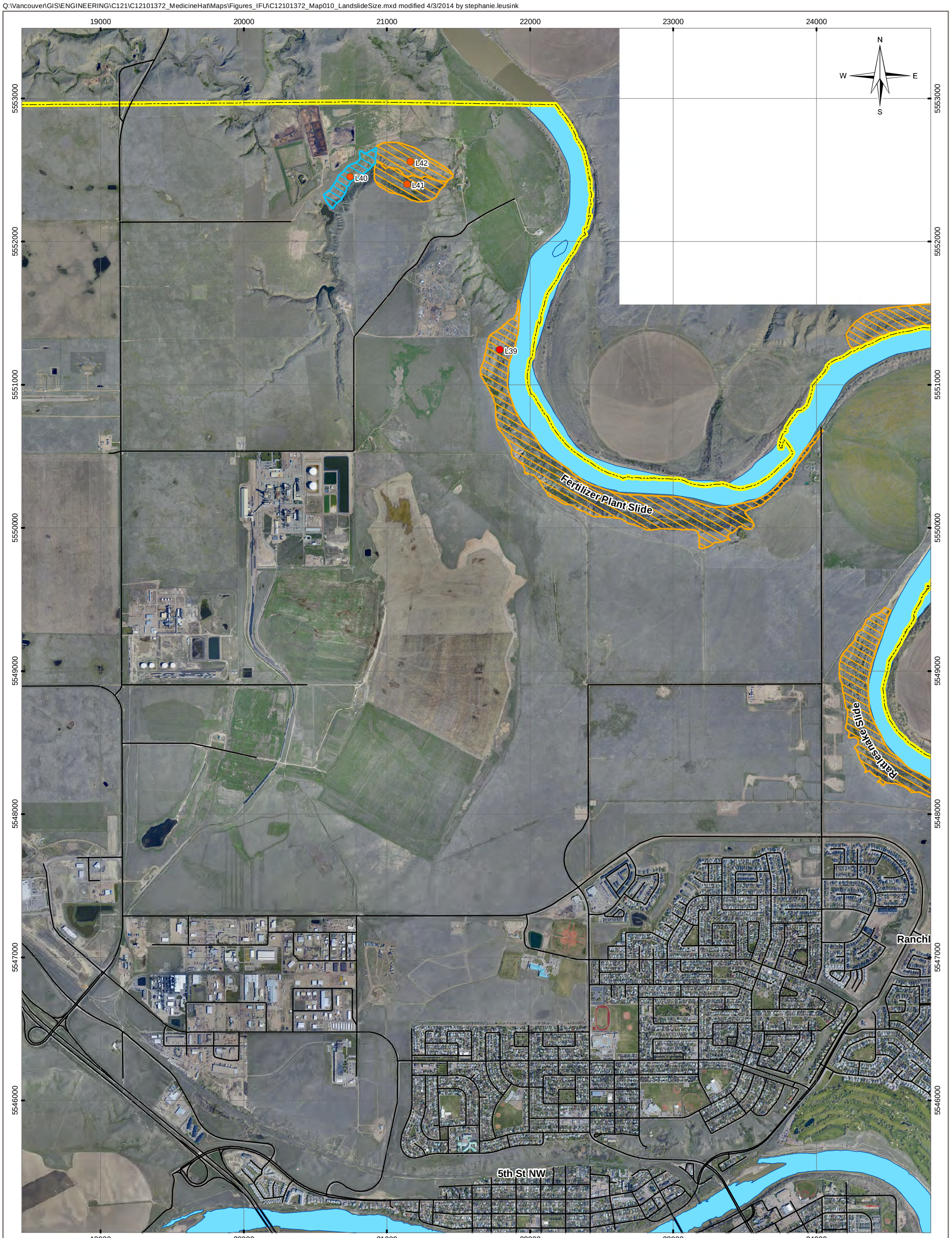
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Landslide Size and Type

PROJECTION: UTM Zone 12 (3TM)	DATUM: NAD83			CLIENT: City of Medicine Hat
Scale: 1:25,000 (500 250 0 500 Metres)				
FILE NO.: C12101372_Map010_LandslideSize.mxd				eba A TETRA TECH COMPANY
PROJECT NO.: C12101372	DWN: MEZ	CKD: SL	APVD: SH	REV: 0
OFFICE: EBA-VANC	DATE: April 3, 2014			Figure 14A

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map010_LandslideSize.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

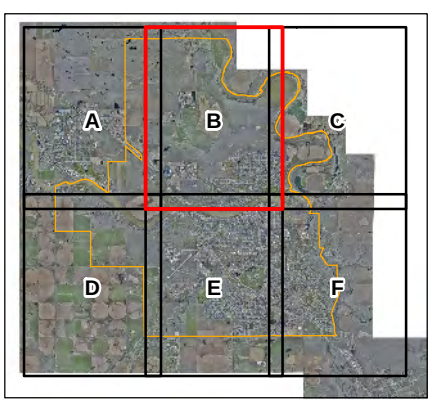
Landslide Size Class

- Very Small (1)
- Small (2)
- Moderately Small (3)
- Moderate (4)
- Moderately Large (5)
- Large (6)
- Very Large (7)

Landslide Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

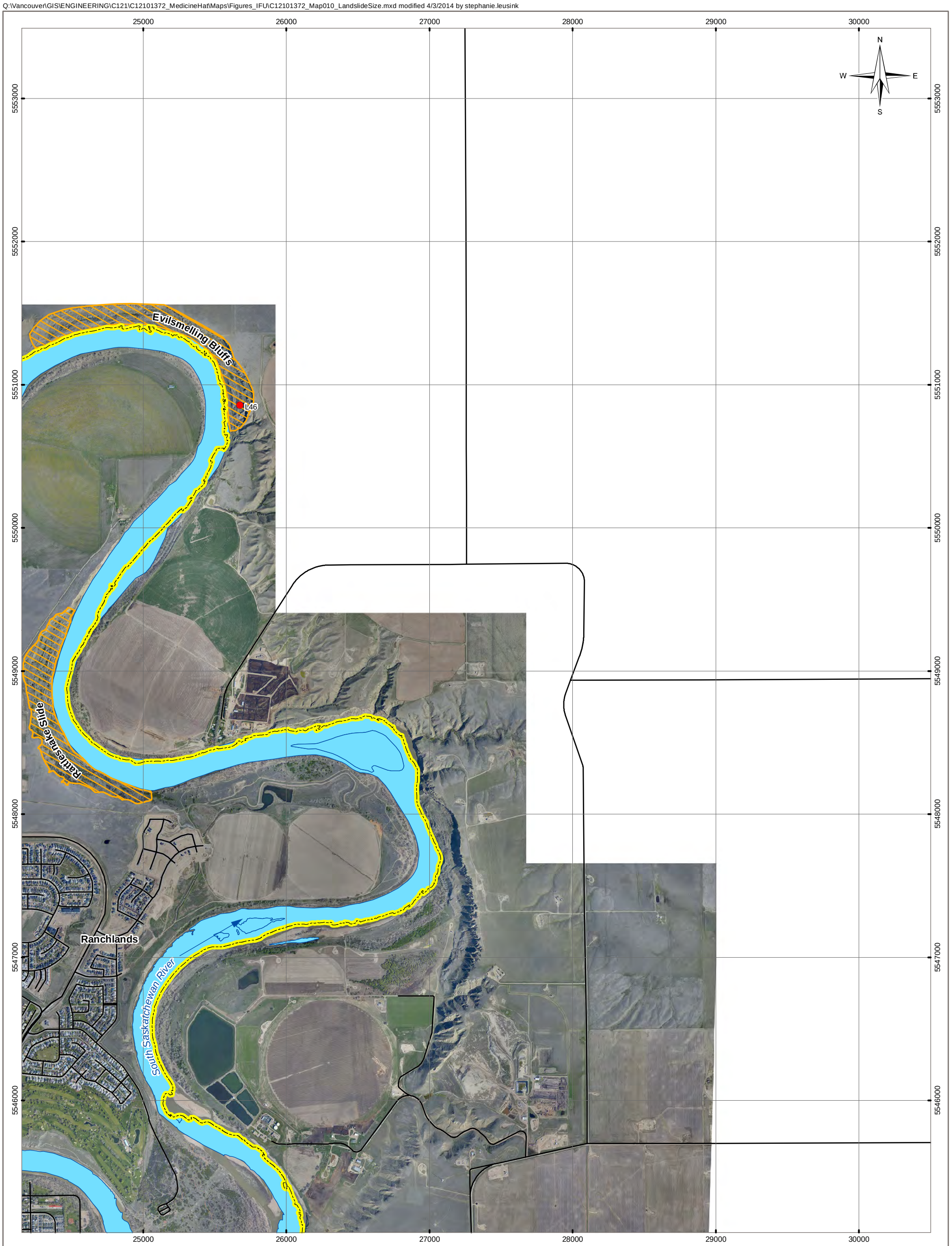
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Landslide Size and Type

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map010_LandslideSize.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 14B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map010_LandslideSize.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

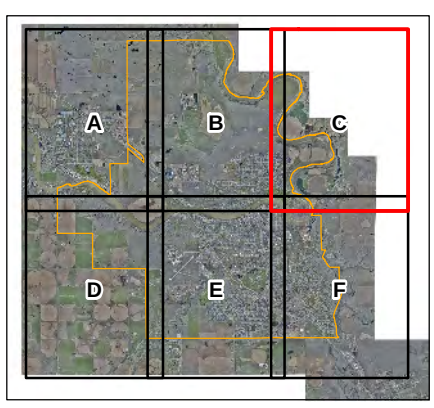
Landslide Size Class

- Very Small (1)
- Small (2)
- Moderately Small (3)
- Moderate (4)
- Moderately Large (5)
- Large (6)
- Very Large (7)

Landslide Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Landslide Size and Type

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat	
Scale: 1:25,000 — 500 250 0 500 Metres					
FILE NO. C12101372_Map010_LandslideSize.mxd				A TETRA TECH COMPANY	
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0	**Figure 14C**
OFFICE EBA-VANC	**DATE** April 3, 2014				

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map010_LandslideSize.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

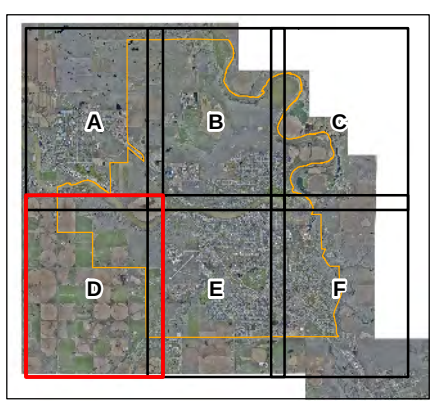
Landslide Size Class

- Very Small (1)
- Small (2)
- Moderately Small (3)
- Moderate (4)
- Moderately Large (5)
- Large (6)
- Very Large (7)

Landslide Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

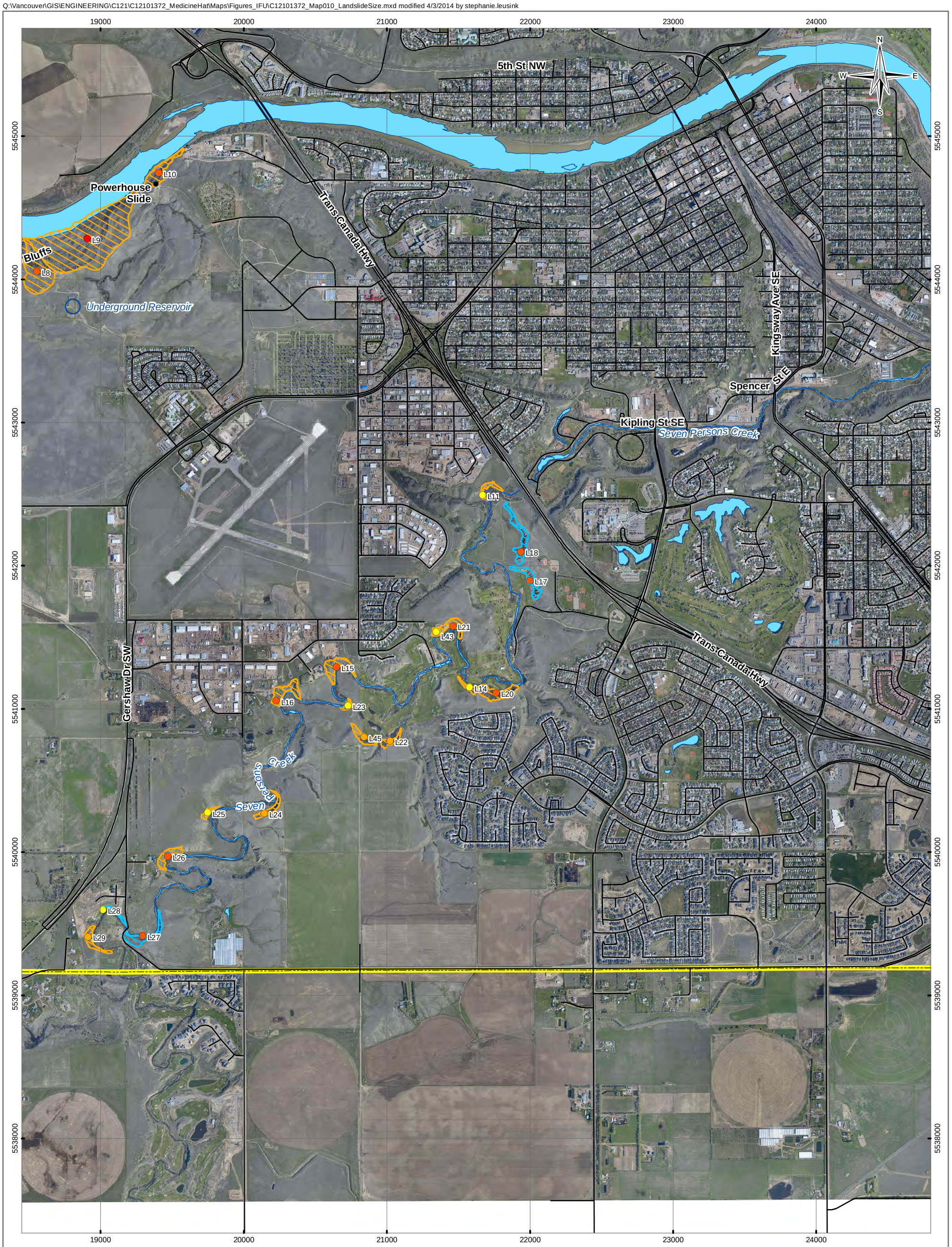
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Landslide Size and Type

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				A TETRA TECH COMPANY
FILE NO. C12101372_Map010_LandslideSize.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 14D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map010_LandslideSize.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

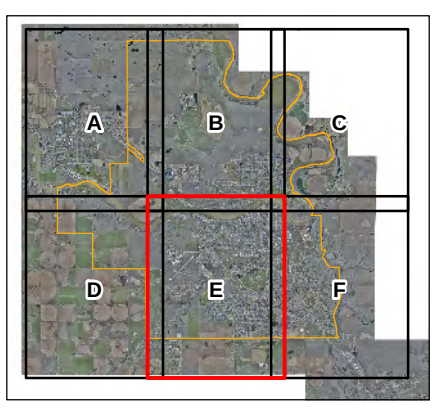
Landslide Size Class

- Very Small (1)
- Small (2)
- Moderately Small (3)
- Moderate (4)
- Moderately Large (5)
- Large (6)
- Very Large (7)

Landslide Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

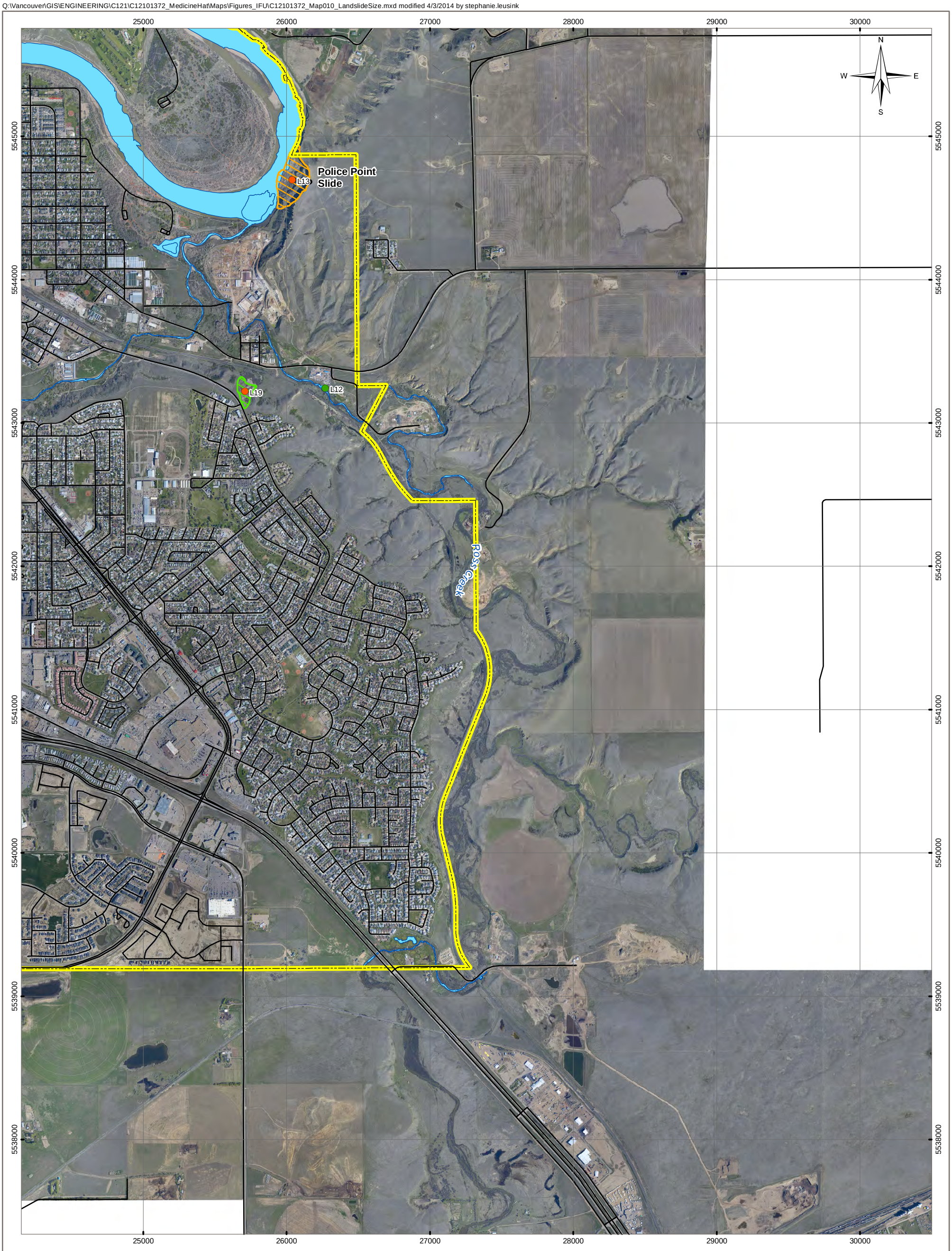
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Landslide Size and Type

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map010_LandslideSize.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 14E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map010_LandslideSize.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

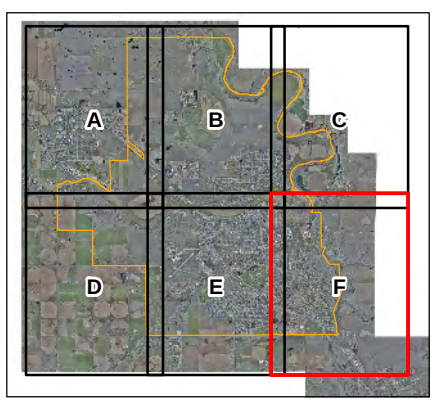
Landslide Size Class

- Very Small (1)
- Small (2)
- Moderately Small (3)
- Moderate (4)
- Moderately Large (5)
- Large (6)
- Very Large (7)

Landslide Type

- Earth/Rock Slump (R)
- Earth/Rock Slide (T)
- Compound (R-T)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

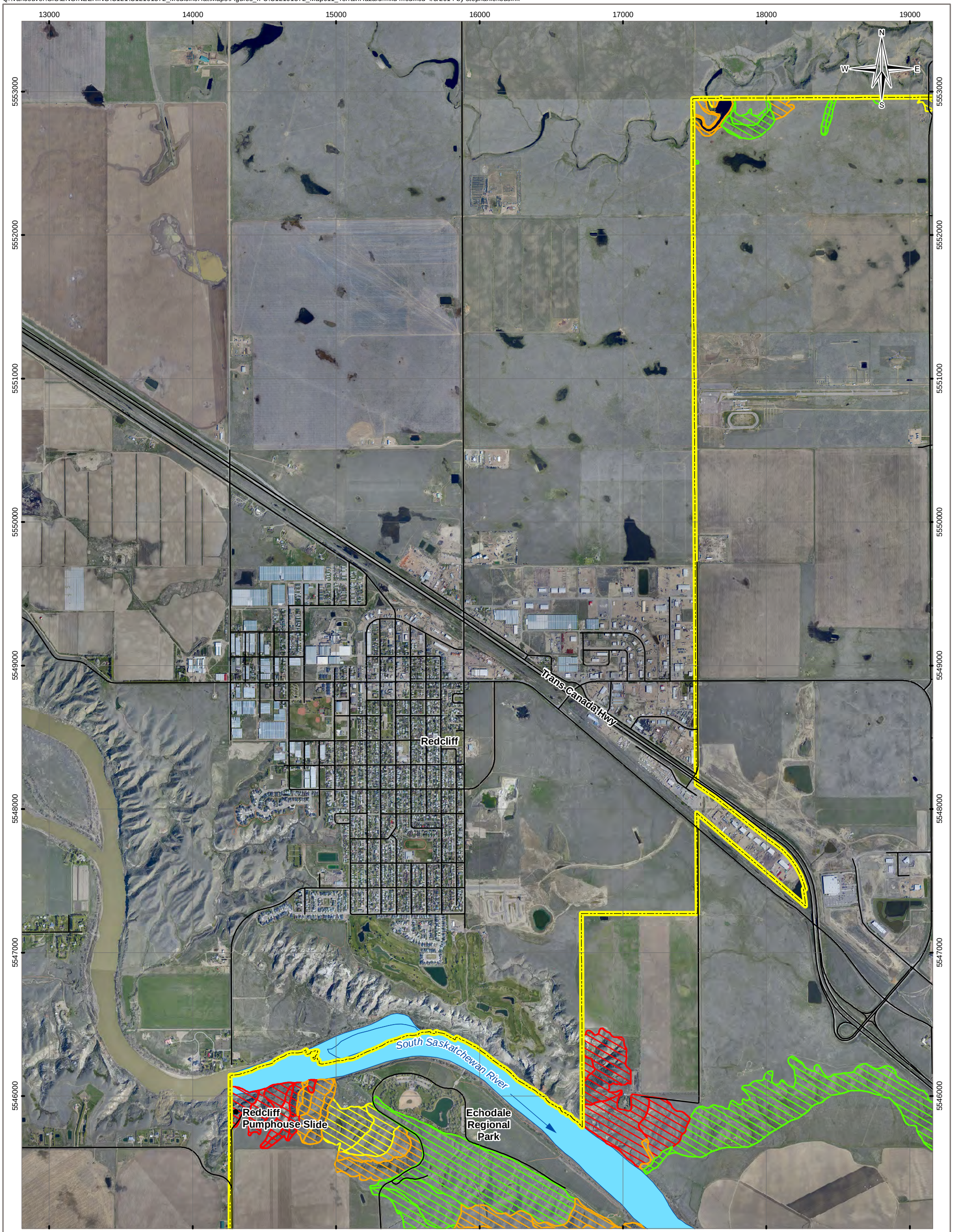
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Landslide Size and Type

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map010_LandslideSize.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 14F**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map011_TerrainHazard.mxd modified 4/3/2014 by stephanie.leusink

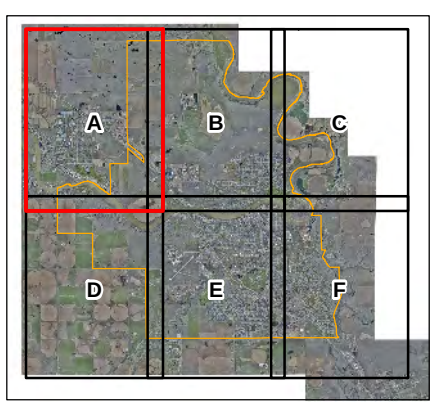


LEGEND

Terrain Hazard Class

- 1
- 2
- 3
- 4

- Roads
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

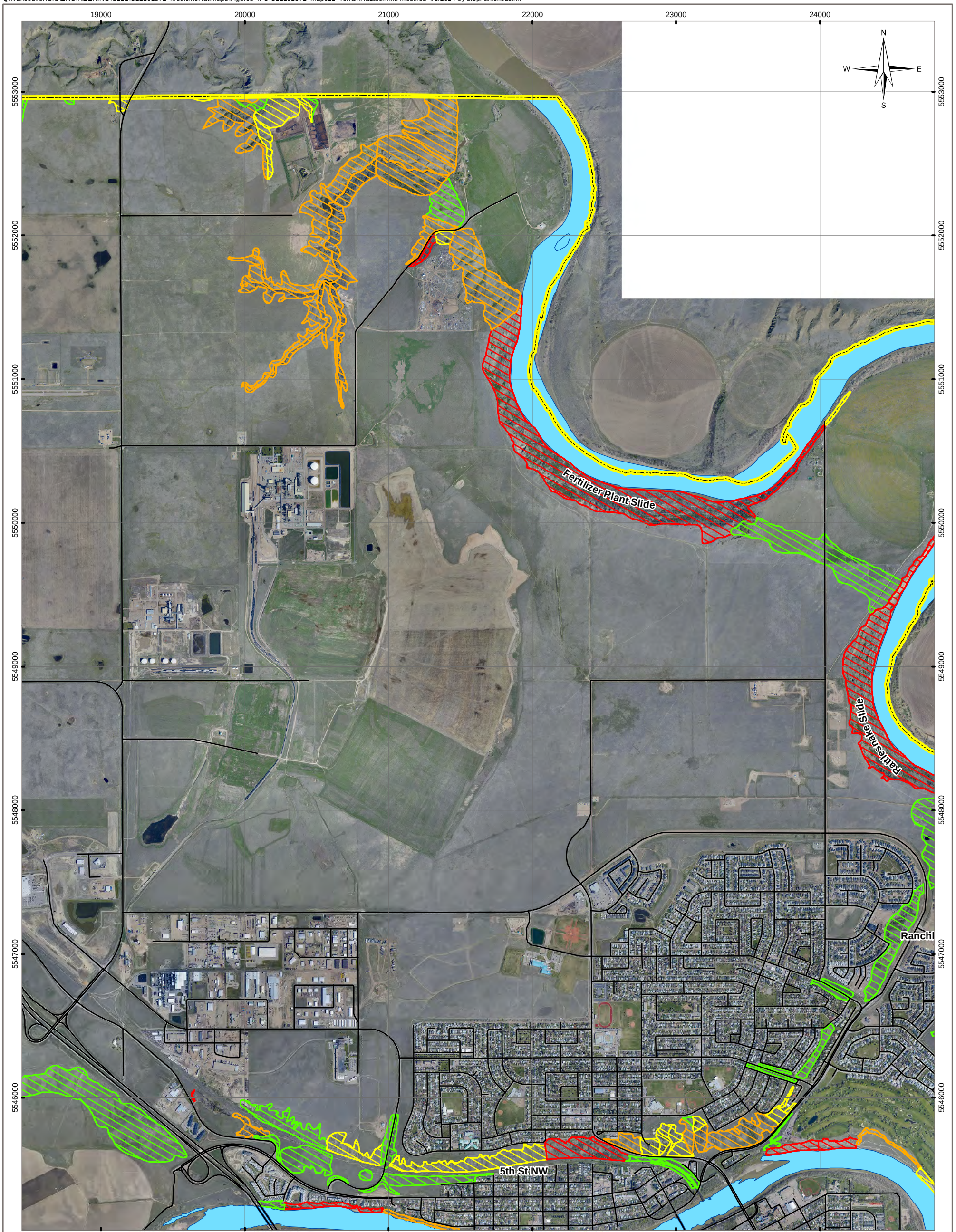
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Terrain Hazard Map

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map011_TerrainHazard.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 15A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map011_TerrainHazard.mxd modified 4/3/2014 by stephanie.leusink

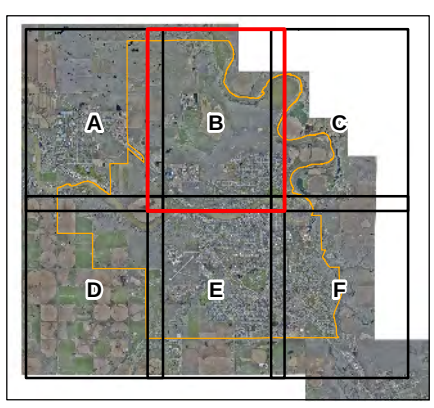


LEGEND

Terrain Hazard Class

- 1
- 2
- 3
- 4

- Roads
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

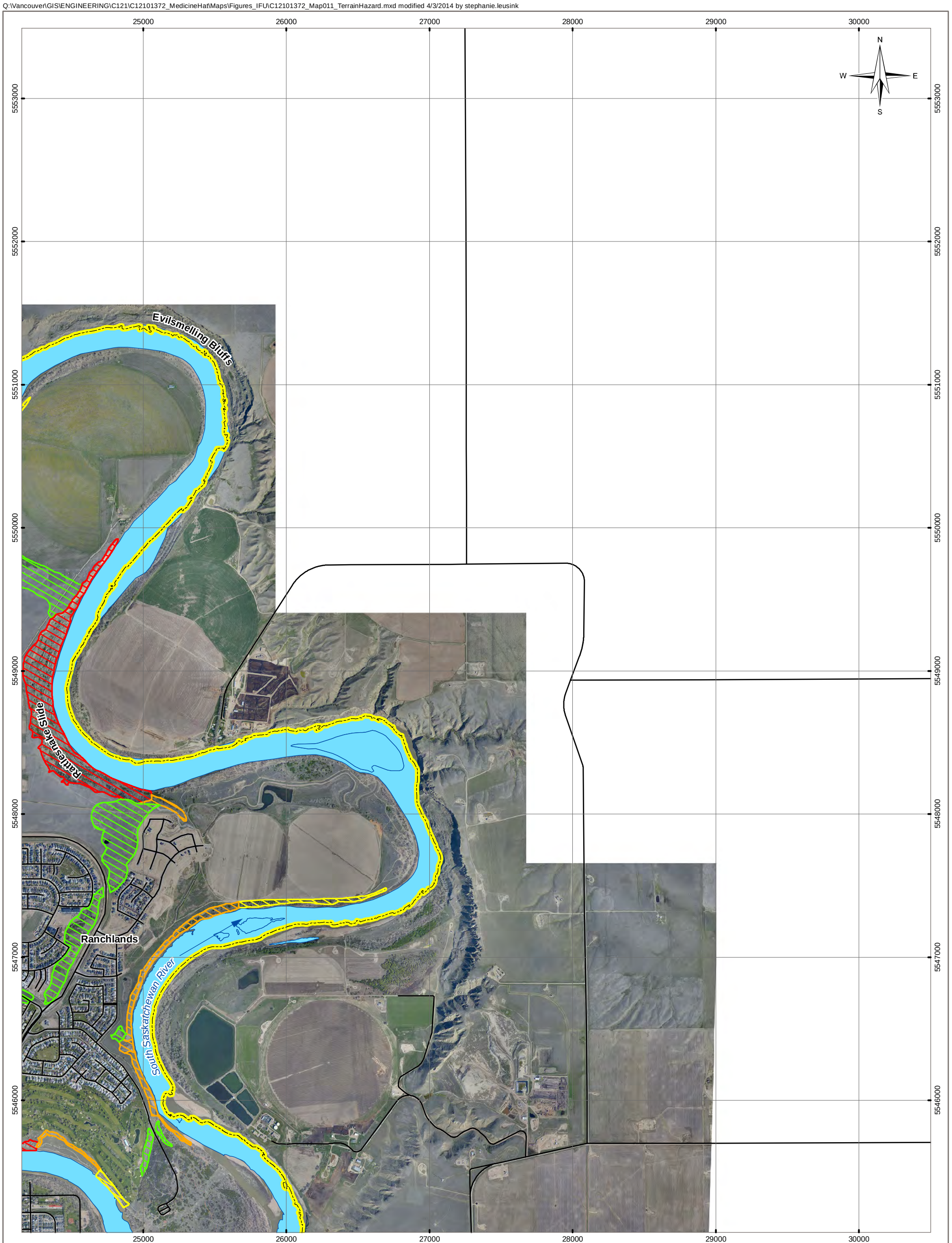
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Terrain Hazard Map

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map011_TerrainHazard.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 15B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map011_TerrainHazard.mxd modified 4/3/2014 by stephanie.leusink

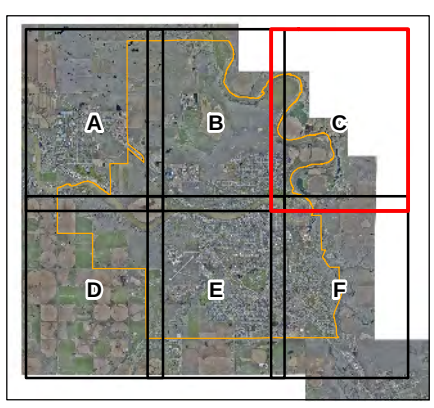


LEGEND

Terrain Hazard Class

- 1
- 2
- 3
- 4

- Roads
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Terrain Hazard Map

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Map011_TerrainHazard.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 15C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map011_TerrainHazard.mxd modified 4/3/2014 by stephanie.leusink

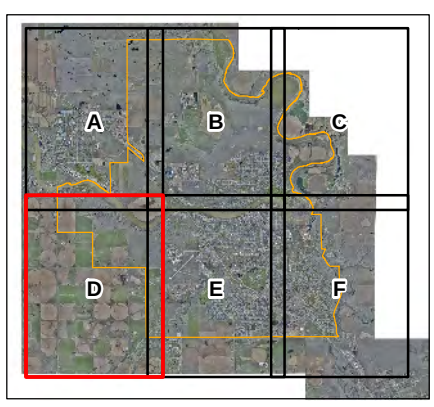


LEGEND

Terrain Hazard Class

- 1
- 2
- 3
- 4

- Roads
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

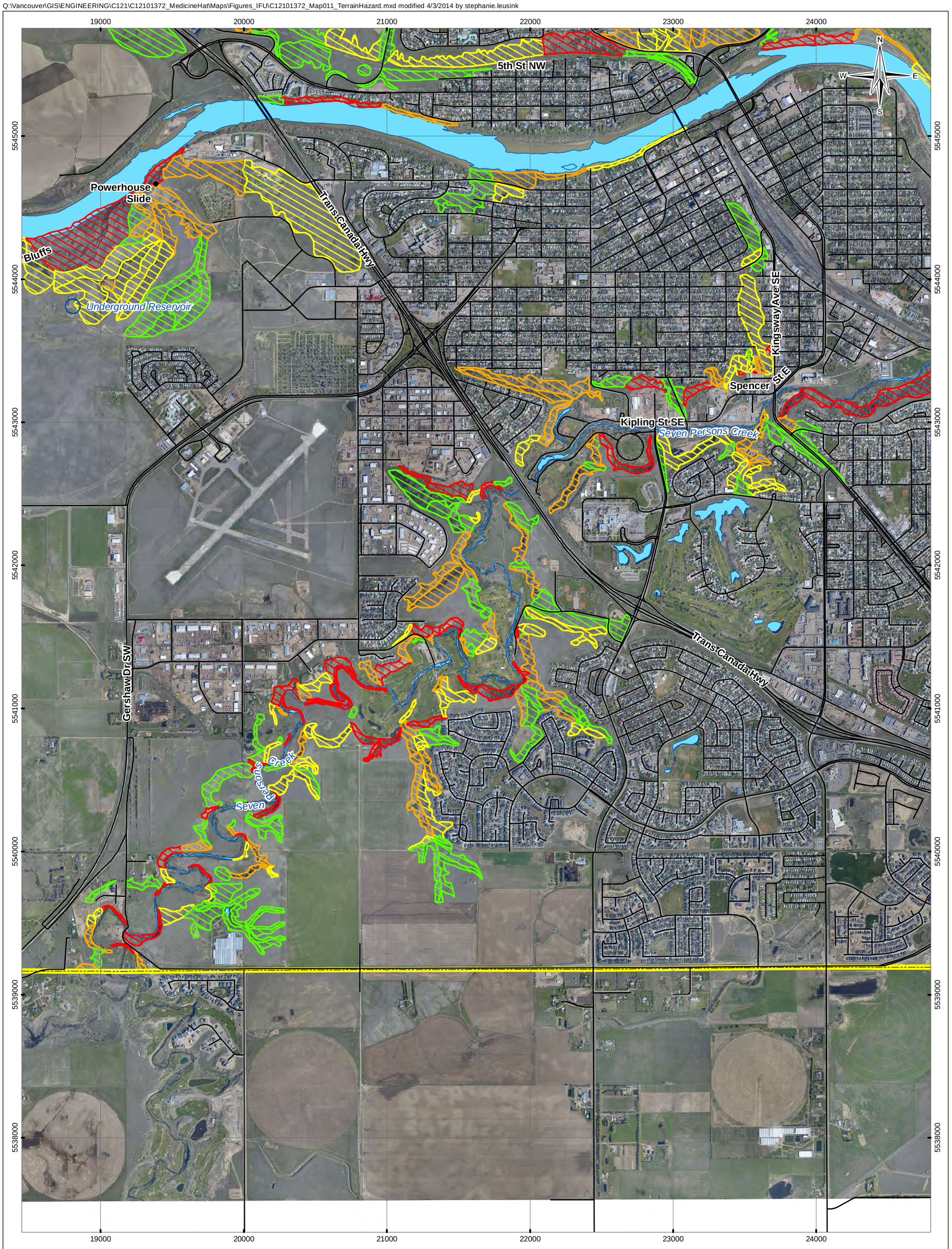
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Terrain Hazard Map

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map011_TerrainHazard.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 15D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map011_TerrainHazard.mxd modified 4/3/2014 by stephanie.leusink

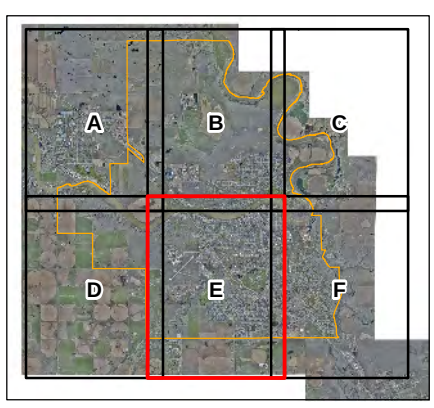


LEGEND

Terrain Hazard Class

- 1
- 2
- 3
- 4

- Roads
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

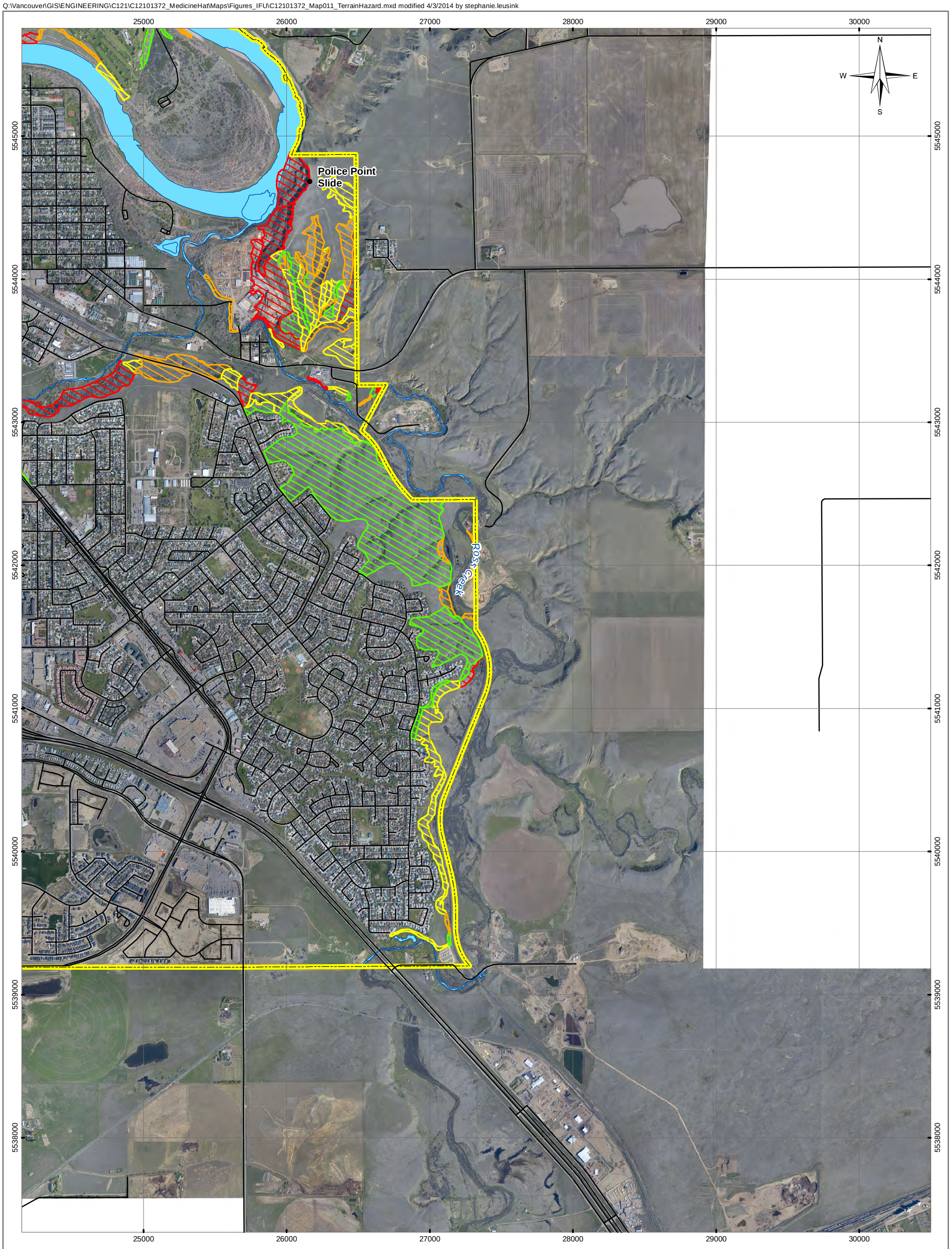
MEDICINE HAT SLOPE SETBACKS

Terrain Hazard Map

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map011_TerrainHazard.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 15E**

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map011_TerrainHazard.mxd modified 4/3/2014 by stephanie.leusink

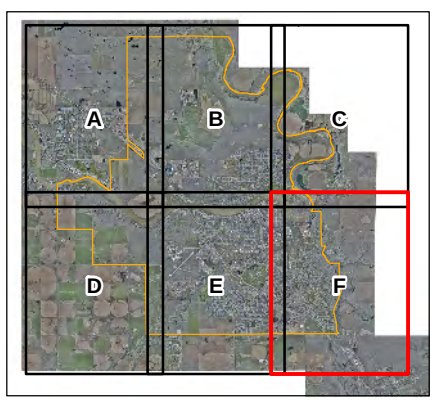


LEGEND

Terrain Hazard Class

- 1
- 2
- 3
- 4

- Roads
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Terrain Hazard Map

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map011_TerrainHazard.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 15F**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map012_HighHazard.mxd modified 4/3/2014 by stephanie.leusink

13000 14000 15000 16000 17000 18000 19000

5553000 5552000 5551000 5550000 5549000 5548000 5547000 5546000

N W E S

Trans-Canada Hwy

Redcliff

South Saskatchewan River

Redcliff Pumphouse Slide

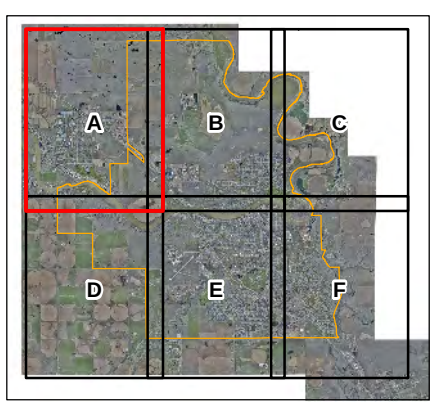
Echodale Regional Park

LEGEND

Terrain Hazard Class

- 3
- 4

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

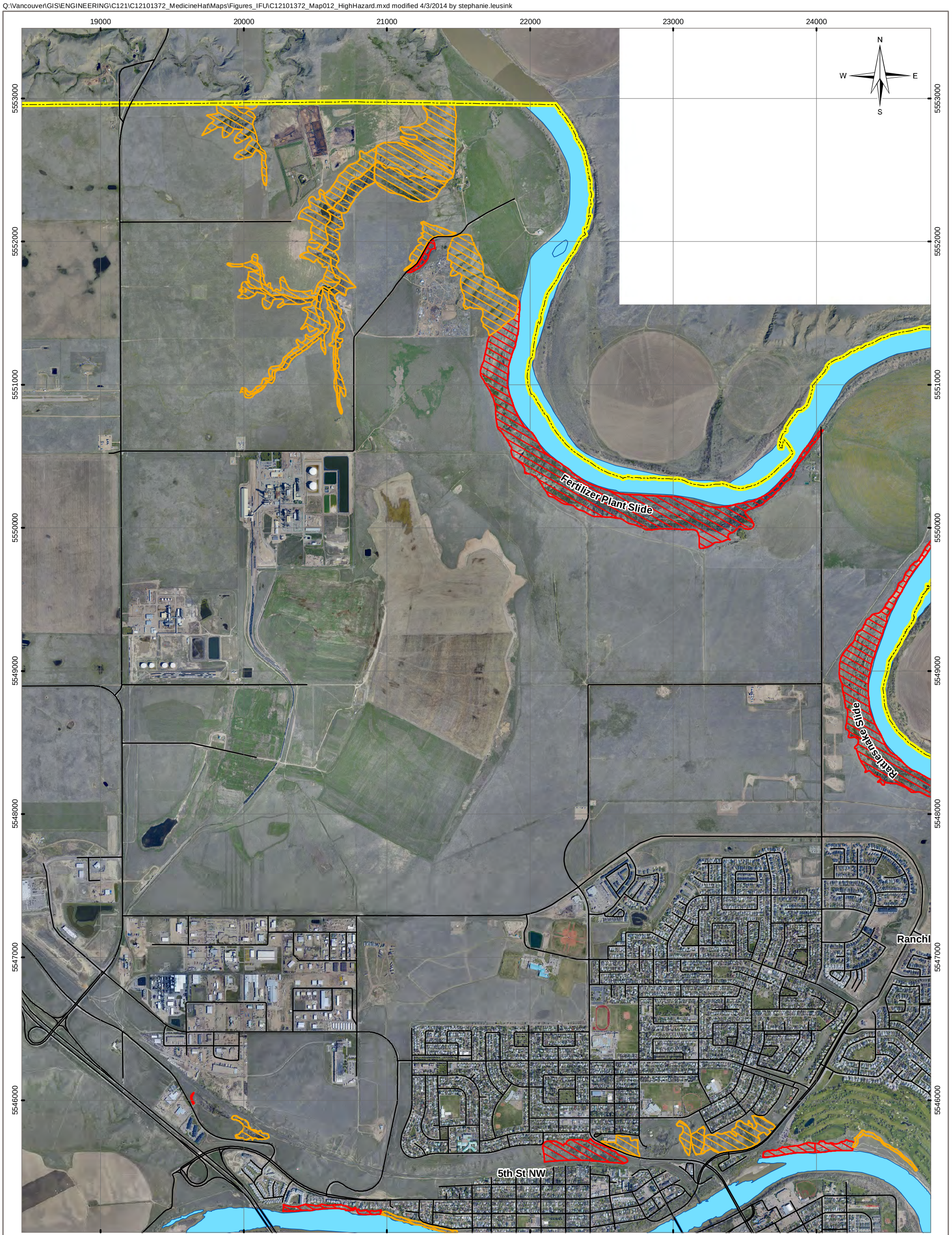
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas with Class 3 and 4 Terrain Hazards

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map012_HighHazard.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 16A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map012_HighHazard.mxd modified 4/3/2014 by stephanie.leusink

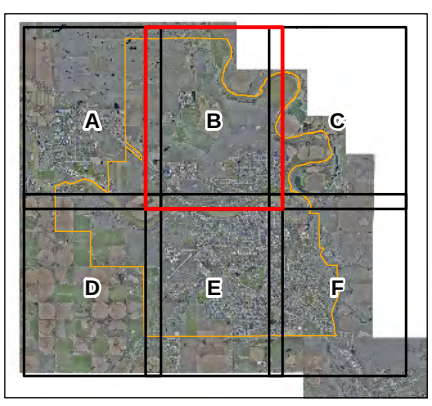


LEGEND

Terrain Hazard Class

- 3
- 4

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

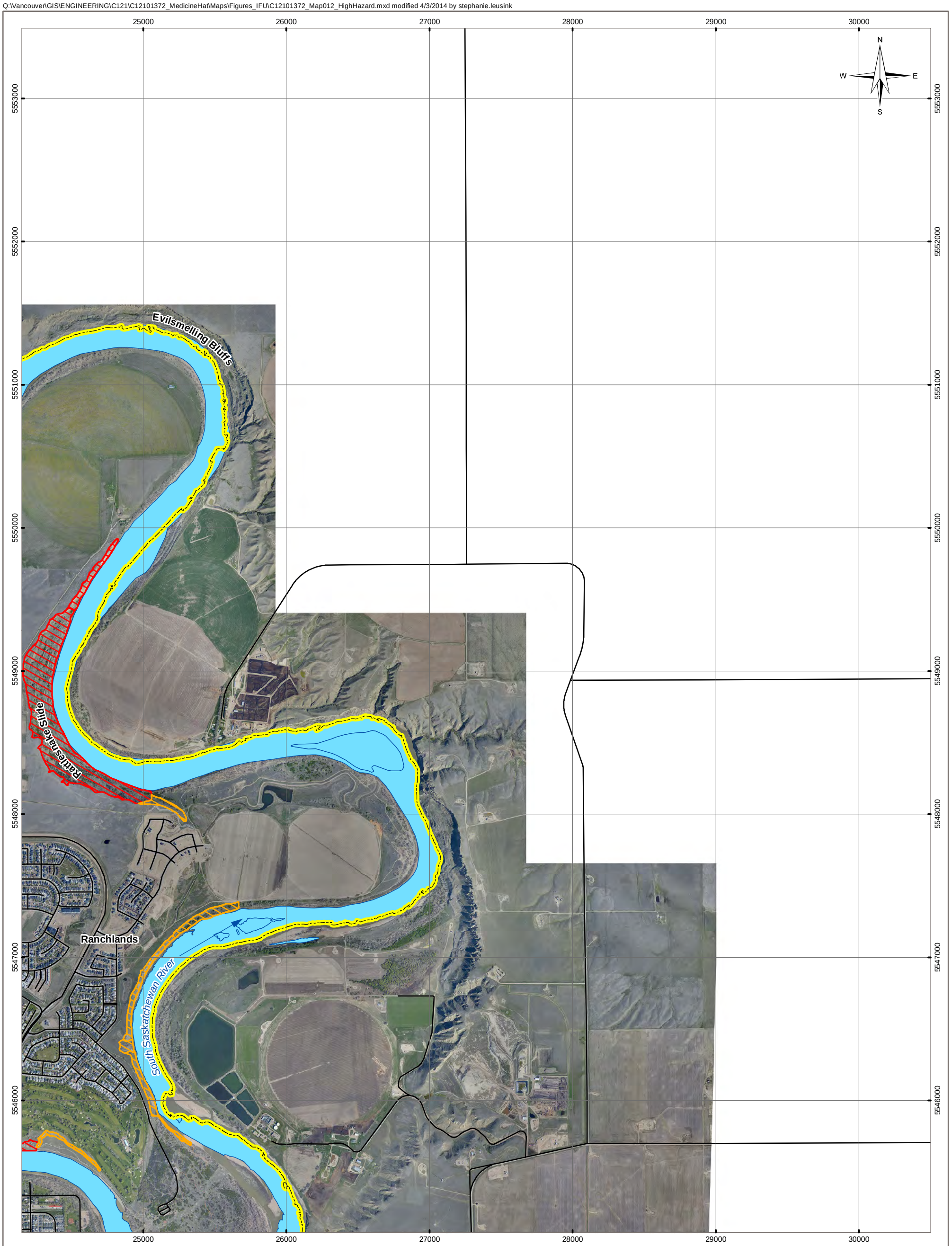
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas with Class 3 and 4 Terrain Hazards

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map012_HighHazard.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 16B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map012_HighHazard.mxd modified 4/3/2014 by stephanie.leusink

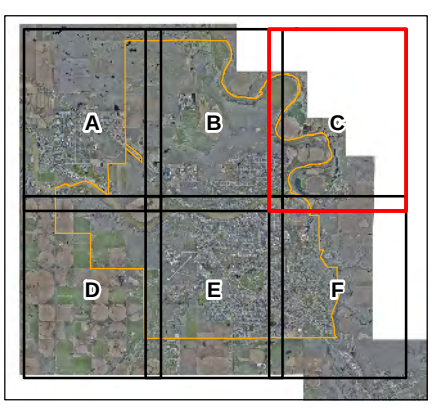


LEGEND

Terrain Hazard Class

- 3
- 4

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas with Class 3 and 4 Terrain Hazards

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Map012_HighHazard.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 16C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map012_HighHazard.mxd modified 4/3/2014 by stephanie.leusink

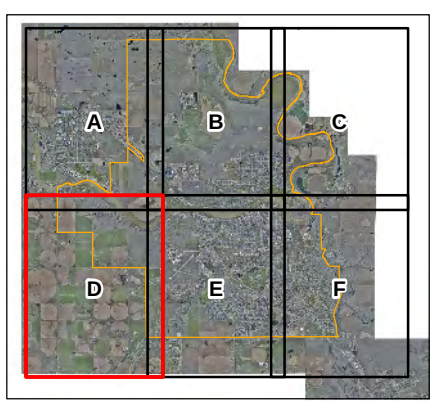


LEGEND

Terrain Hazard Class

- 3
- 4

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

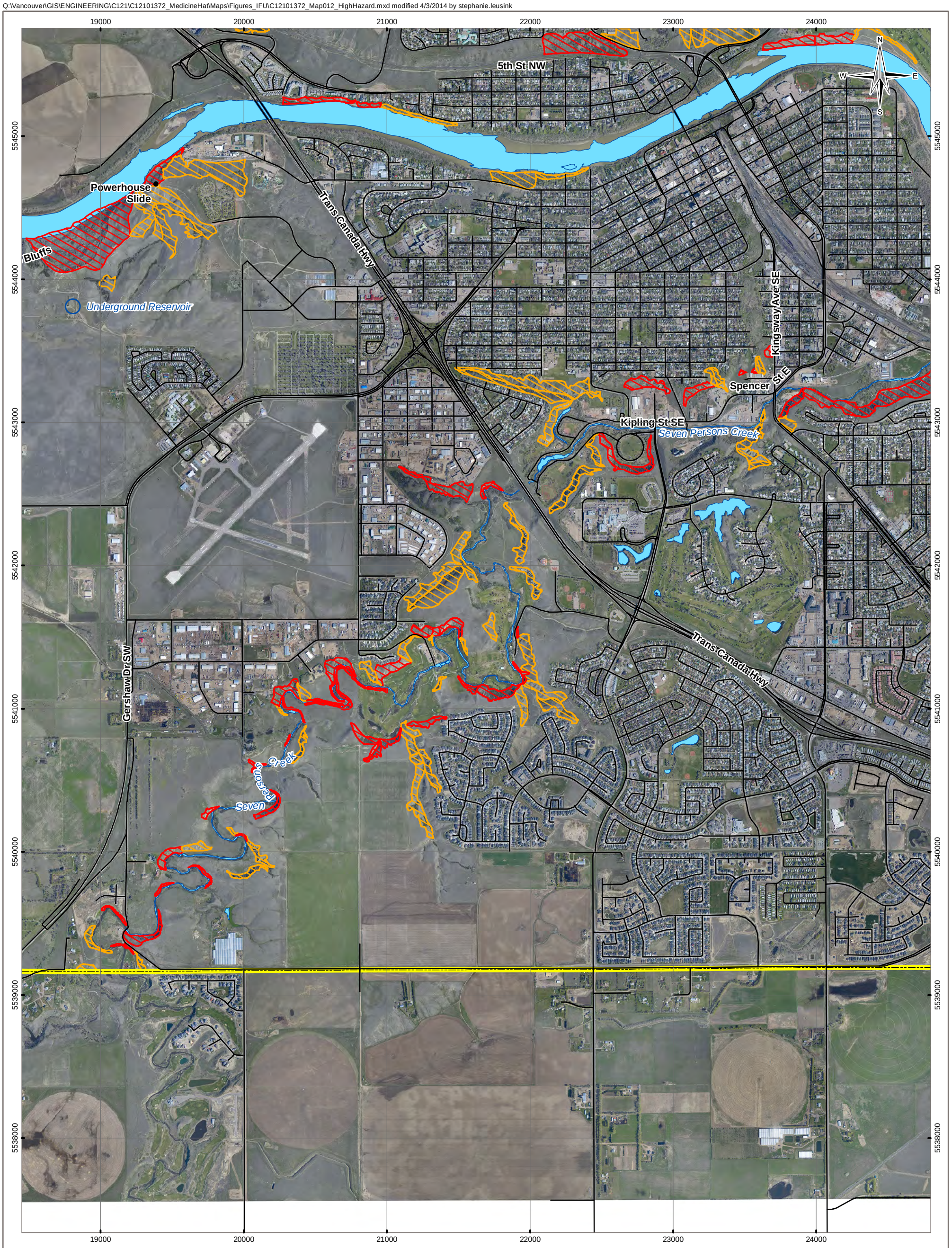
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas with Class 3 and 4 Terrain Hazards

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map012_HighHazard.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 16D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map012_HighHazard.mxd modified 4/3/2014 by stephanie.leusink

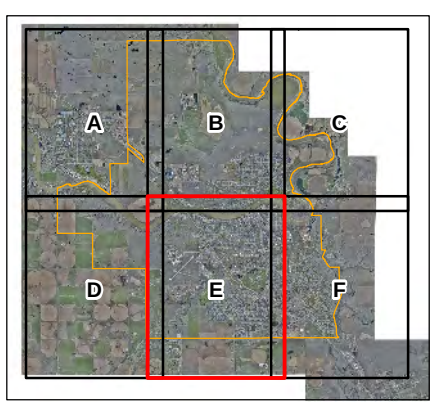


LEGEND

Terrain Hazard Class

- 3
- 4

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

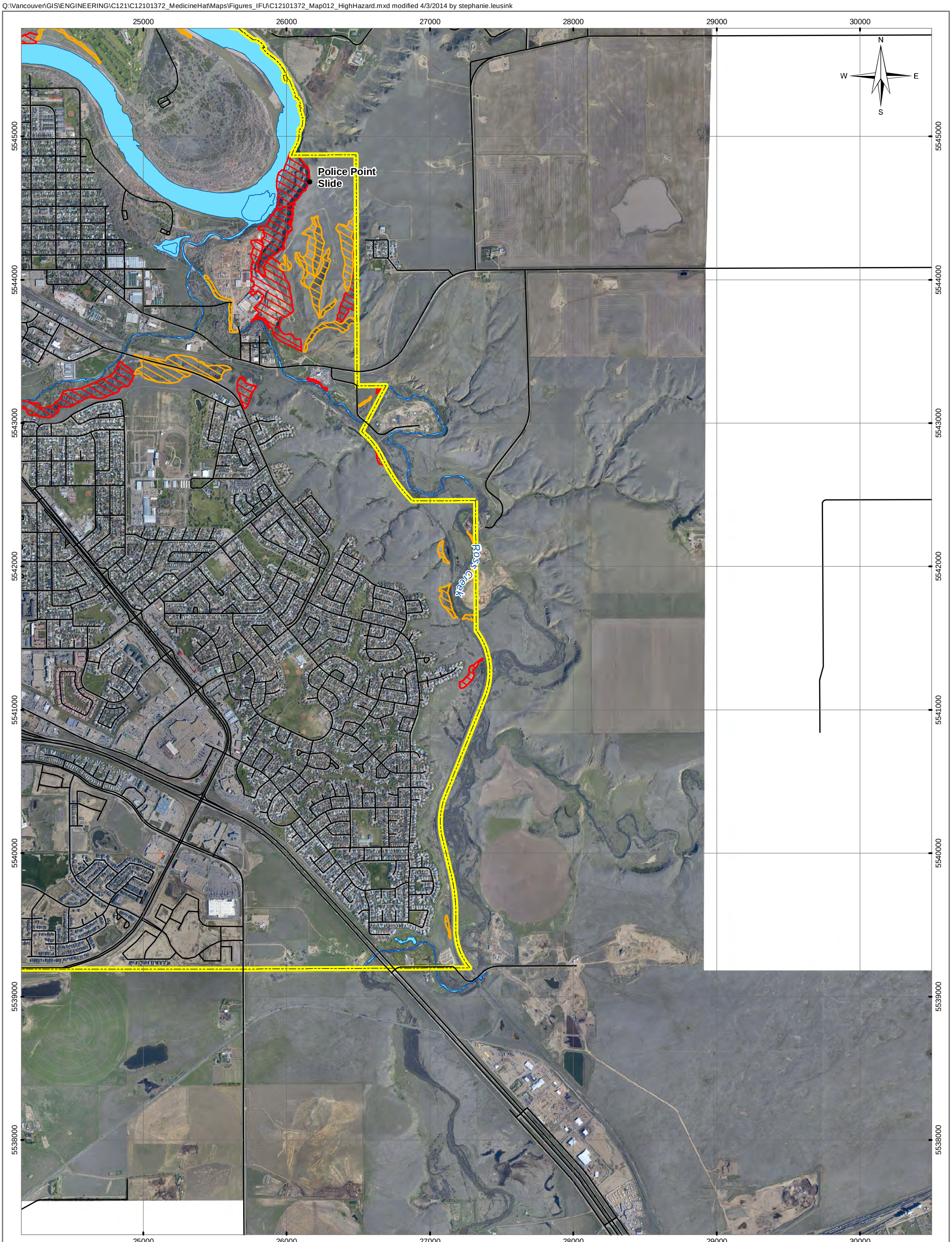
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Areas with Class 3 and 4 Terrain Hazards

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map012_HighHazard.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 16E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map012_HighHazard.mxd modified 4/3/2014 by stephanie.leusink

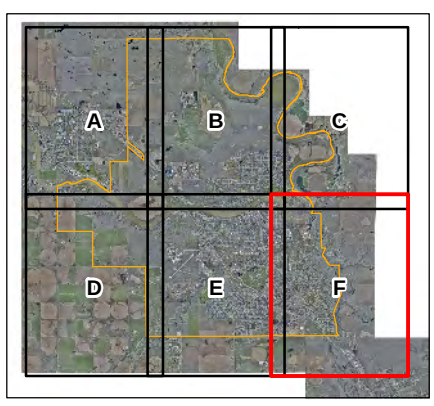


LEGEND

Terrain Hazard Class

- 3
- 4

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

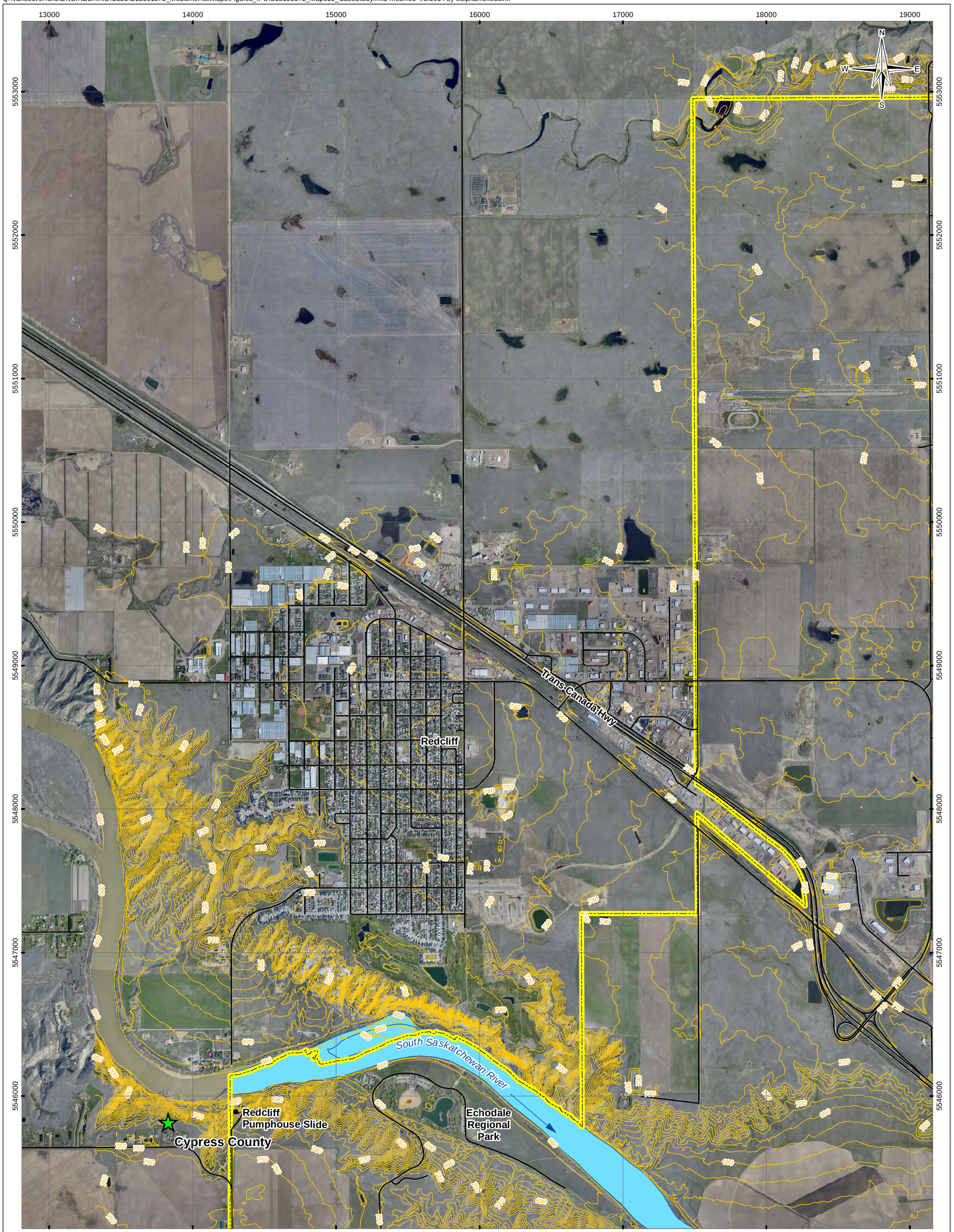
MEDICINE HAT SLOPE SETBACKS

Areas with Class 3 and 4 Terrain Hazards

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres			
FILE NO. C12101372_Map012_HighHazard.mxd			
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL / **APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014		**Figure 16F**

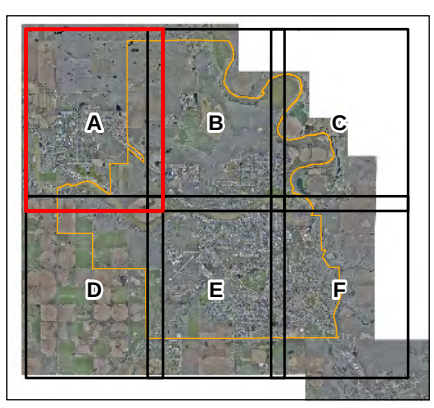
eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map013_CaseStudy.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Case Study Location
- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

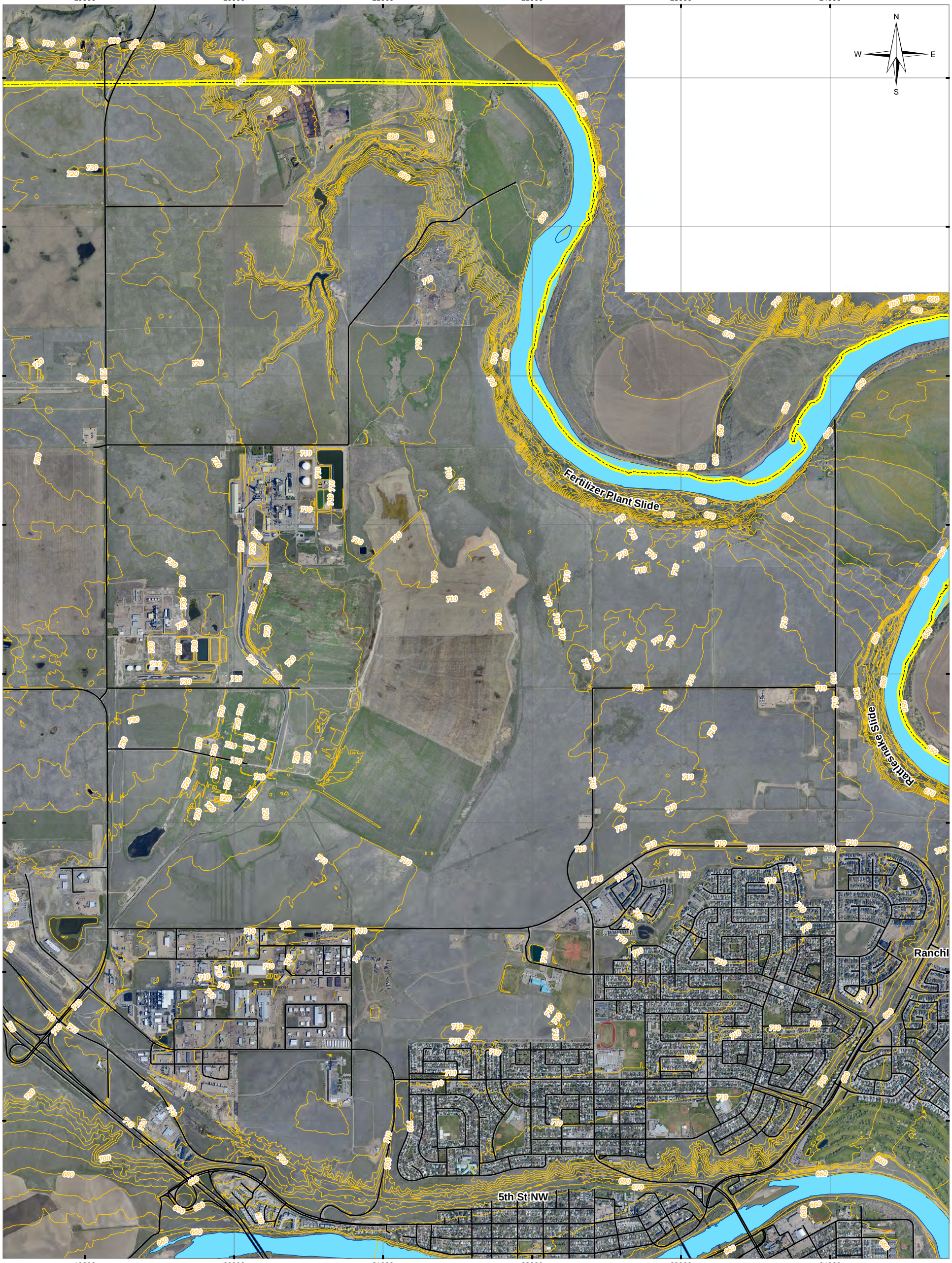
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Case Study Location Plan

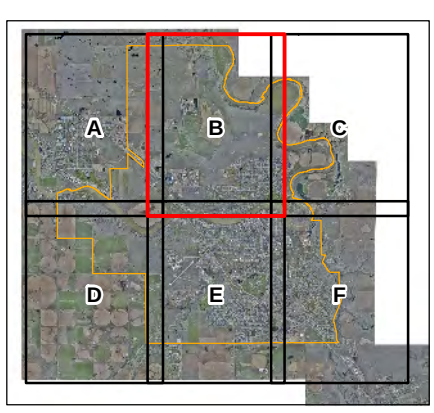
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map013_CaseStudy.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 17A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map013_CaseStudy.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Case Study Location
- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Case Study Location Plan

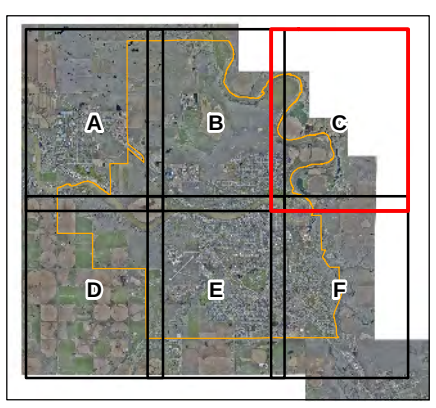
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map013_CaseStudy.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 17B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map013_CaseStudy.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Case Study Location
- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

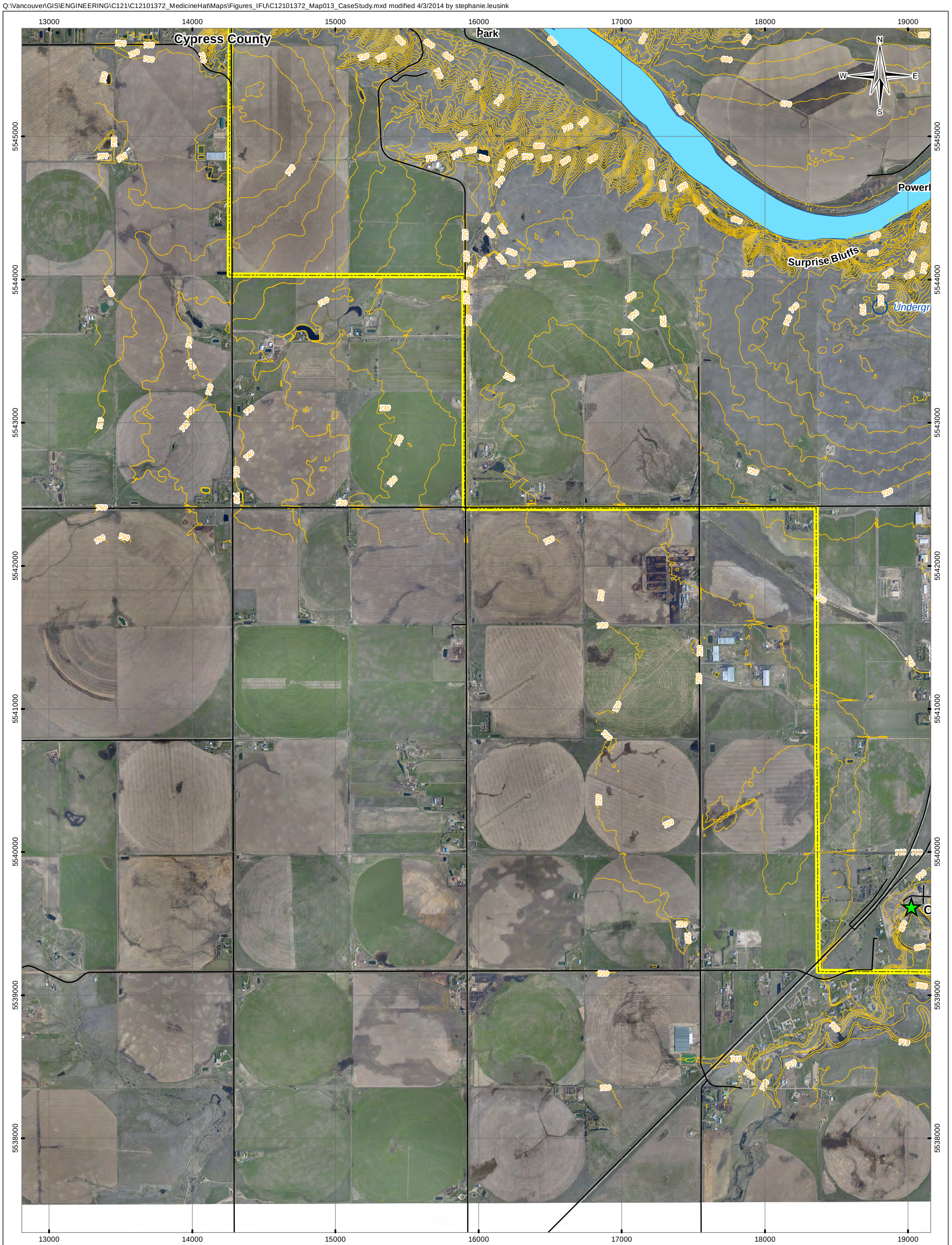
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Case Study Location Plan

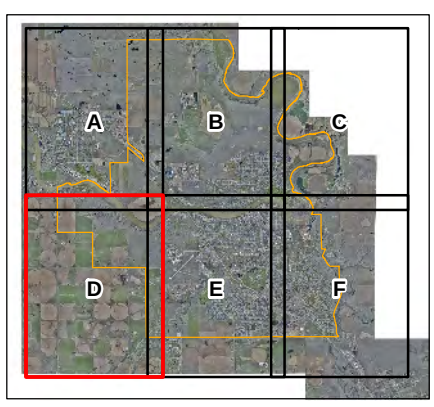
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map013_CaseStudy.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 17C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map013_CaseStudy.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Case Study Location
- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Case Study Location Plan

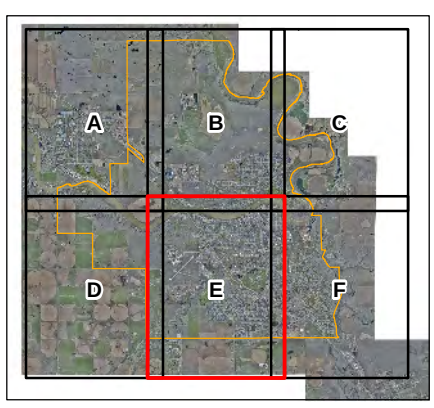
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map013_CaseStudy.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 17D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map013_CaseStudy.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Case Study Location
- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

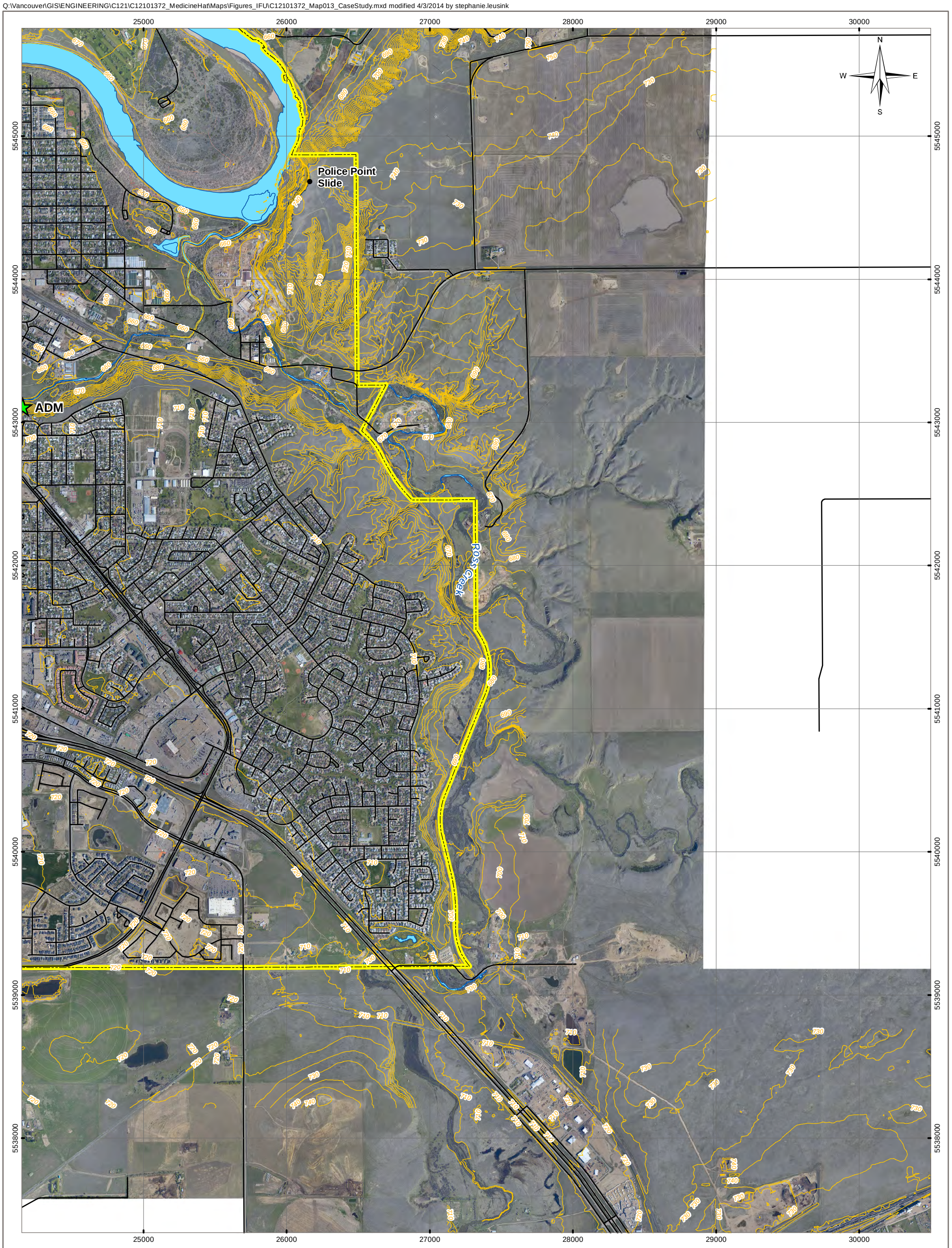
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Case Study Location Plan

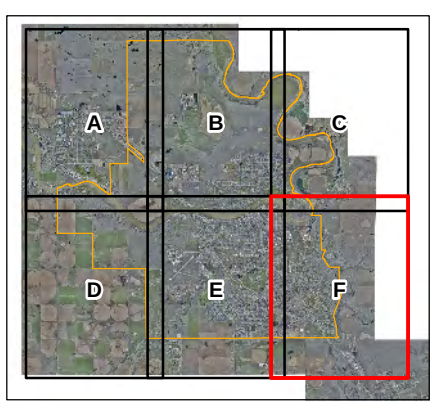
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map013_CaseStudy.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 17E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map013_CaseStudy.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Case Study Location
- Road
- City Boundary
- Contour (5 m)
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

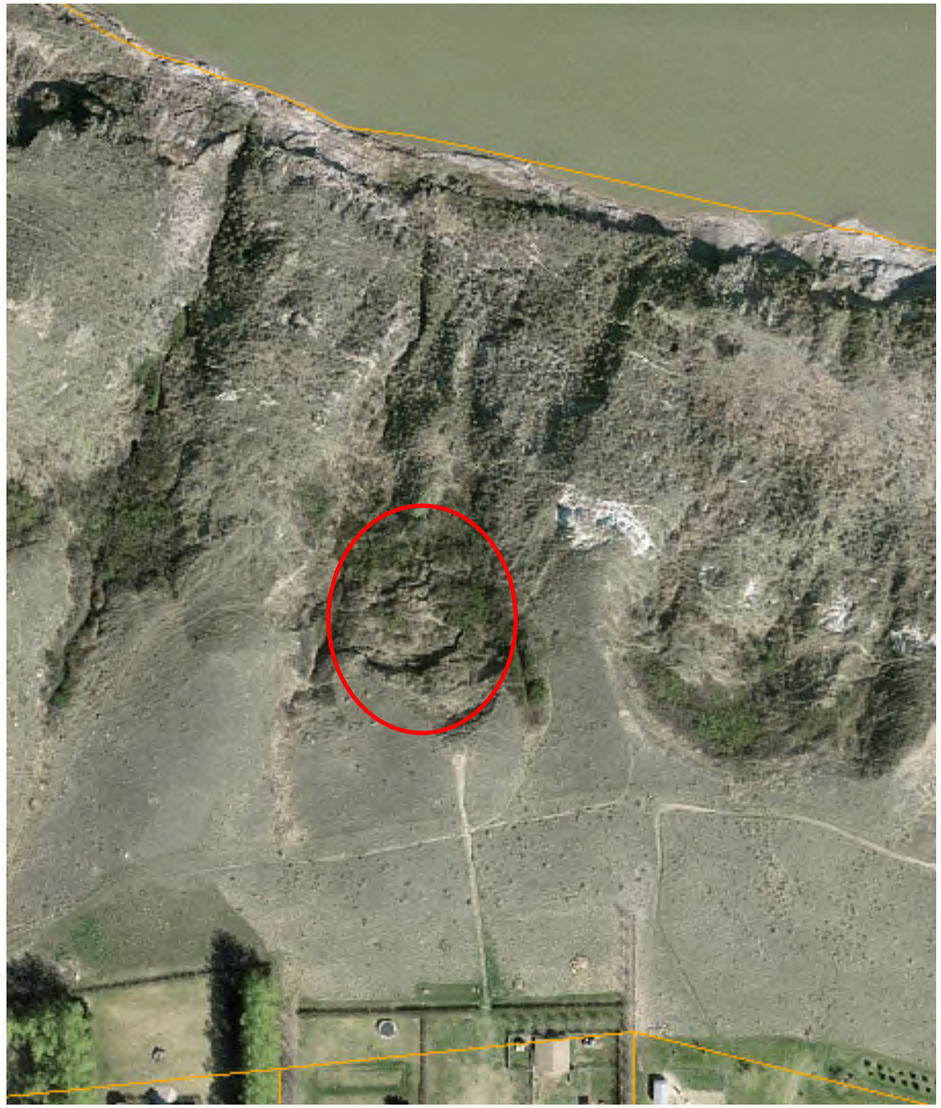
MEDICINE HAT SLOPE SETBACKS

Case Study Location Plan

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map013_CaseStudy.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 17F**



2005 GoogleEarth Pro Image



2006 Orthophoto

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

eba
A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

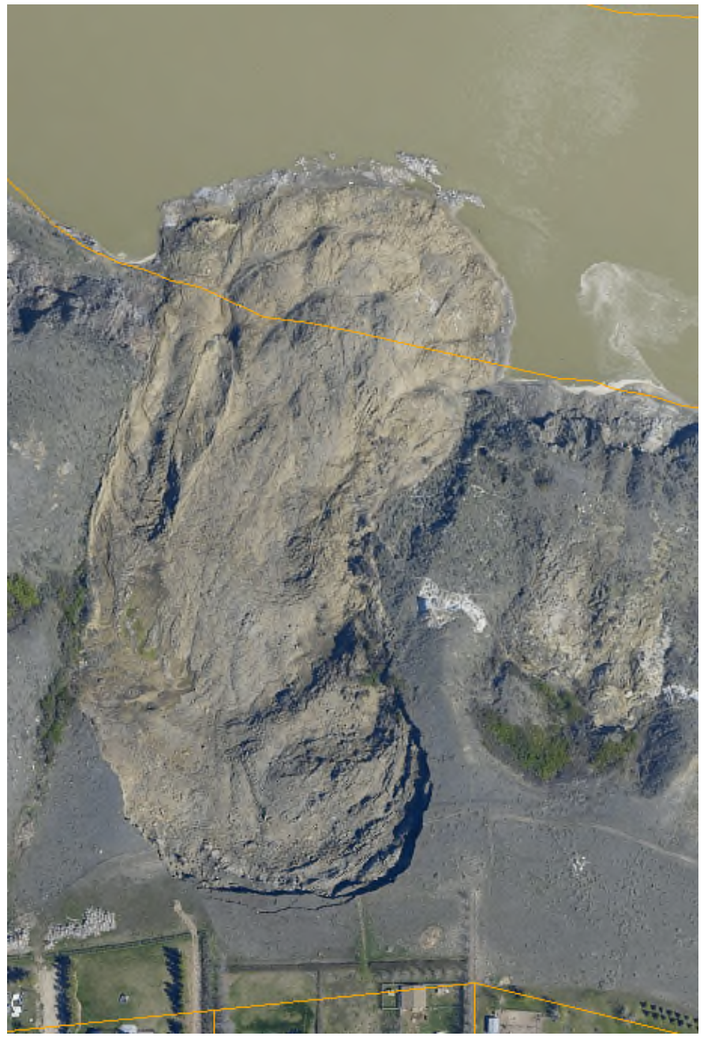
Landslide Regression Plan
Cypress County TWP Rd 130 Slide

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	January 12, 2012

Figure 18-1

C:\Users\becky.wohlgemuth\Desktop\C12101372 Figures\Figure 18-1.doc



2010 Orthophoto



2010 Orthophoto

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Landslide Regression Plan
Cypress County TWP Rd 130 Slide

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

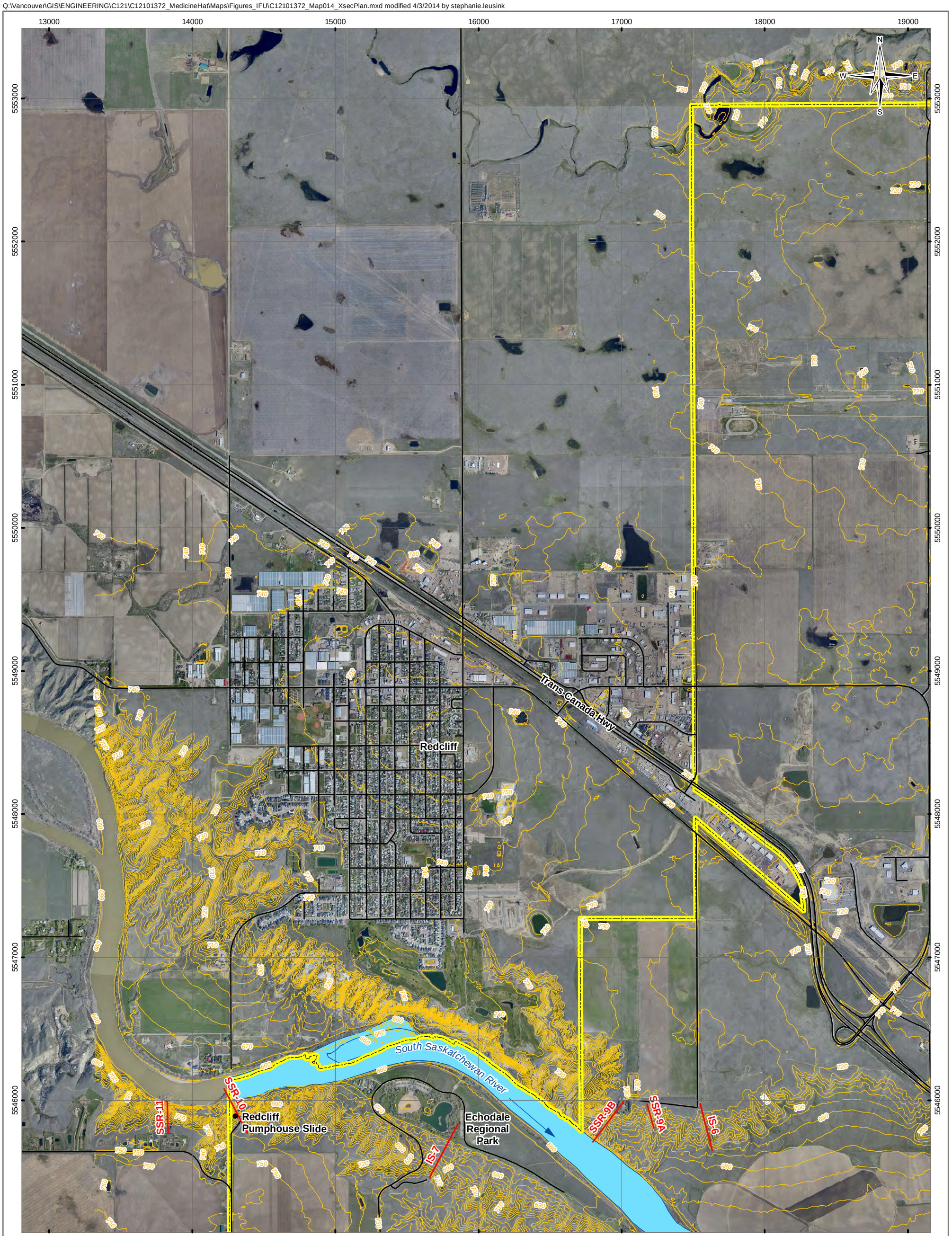
OFFICE
EBA-Riverbend

DATE
January 12, 2012

Figure 18-2

C:\Users\becky.wohlgemuth\Desktop\C12101372 Figures\Figure 18-2.doc

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map014_XsecPlan.mxd modified 4/3/2014 by stephanie.leusink

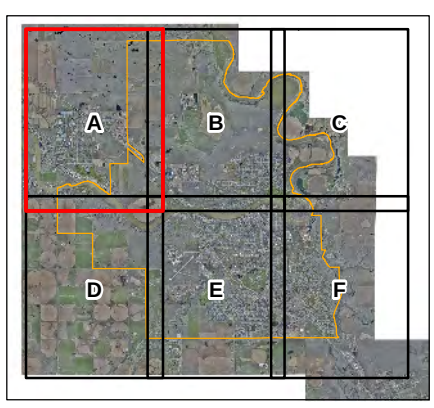


LEGEND

- Cross-Section[2]
- Road
- City Boundary
- Contour (5 m)
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Cross-Section labels contain the following abbreviations:
   IS - Interior Slopes
   RC - Ross Creek
   SPC - Seven Persons Creek
   SSR - South Saskatchewan River



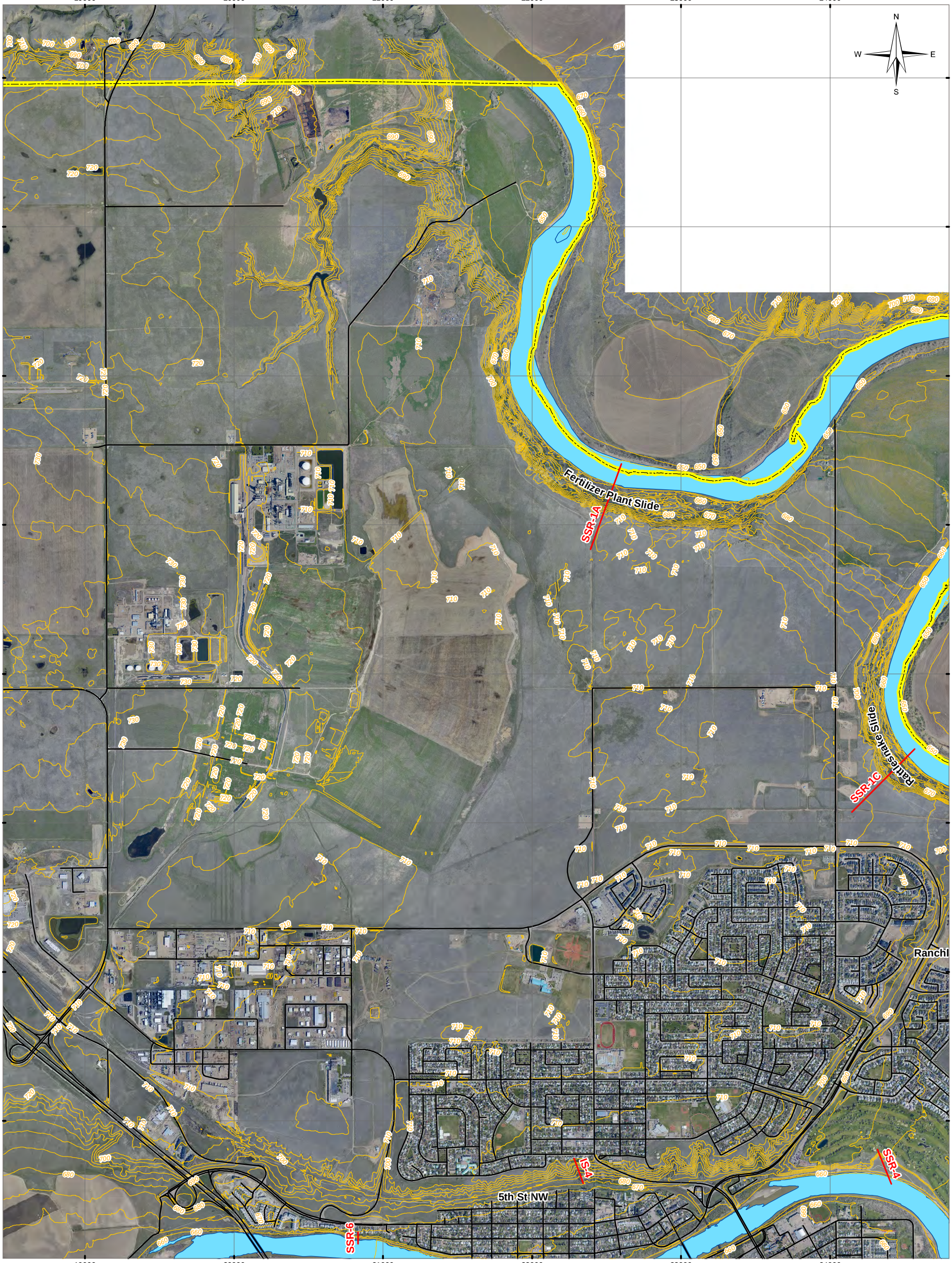
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Cross-Section Location Plan

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres					eba A TETRA TECH COMPANY
FILE NO. C12101372_Map014_XsecPlan.mxd					
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0	**Figure 19A**
OFFICE EBA-VANC	**DATE** April 3, 2014				

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map014_XsecPlan.mxd modified 4/3/2014 by stephanie.leusink

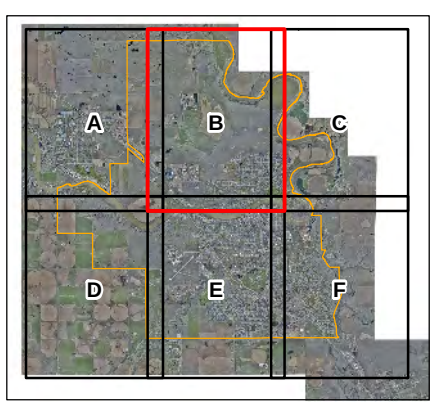


LEGEND

- Cross-Section[2]
- Road
- City Boundary
- Contour (5 m)
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Cross-Section labels contain the following abbreviations:
   IS - Interior Slopes
   RC - Ross Creek
   SPC - Seven Persons Creek
   SSR - South Saskatchewan River



STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Cross-Section Location Plan

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map014_XsecPlan.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 19B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map014_XsecPlan.mxd modified 4/3/2014 by stephanie.leusink

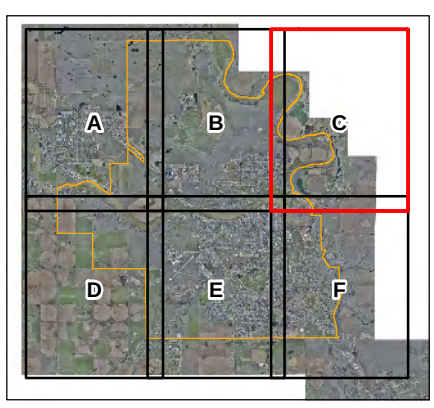


LEGEND

- Cross-Section[2]
- Road
- City Boundary
- Contour (5 m)
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Cross-Section labels contain the following abbreviations:
   IS - Interior Slopes
   RC - Ross Creek
   SPC - Seven Persons Creek
   SSR - South Saskatchewan River



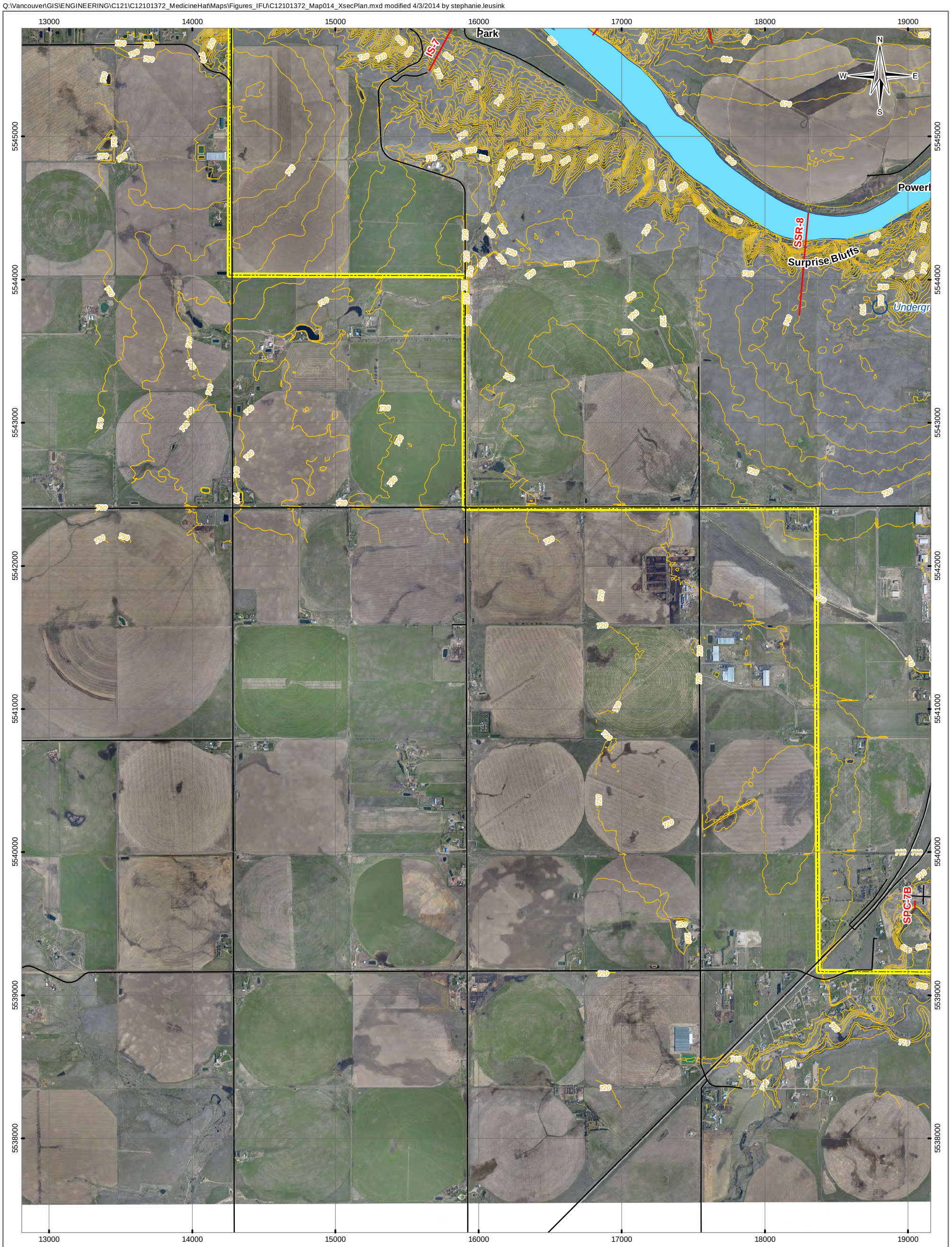
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Cross-Section Location Plan

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres					eba A TETRA TECH COMPANY
FILE NO. C12101372_Map014_XsecPlan.mxd					
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0	**Figure 19C**
OFFICE EBA-VANC	**DATE** April 3, 2014				

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map014_XsecPlan.mxd modified 4/3/2014 by stephanie.leusink

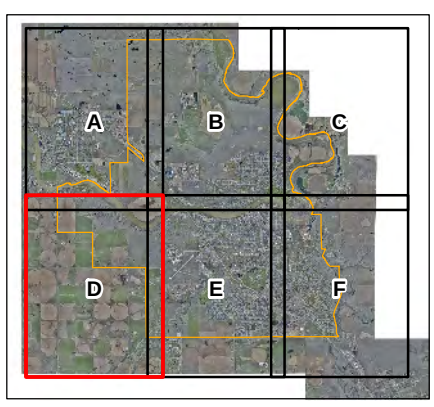


LEGEND

- Cross-Section[2]
- Road
- City Boundary
- Contour (5 m)
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Cross-Section labels contain the following abbreviations:
   IS - Interior Slopes
   RC - Ross Creek
   SPC - Seven Persons Creek
   SSR - South Saskatchewan River



STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Cross-Section Location Plan

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map014_XsecPlan.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 19D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map014_XsecPlan.mxd modified 4/3/2014 by stephanie.leusink

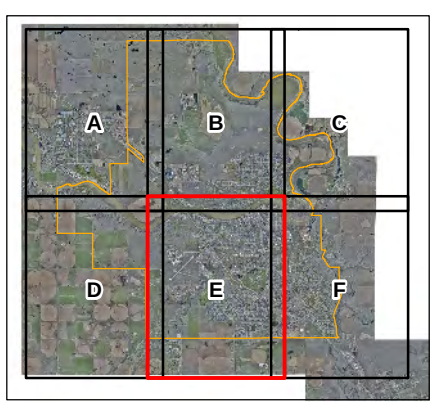


LEGEND

- Cross-Section[2]
- Road
- City Boundary
- Contour (5 m)
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Cross-Section labels contain the following abbreviations:
   IS - Interior Slopes
   RC - Ross Creek
   SPC - Seven Persons Creek
   SSR - South Saskatchewan River



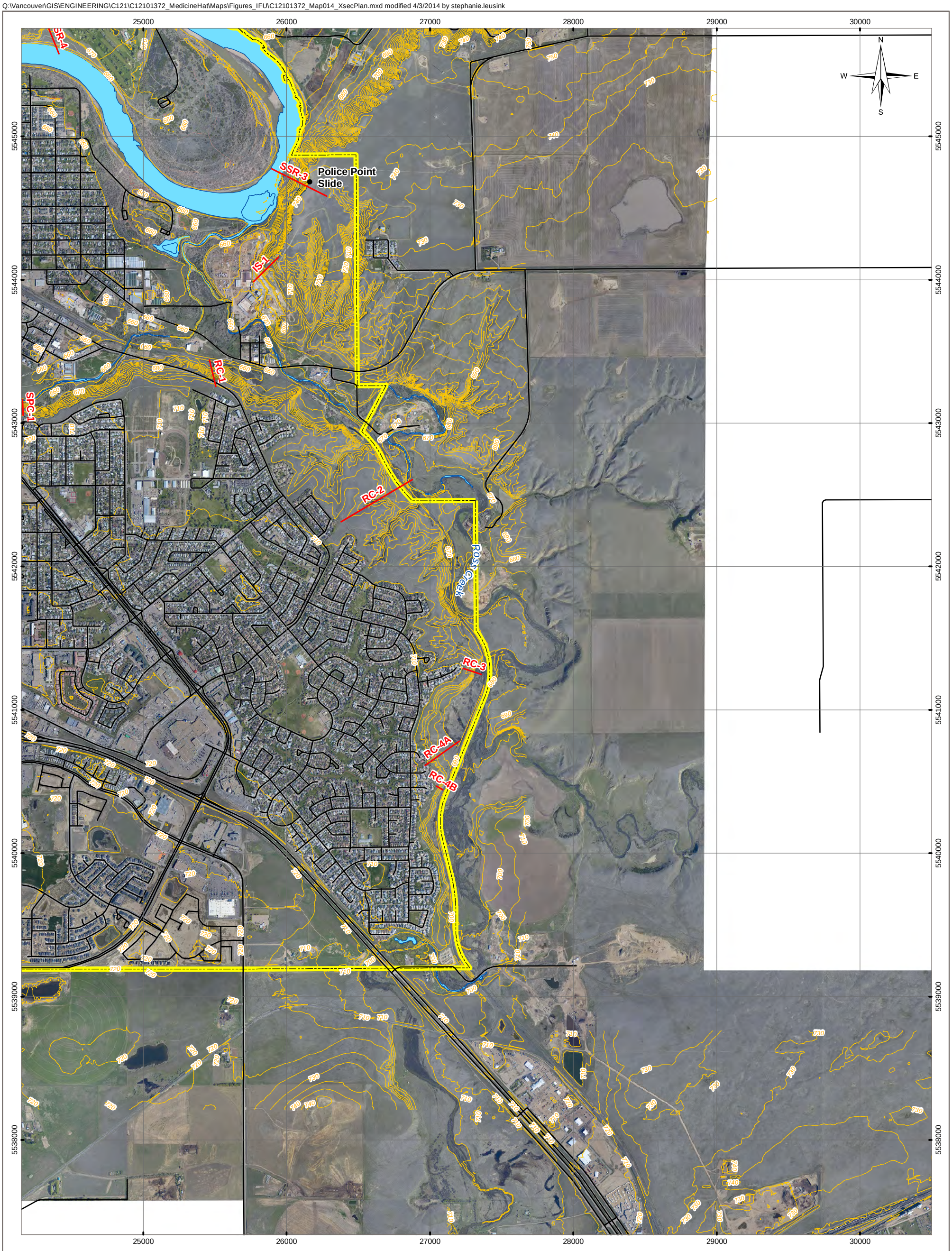
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Cross-Section Location Plan

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map014_XsecPlan.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 19E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map014_XsecPlan.mxd modified 4/3/2014 by stephanie.leusink

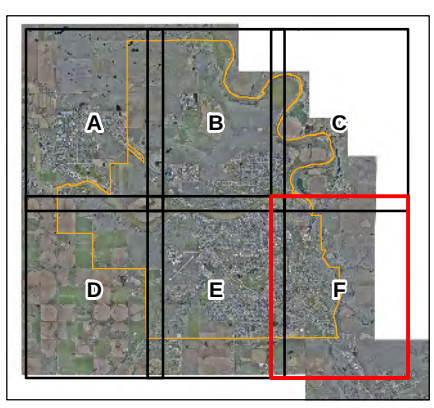


LEGEND

- Cross-Section[2]
- Road
- City Boundary
- Contour (5 m)
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Cross-Section labels contain the following abbreviations:
   IS - Interior Slopes
   RC - Ross Creek
   SPC - Seven Persons Creek
   SSR - South Saskatchewan River



STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Cross-Section Location Plan

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map014_XsecPlan.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 19F**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map015_LatMigration.mxd modified 4/3/2014 by stephanie.leusink

13000 14000 15000 16000 17000 18000 19000

5553000 5552000 5551000 5550000 5549000 5548000 5547000 5546000

N W E S

Trans-Canada Hwy

Redcliff

South Saskatchewan River

SSR-R4

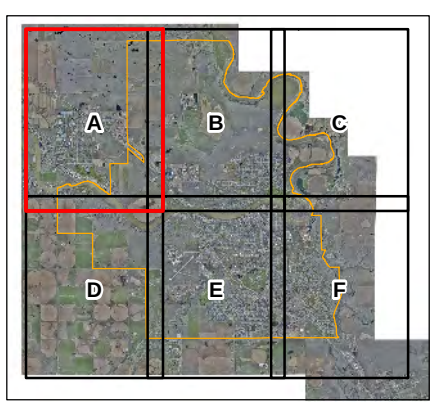
Redcliff Pumphouse Slide

Echodale Regional Park

LEGEND

- Stream Reach[2]
- Creek Edge (1955)
- Creek Edge (2010)
- Road
- City Boundary
- River / Creek

NOTES
1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



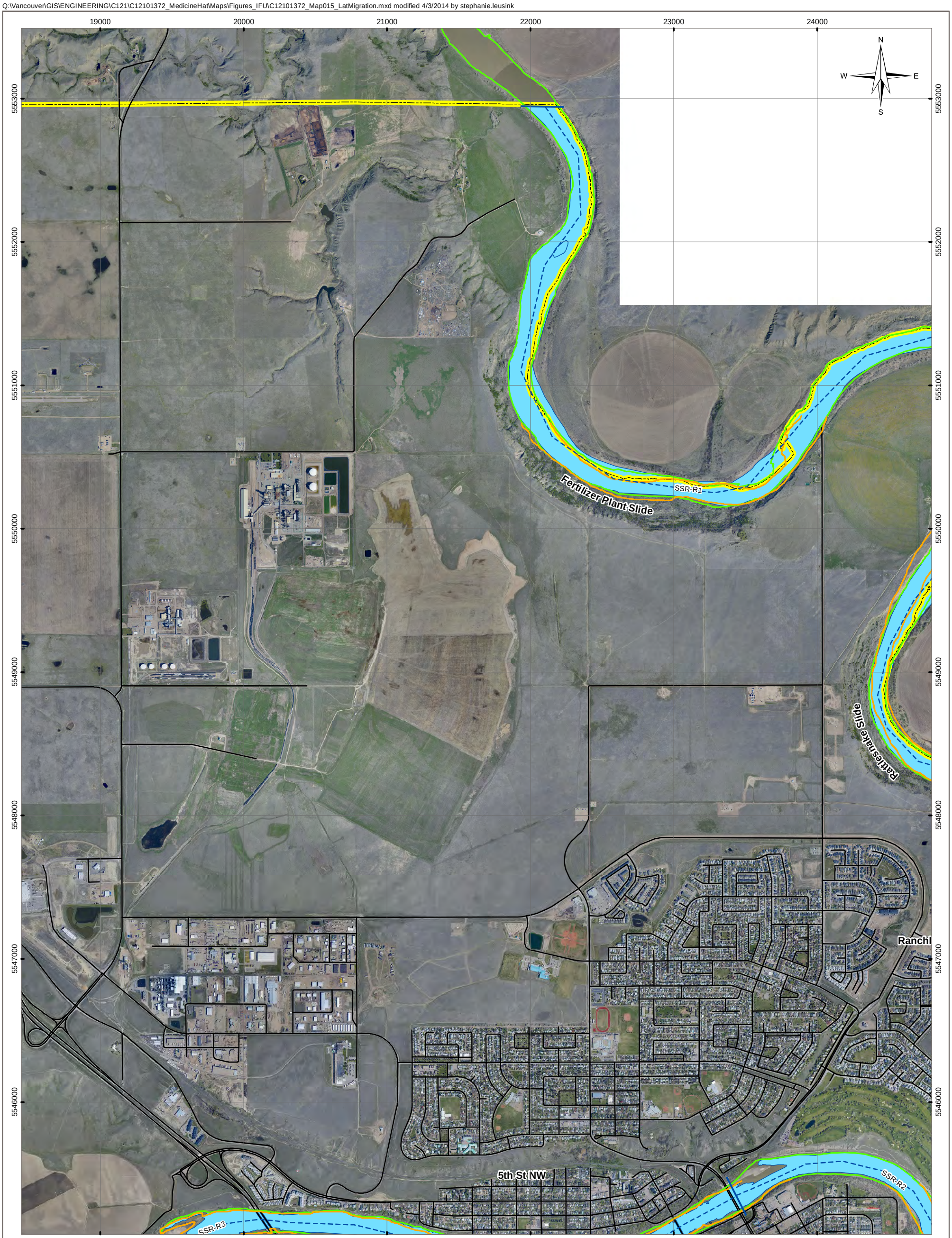
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Lateral Migration and Stream Reaches

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map015_LatMigration.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 20A**

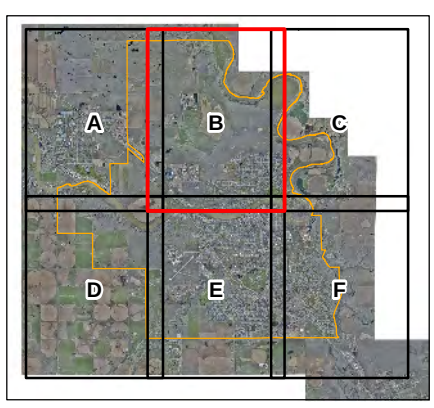
Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map015_LatMigration.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Stream Reach[2]
- Creek Edge (1955)
- Creek Edge (2010)
- Road
- City Boundary
- River / Creek

NOTES
1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



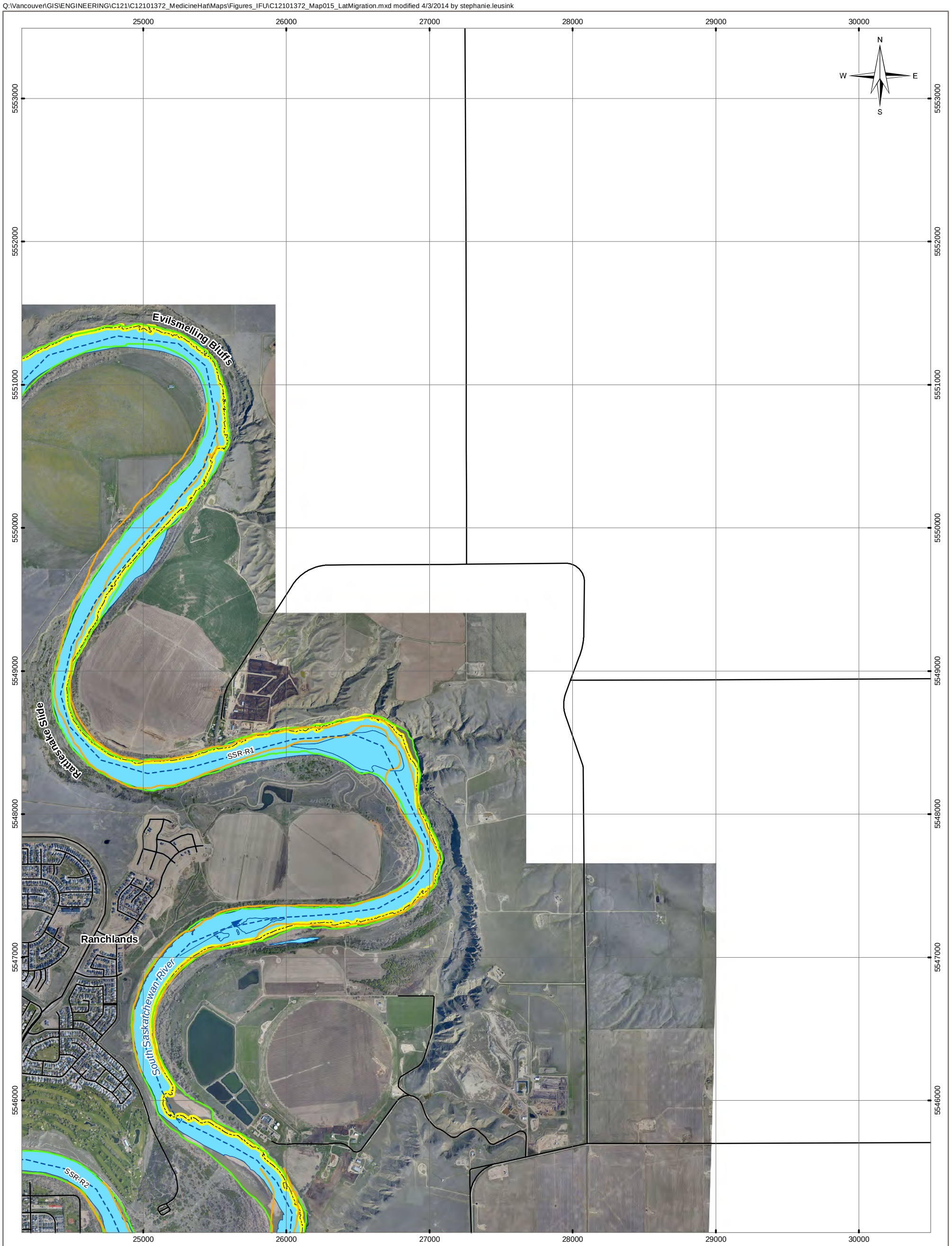
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Lateral Migration and Stream Reaches

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Map015_LatMigration.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 20B**

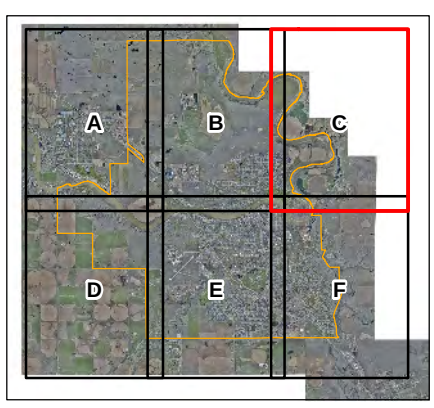
Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map015_LatMigration.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Stream Reach[2]
- Creek Edge (1955)
- Creek Edge (2010)
- Road
- City Boundary
- River / Creek

NOTES
1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



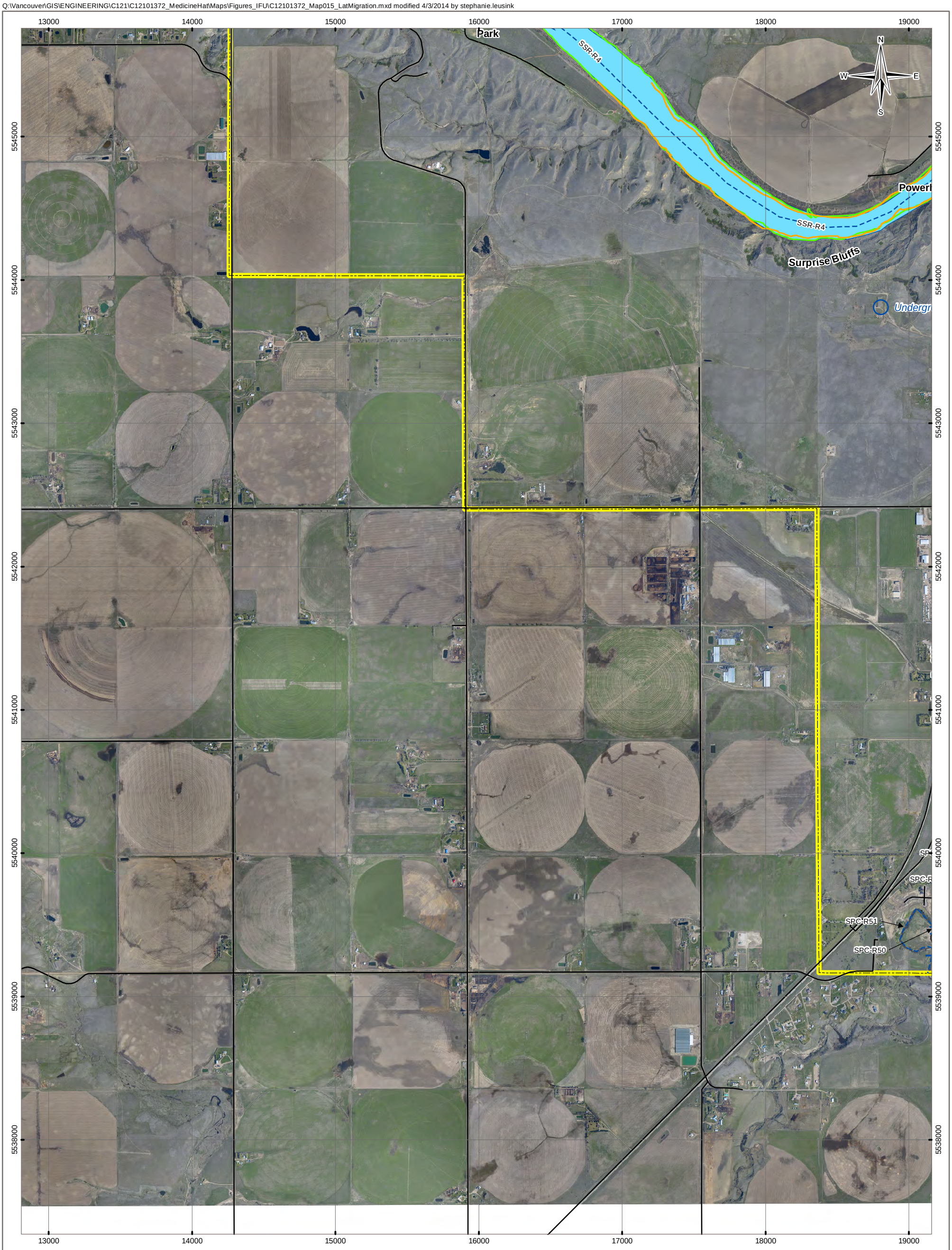
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Lateral Migration and Stream Reaches

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map015_LatMigration.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 20C**

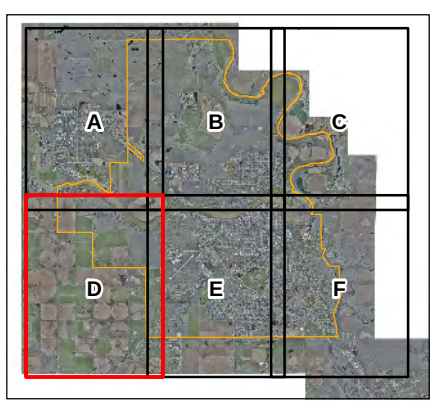
Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map015_LatMigration.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Stream Reach[2]
- Creek Edge (1955)
- Creek Edge (2010)
- Road
- City Boundary
- River / Creek

NOTES
1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



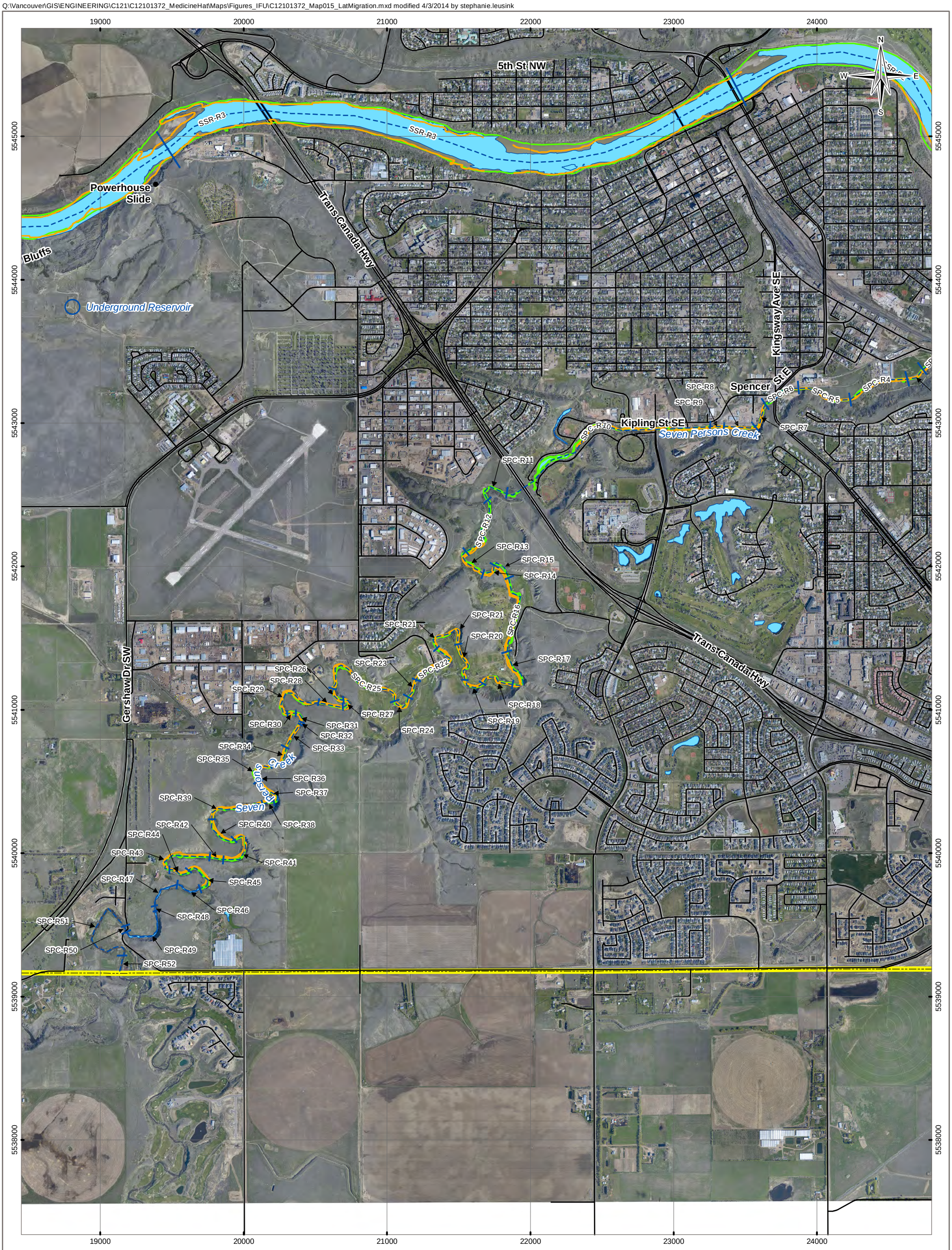
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Lateral Migration and Stream Reaches

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map015_LatMigration.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 20D**

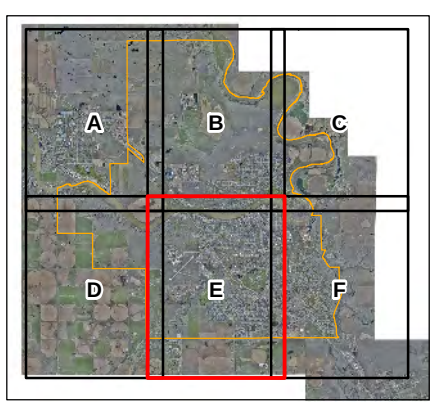
Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map015_LatMigration.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Stream Reach[2]
- Creek Edge (1955)
- Creek Edge (2010)
- Road
- City Boundary
- River / Creek

NOTES
1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Lateral Migration and Stream Reaches

PROJECTION	DATUM	CLIENT
UTM Zone 12 (3TM)	NAD83	City of Medicine Hat

Scale: 1:25,000
500 250 0 500
Metres

FILE NO. C12101372_Map015_LatMigration.mxd

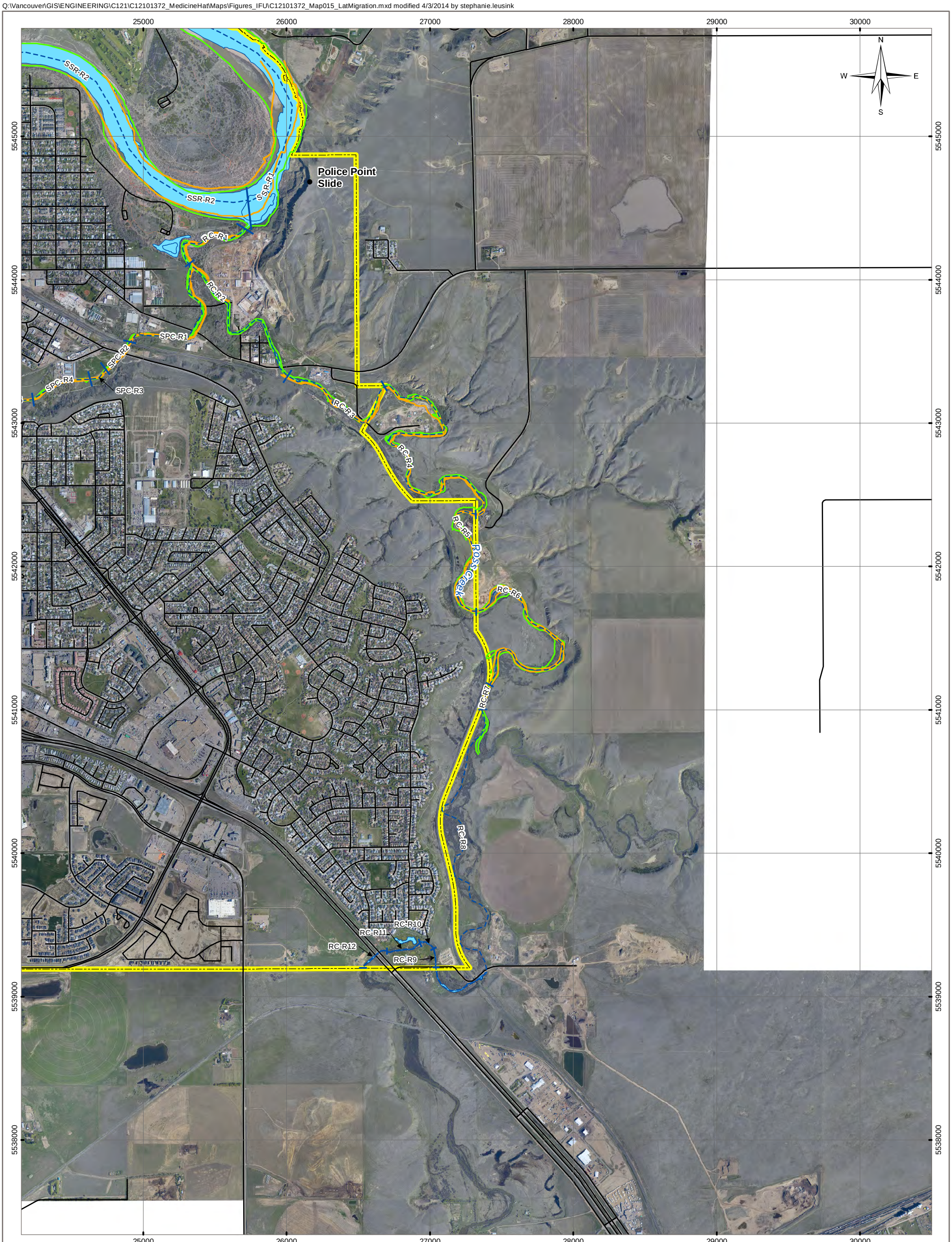
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	MEZ	SL	SH	0

OFFICE	DATE
EBA-VANC	April 3, 2014

eba A TETRA TECH COMPANY

Figure 20E

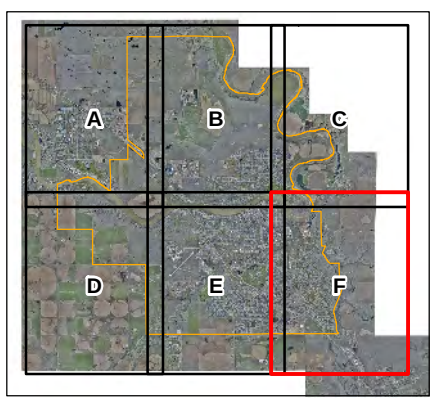
Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map015_LatMigration.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Stream Reach[2]
- Creek Edge (1955)
- Creek Edge (2010)
- Road
- City Boundary
- River / Creek

NOTES
1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



STATUS
ISSUED FOR USE

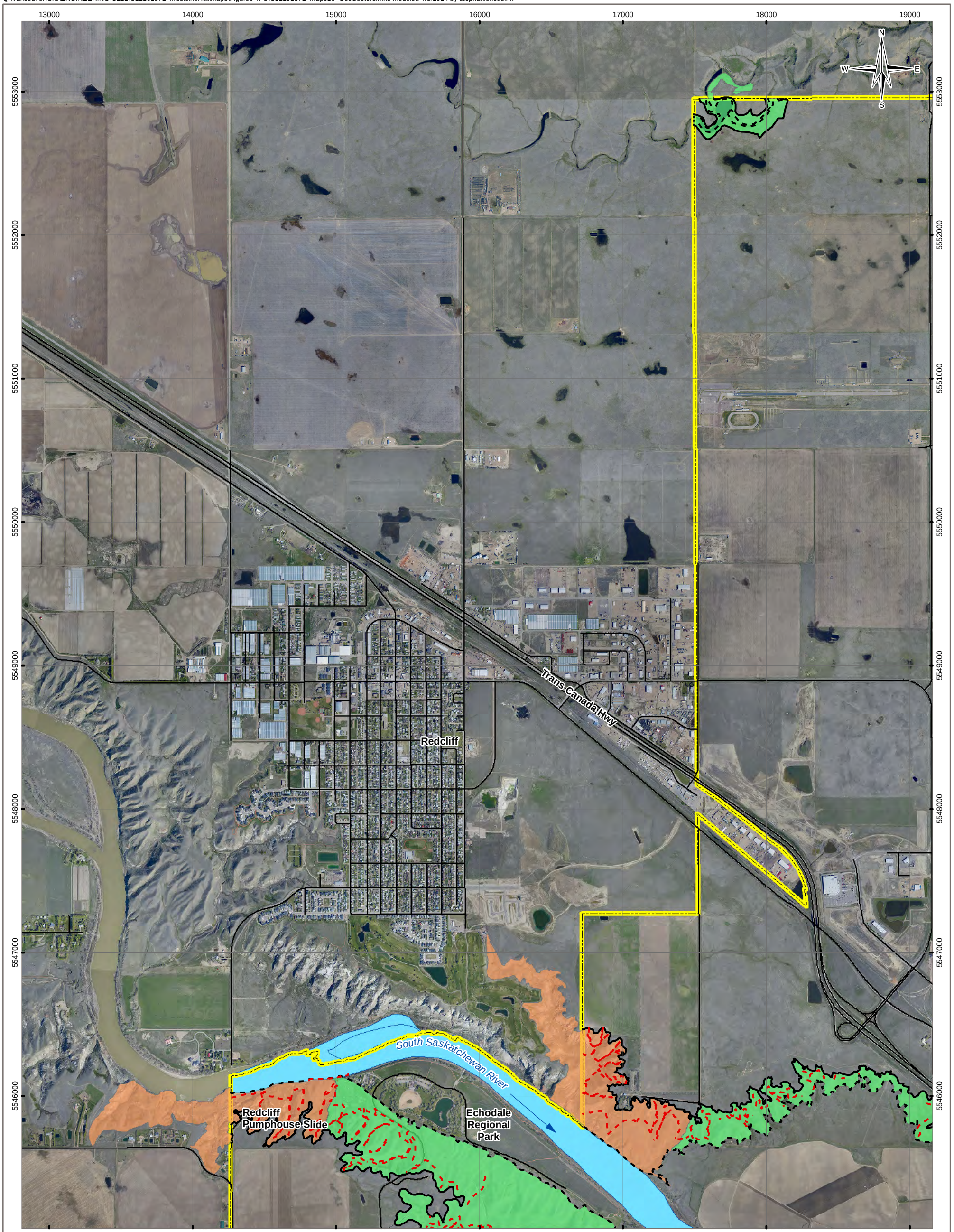
MEDICINE HAT SLOPE SETBACKS

Lateral Migration and Stream Reaches

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres			
FILE NO. C12101372_Map015_LatMigration.mxd			
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL / **APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014		**Figure 20F**

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map016_GeoSectors.mxd modified 4/3/2014 by stephanie.leusink

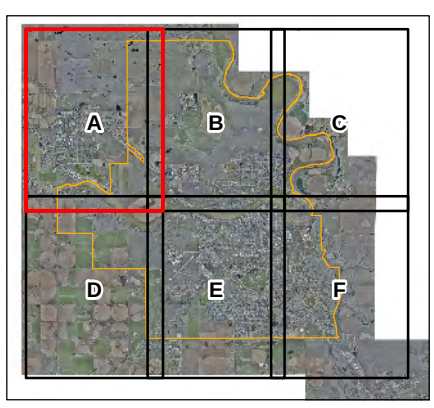


LEGEND

Geological Sector

- Interior Slopes
- Ross Creek
- Seven Persons Creek
- South Saskatchewan River

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

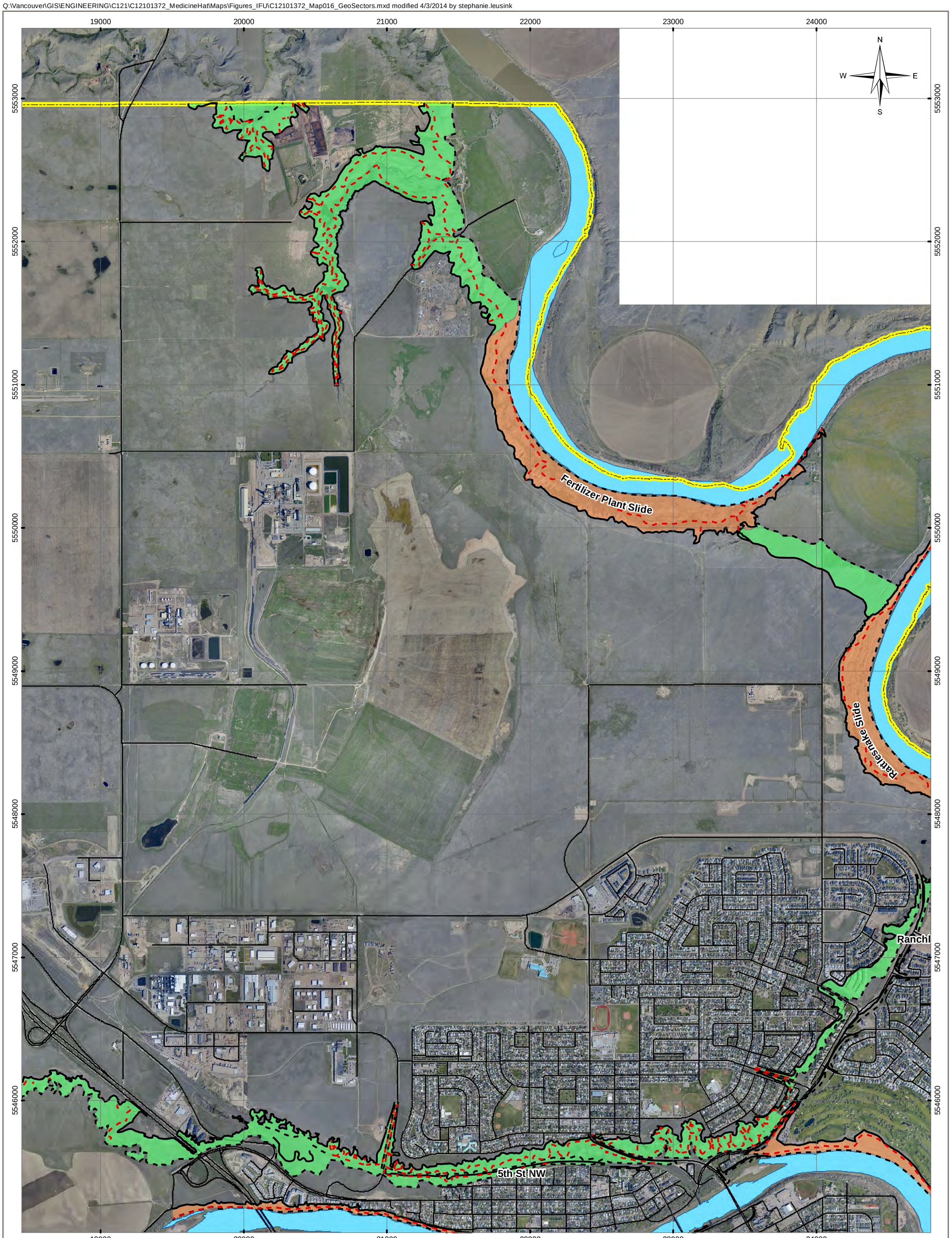
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geological Sectors

PROJECTION: UTM Zone 12 (3TM)			DATUM: NAD83	CLIENT: City of Medicine Hat
Scale: 1:25,000 (500 250 0 500 Metres)				
FILE NO.: C12101372_Map016_GeoSectors.mxd				A TETRA TECH COMPANY
PROJECT NO.: C12101372	DWN: MEZ	CKD: SL	APVD: SH	REV: 0
OFFICE: EBA-VANC	DATE: April 3, 2014			Figure 21A

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map016_GeoSectors.mxd modified 4/3/2014 by stephanie.leusink

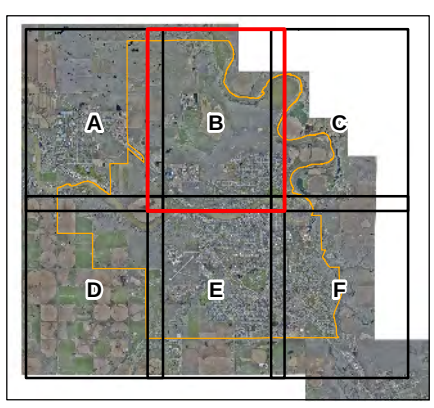


LEGEND

Geological Sector

- Interior Slopes
- Ross Creek
- Seven Persons Creek
- South Saskatchewan River

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

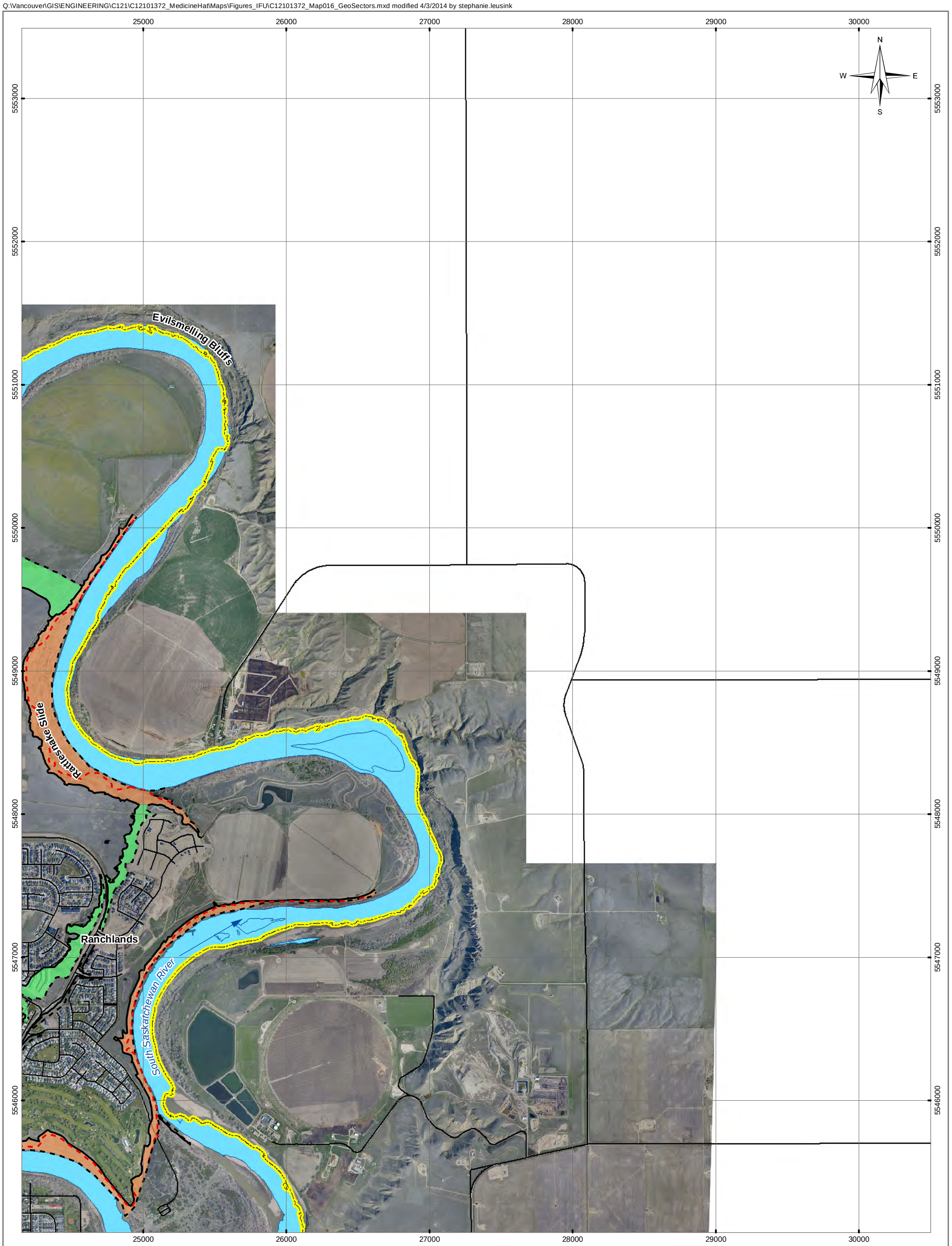
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geological Sectors

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map016_GeoSectors.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 21B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map016_GeoSectors.mxd modified 4/3/2014 by stephanie.leusink

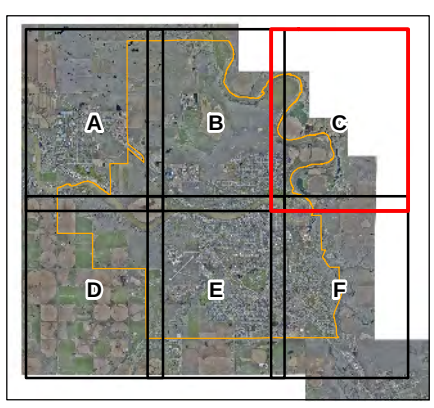


LEGEND

Geological Sector

- Interior Slopes
- Ross Creek
- Seven Persons Creek
- South Saskatchewan River

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geological Sectors

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map016_GeoSectors.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 21C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map016_GeoSectors.mxd modified 4/3/2014 by stephanie.leusink

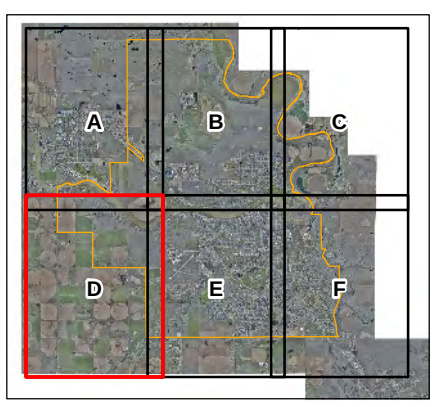


LEGEND

Geological Sector

- Interior Slopes
- Ross Creek
- Seven Persons Creek
- South Saskatchewan River

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

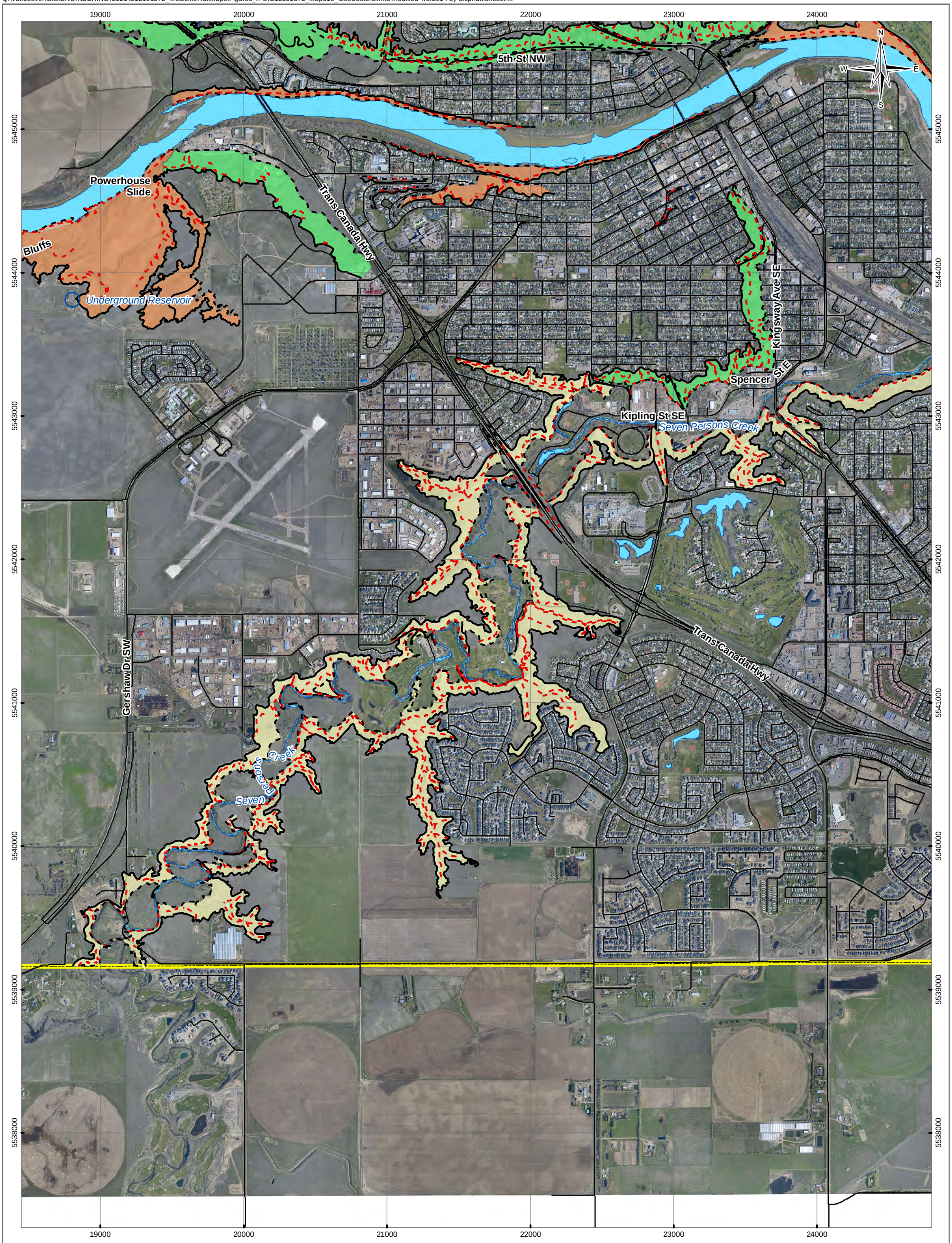
MEDICINE HAT SLOPE SETBACKS

Geological Sectors

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map016_GeoSectors.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 21D**

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map016_GeoSectors.mxd modified 4/3/2014 by stephanie.leusink

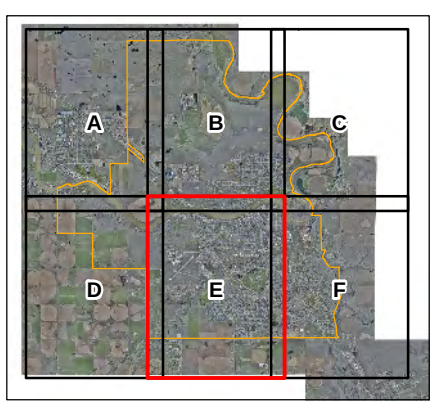


LEGEND

Geological Sector

- Interior Slopes
- Ross Creek
- Seven Persons Creek
- South Saskatchewan River

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

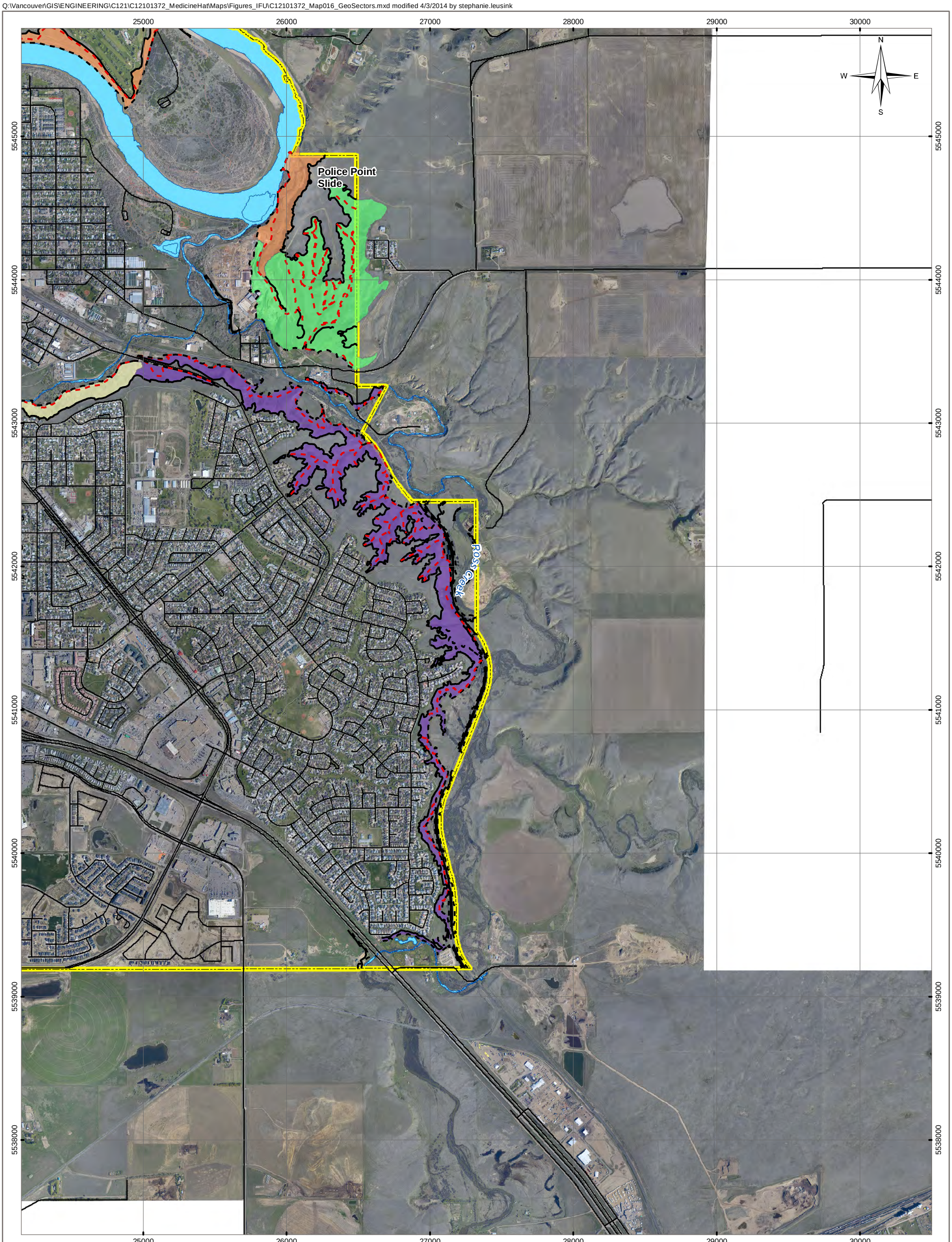
MEDICINE HAT SLOPE SETBACKS

Geological Sectors

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map016_GeoSectors.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 21E**

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map016_GeoSectors.mxd modified 4/3/2014 by stephanie.leusink

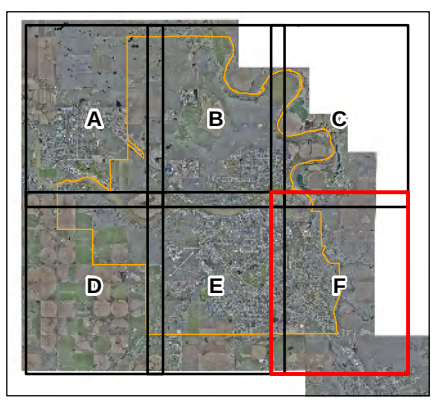


LEGEND

Geological Sector

- Interior Slopes
- Ross Creek
- Seven Persons Creek
- South Saskatchewan River

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

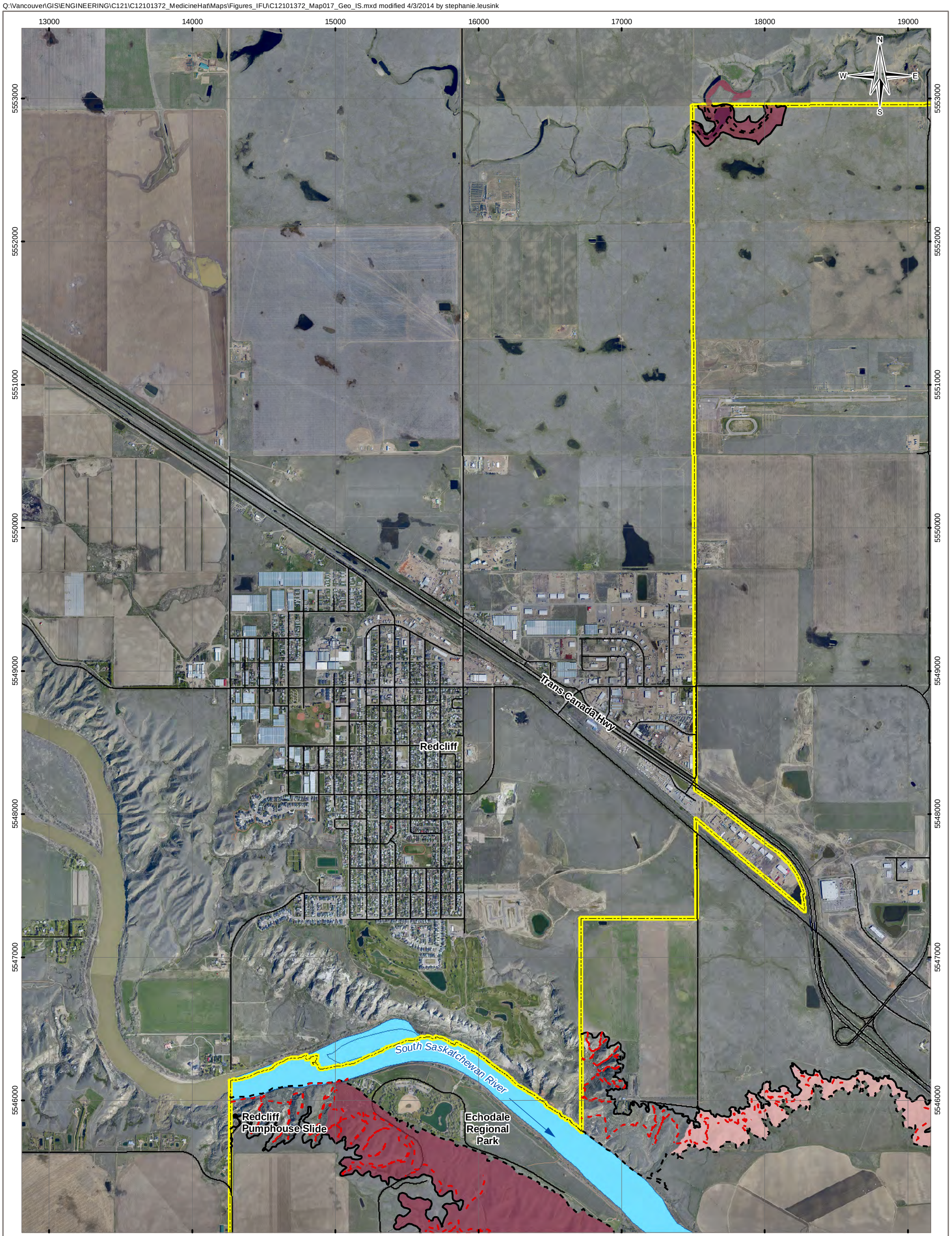
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geological Sectors

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Map016_GeoSectors.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 21F**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map017_Geo_IS.mxd modified 4/3/2014 by stephanie.leusink

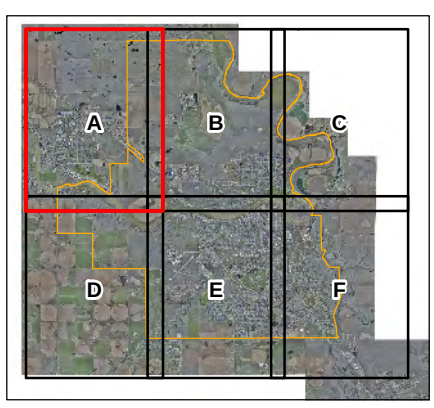


LEGEND

Interior Slopes Setback Sector

- IS-A
- IS-B
- IS-C
- IS-D

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

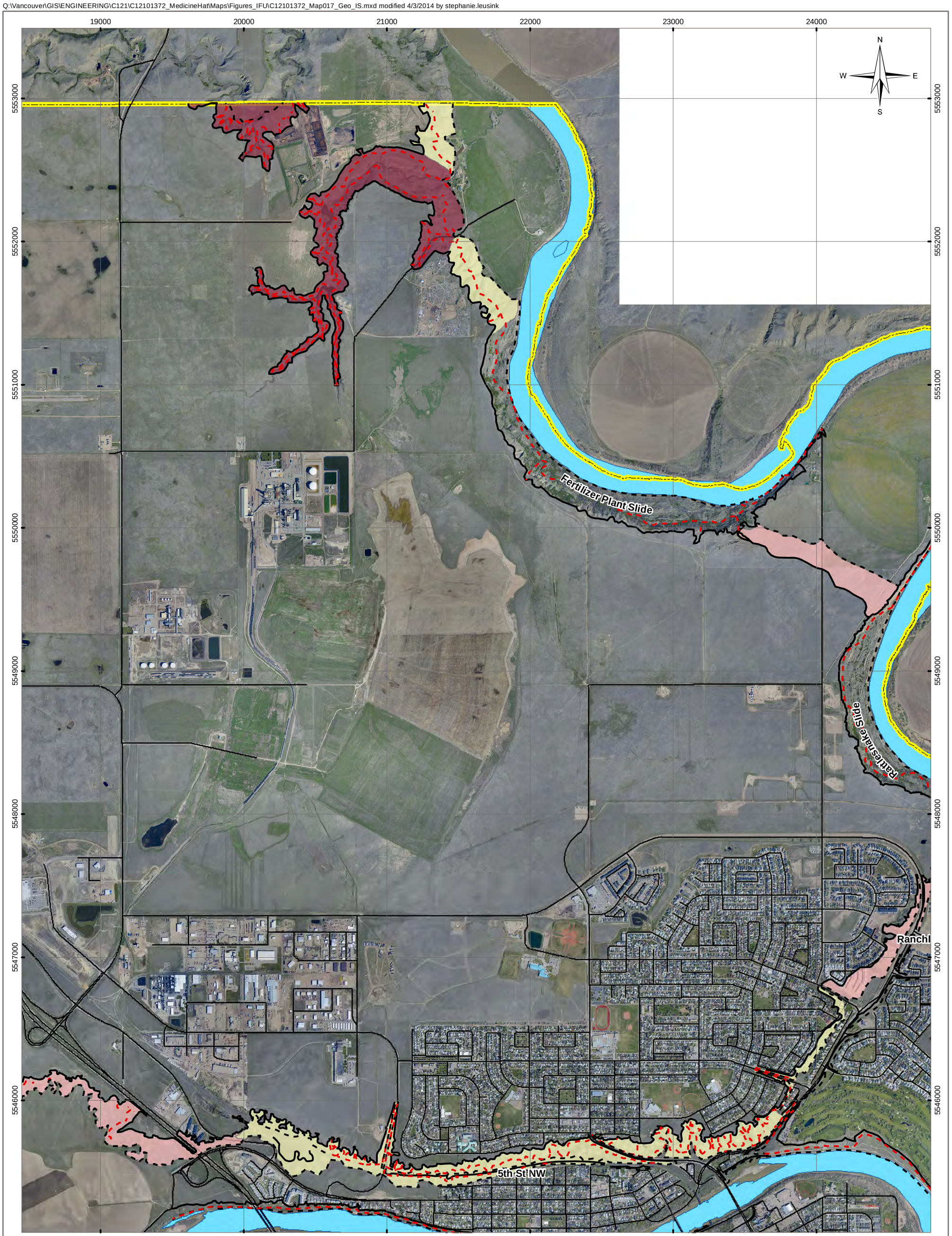
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for Interior Slopes

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map017_Geo_IS.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 22A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map017_Geo_IS.mxd modified 4/3/2014 by stephanie.leusink

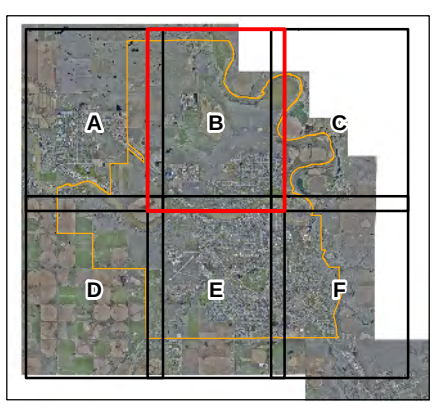


LEGEND

Interior Slopes Setback Sector

- IS-A
- IS-B
- IS-C
- IS-D

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

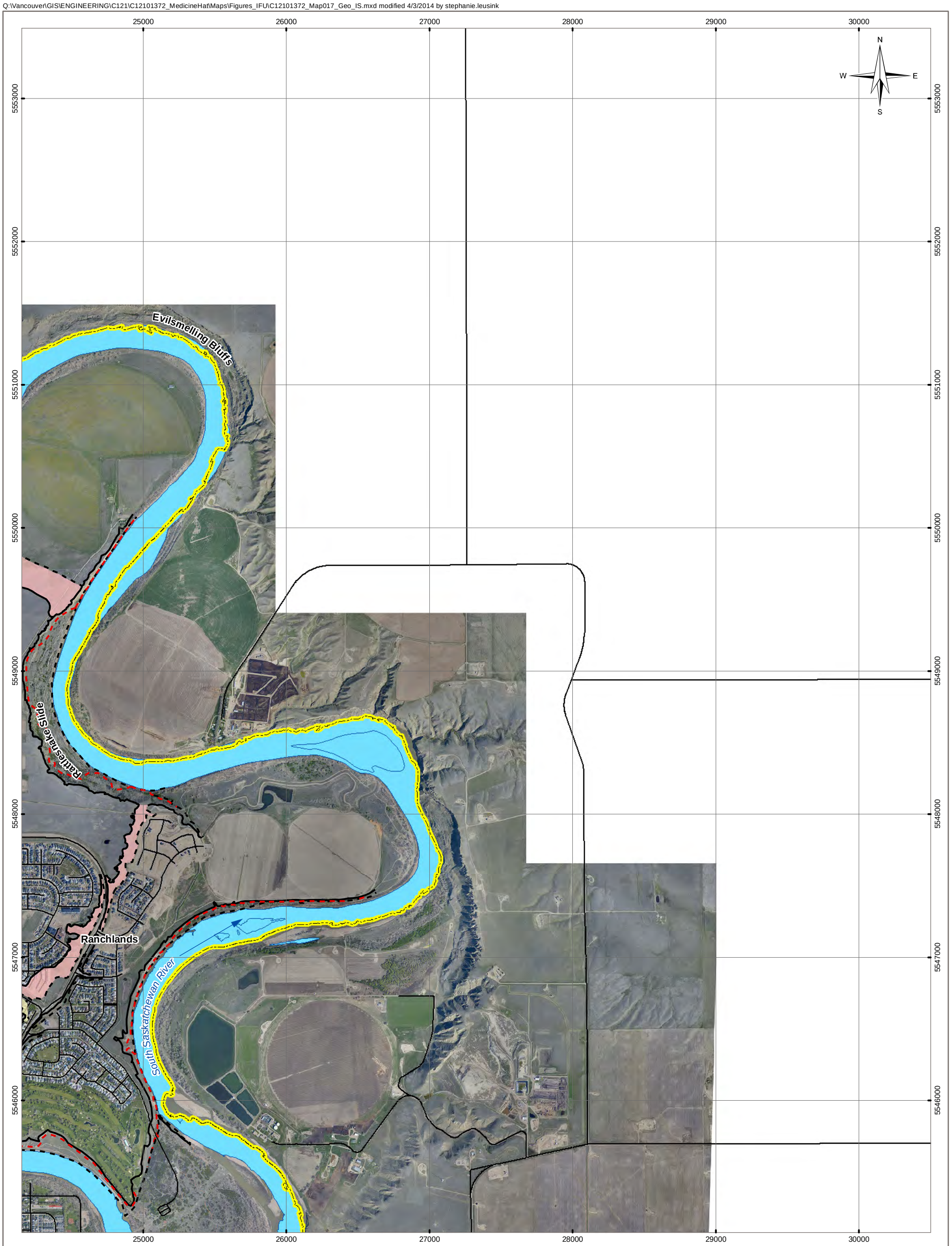
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for Interior Slopes

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map017_Geo_IS.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 22B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map017_Geo_IS.mxd modified 4/3/2014 by stephanie.leusink

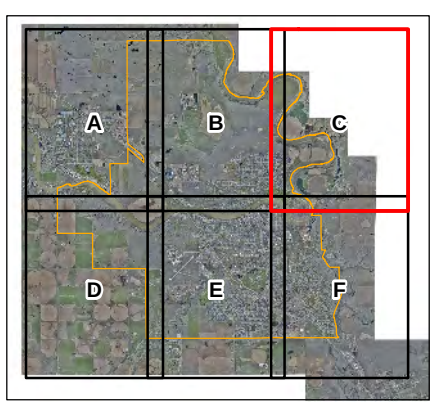


LEGEND

Interior Slopes Setback Sector

- IS-A
- IS-B
- IS-C
- IS-D

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

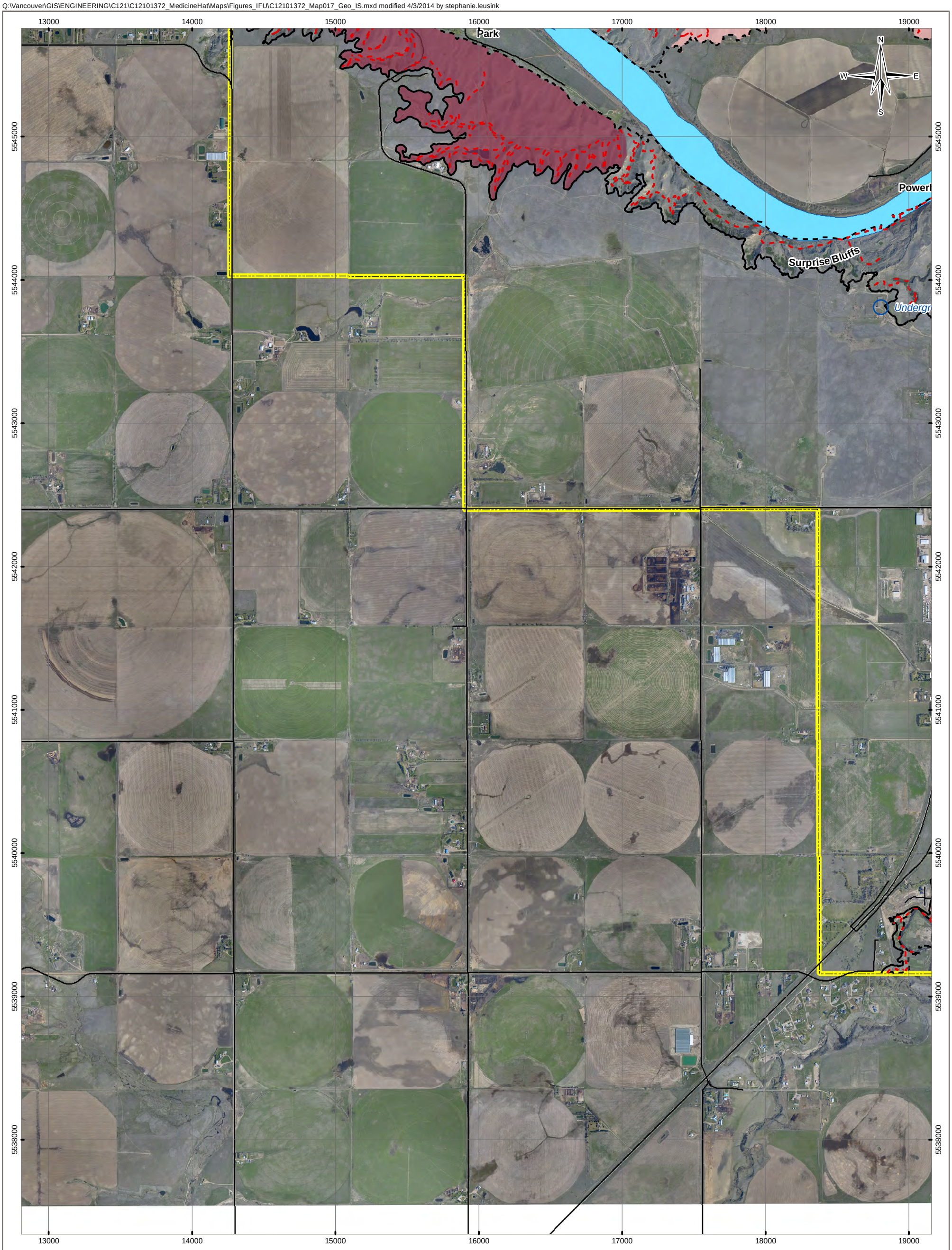
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for Interior Slopes

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map017_Geo_IS.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 22C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map017_Geo_IS.mxd modified 4/3/2014 by stephanie.leusink

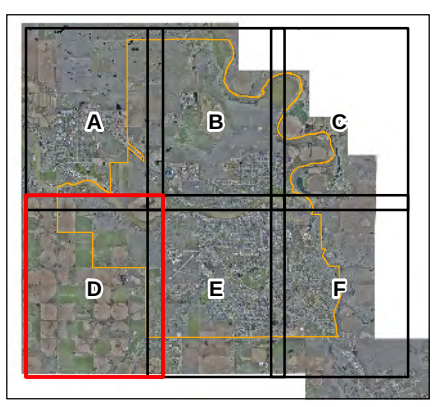


LEGEND

Interior Slopes Setback Sector

- IS-A
- IS-B
- IS-C
- IS-D

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

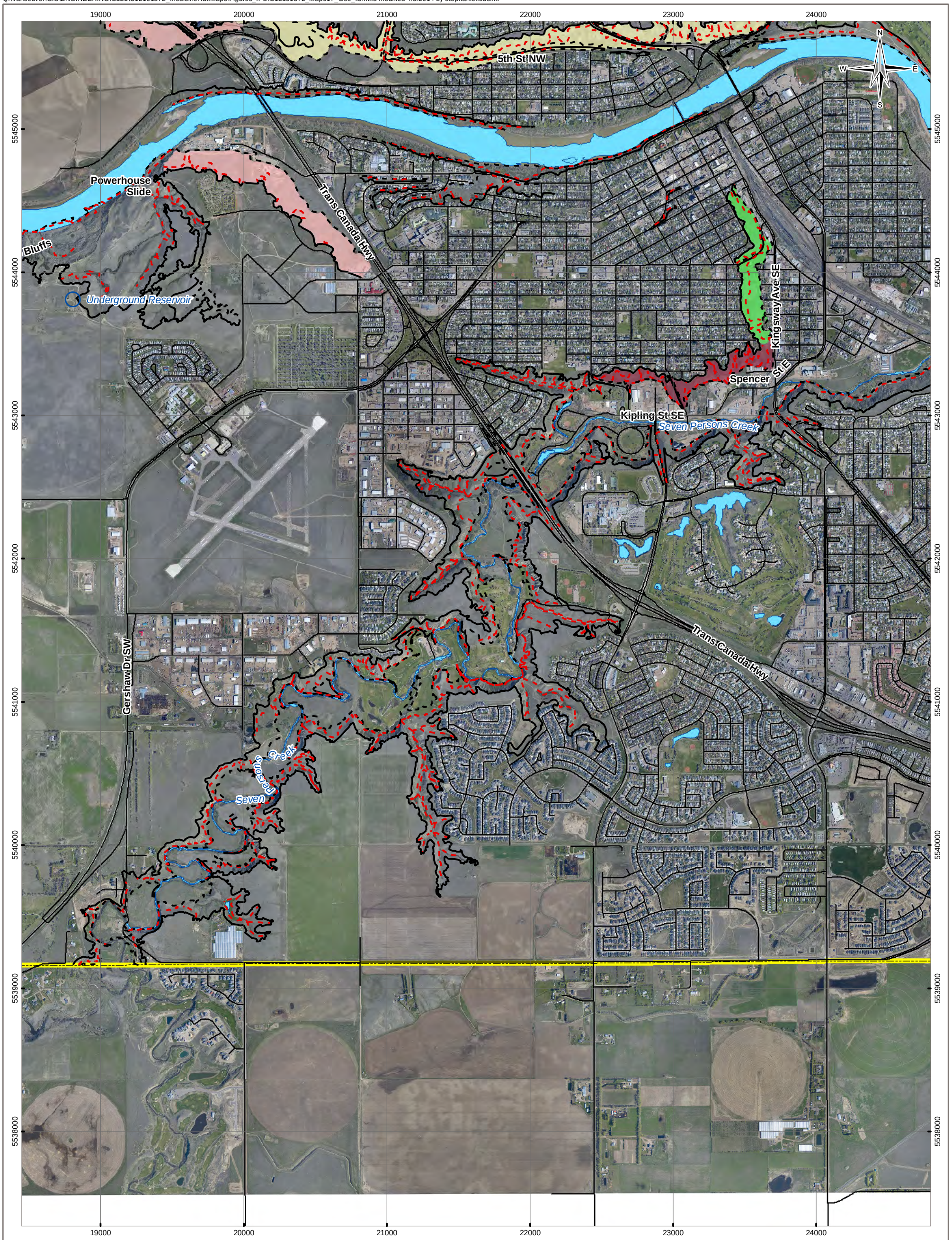
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for Interior Slopes

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map017_Geo_IS.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 22D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map017_Geo_IS.mxd modified 4/3/2014 by stephanie.leusink

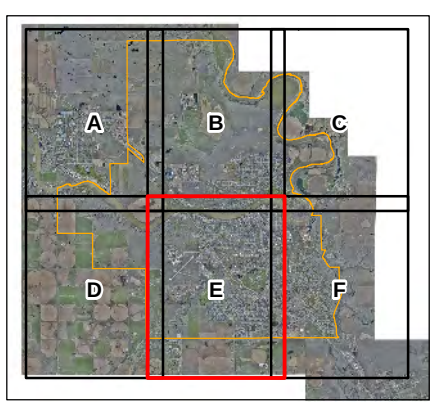


LEGEND

Interior Slopes Setback Sector

- IS-A
- IS-B
- IS-C
- IS-D

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

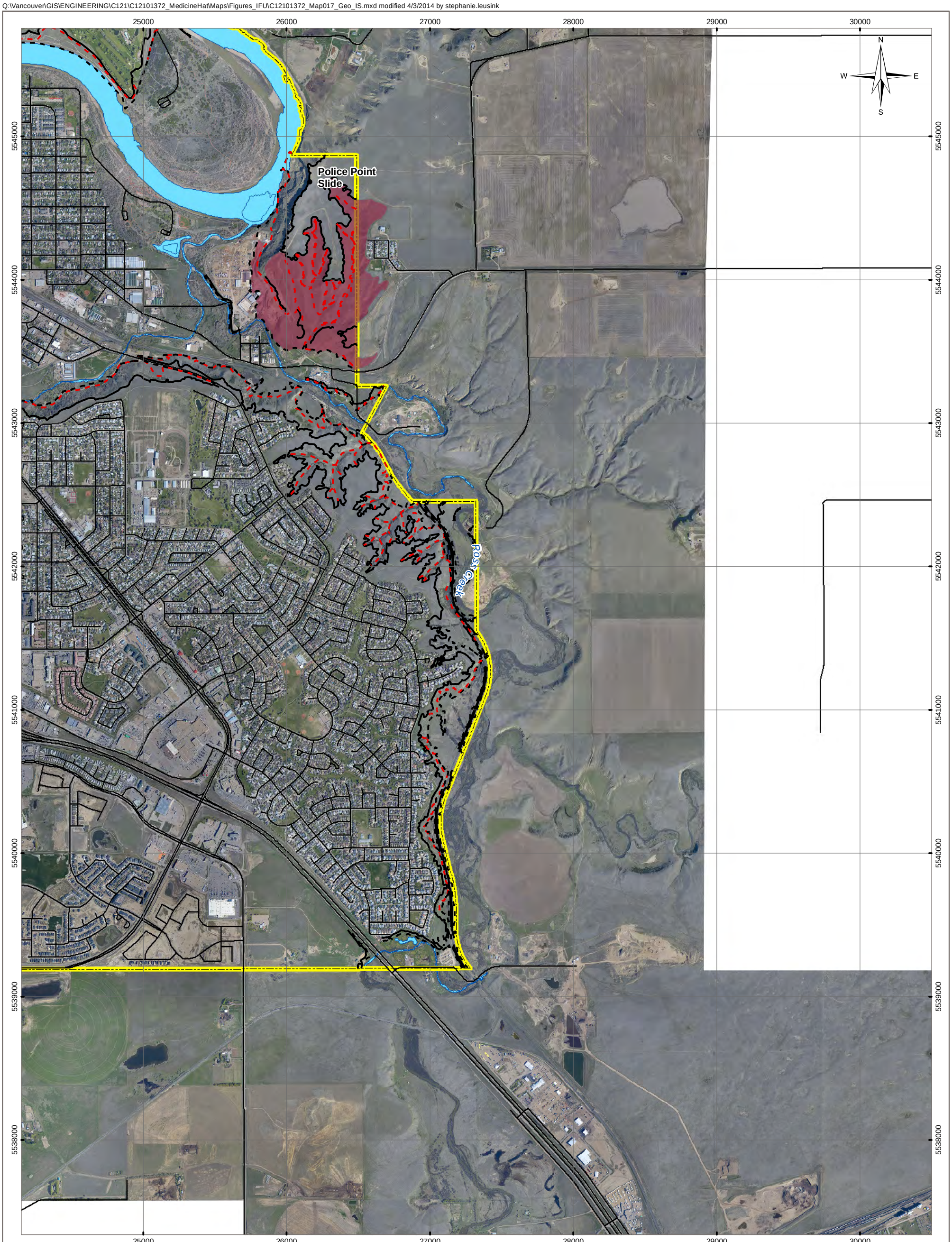
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for Interior Slopes

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map017_Geo_IS.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 22E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map017_Geo_IS.mxd modified 4/3/2014 by stephanie.leusink

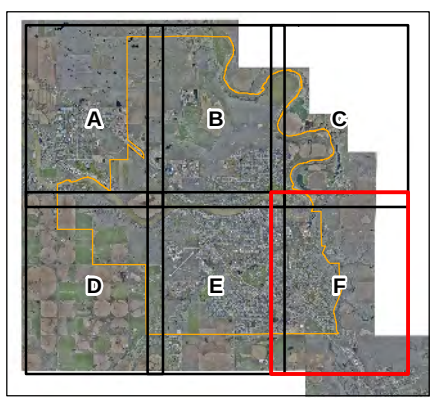


LEGEND

Interior Slopes Setback Sector

- IS-A
- IS-B
- IS-C
- IS-D

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

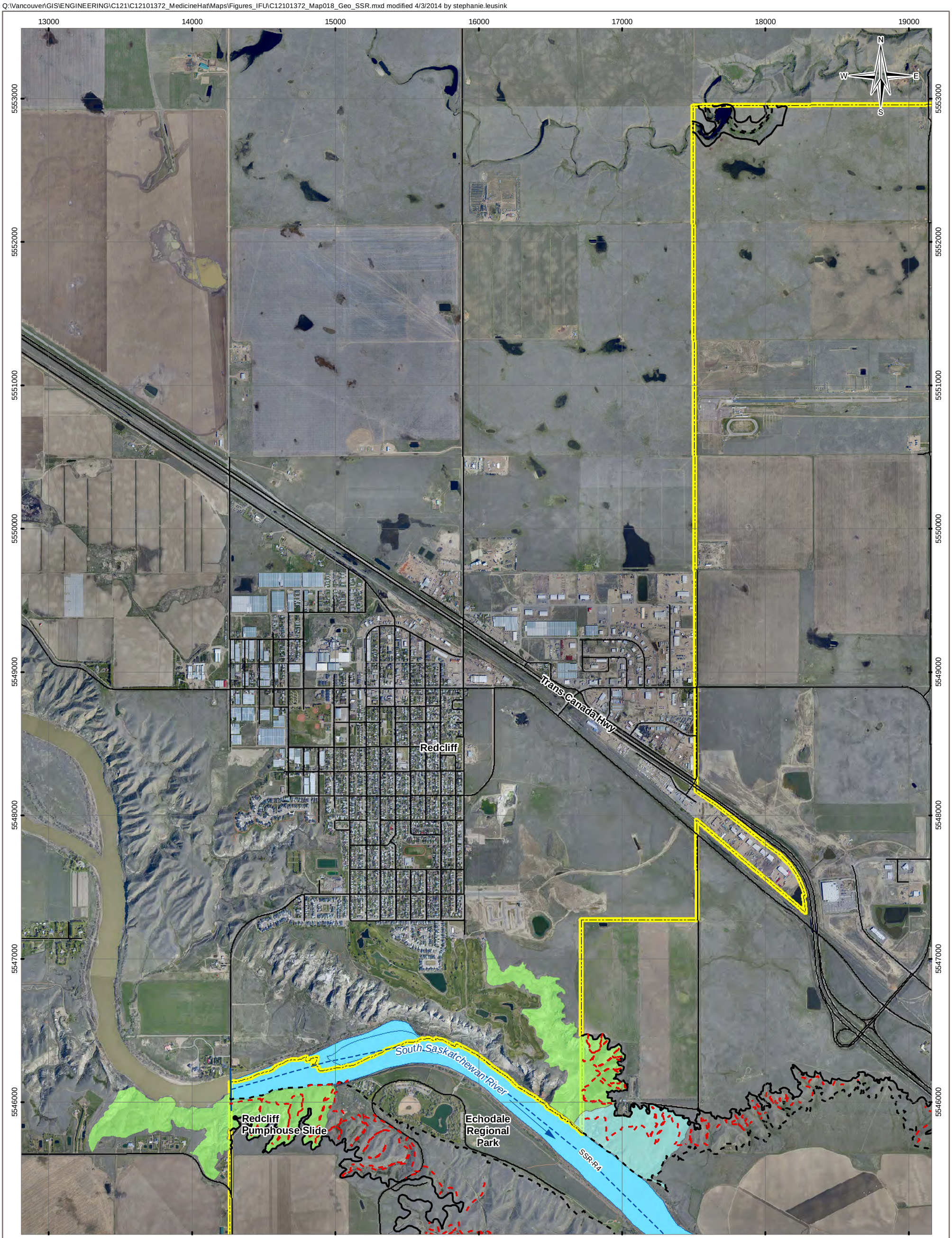
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for Interior Slopes

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map017_Geo_IS.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 22F**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map018_Geo_SSR.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

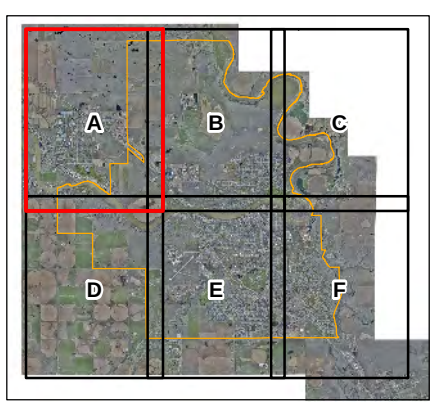
South Saskatchewan River Setback Sector

- SSR-A
- SSR-B
- SSR-C
- SSR-D
- SSR-E
- SSR-F
- SSR-G

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Stream Reach[2]
- Road
- City Boundary
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



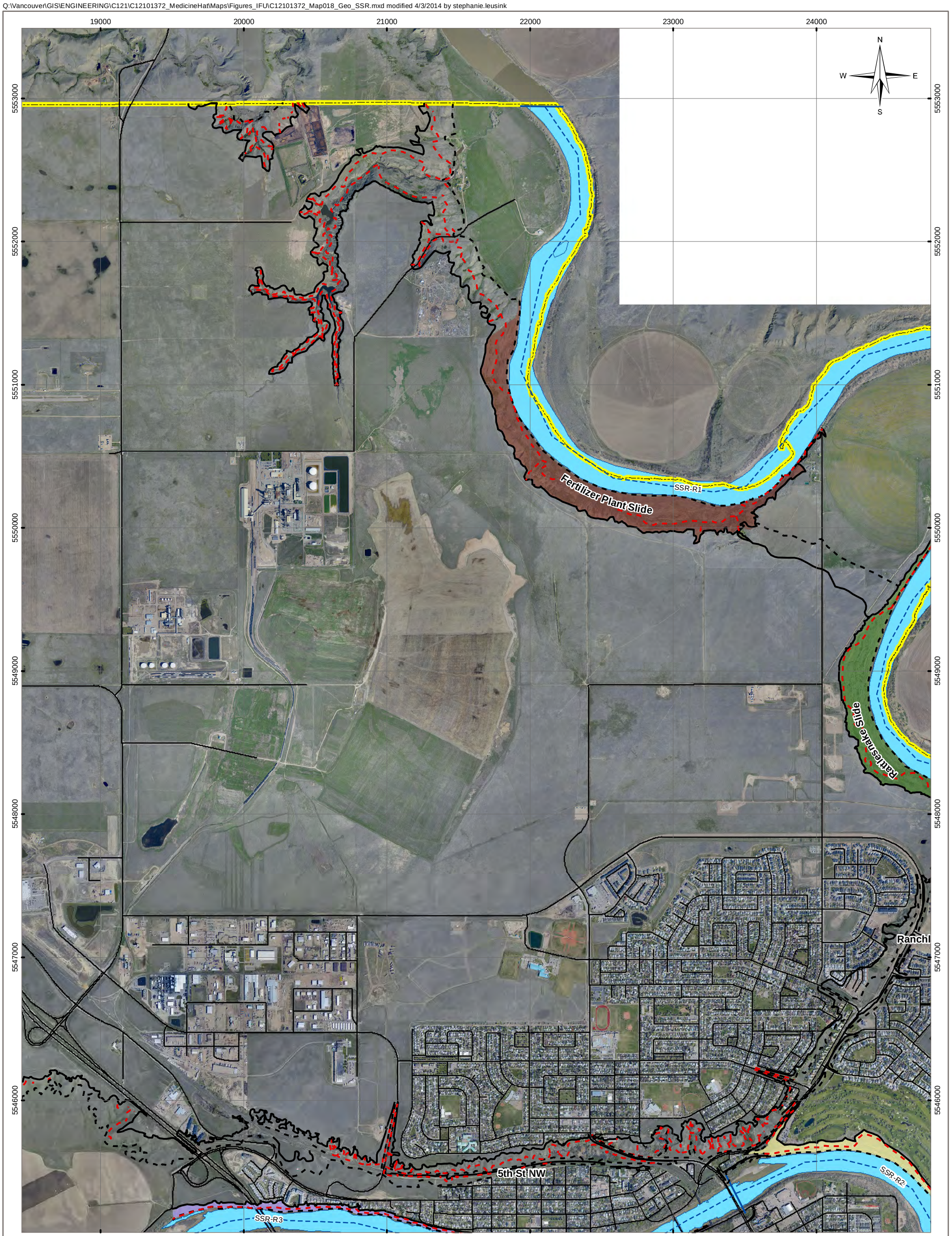
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for the South Saskatchewan River

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Map018_Geo_SSR.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 23A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map018_Geo_SSR.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

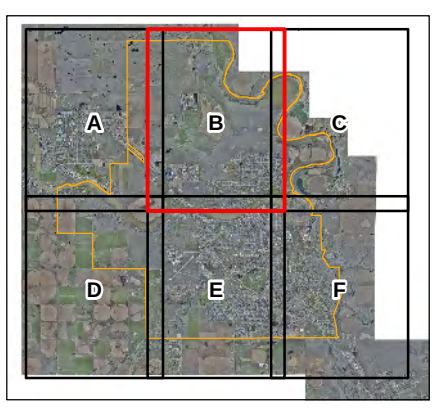
South Saskatchewan River Setback Sector

- SSR-A
- SSR-B
- SSR-C
- SSR-D
- SSR-E
- SSR-F
- SSR-G

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Stream Reach[2]
- Road
- City Boundary
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



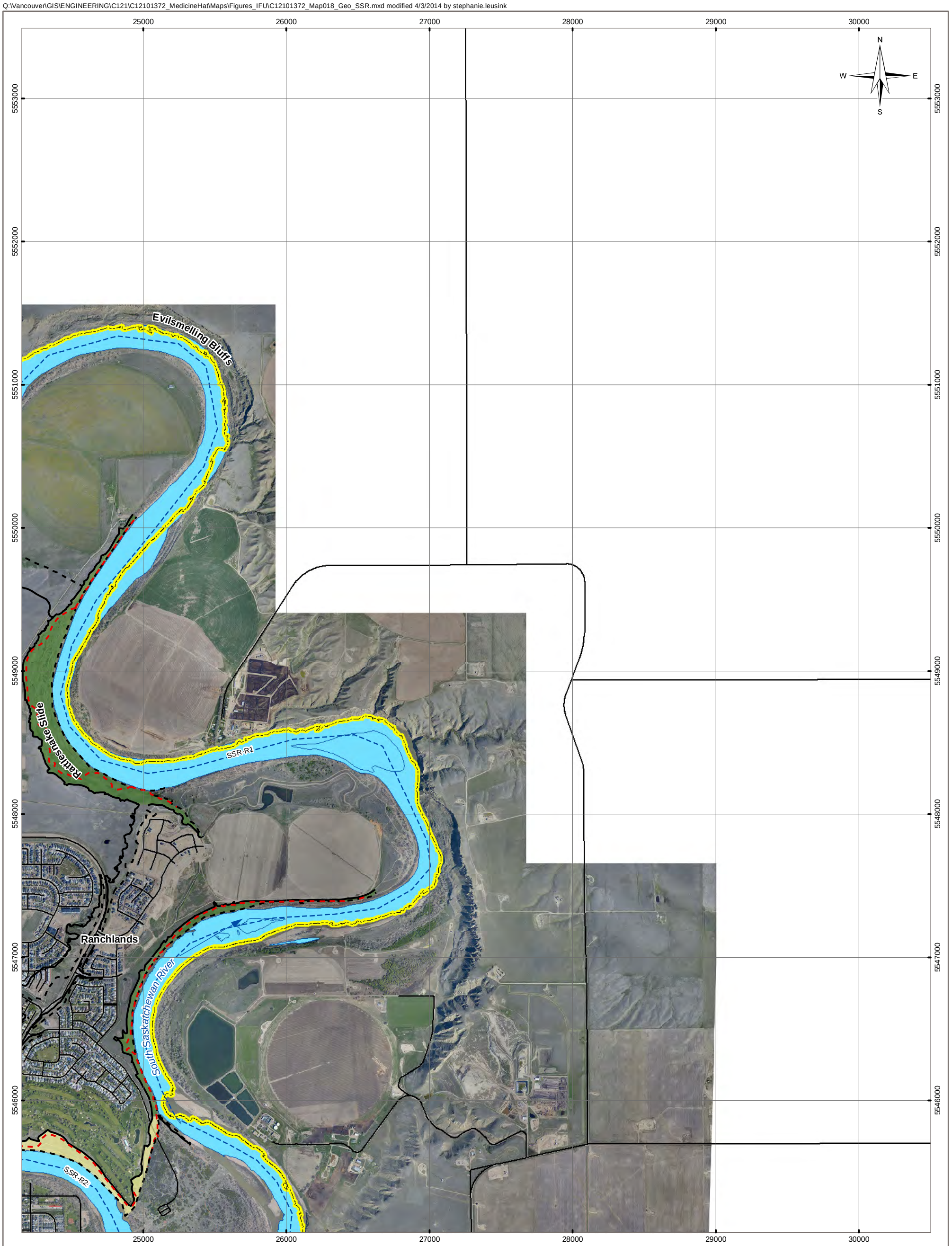
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for the South Saskatchewan River

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map018_Geo_SSR.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 23B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map018_Geo_SSR.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

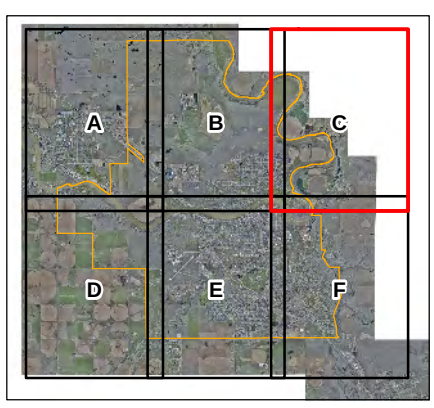
South Saskatchewan River Setback Sector

- SSR-A
- SSR-B
- SSR-C
- SSR-D
- SSR-E
- SSR-F
- SSR-G

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Stream Reach[2]
- Road
- City Boundary
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for the South Saskatchewan River

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres					eba A TETRA TECH COMPANY
FILE NO. C12101372_Map018_Geo_SSR.mxd					
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0	**Figure 23C**
OFFICE EBA-VANC	**DATE** April 3, 2014				

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map018_Geo_SSR.mxd modified 4/3/2014 by stephanie.leusink



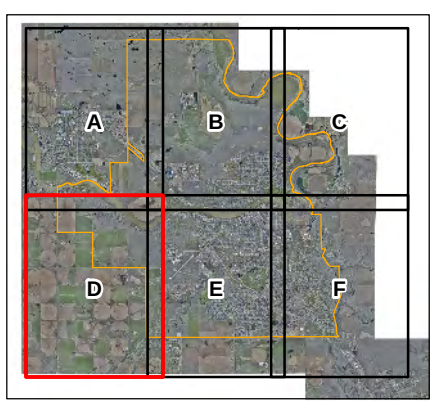
LEGEND

South Saskatchewan River Setback Sector

- SSR-A
- SSR-B
- SSR-C
- SSR-D
- SSR-E
- SSR-F
- SSR-G

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Stream Reach[2]
- Road
- City Boundary
- River / Creek

NOTES
1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



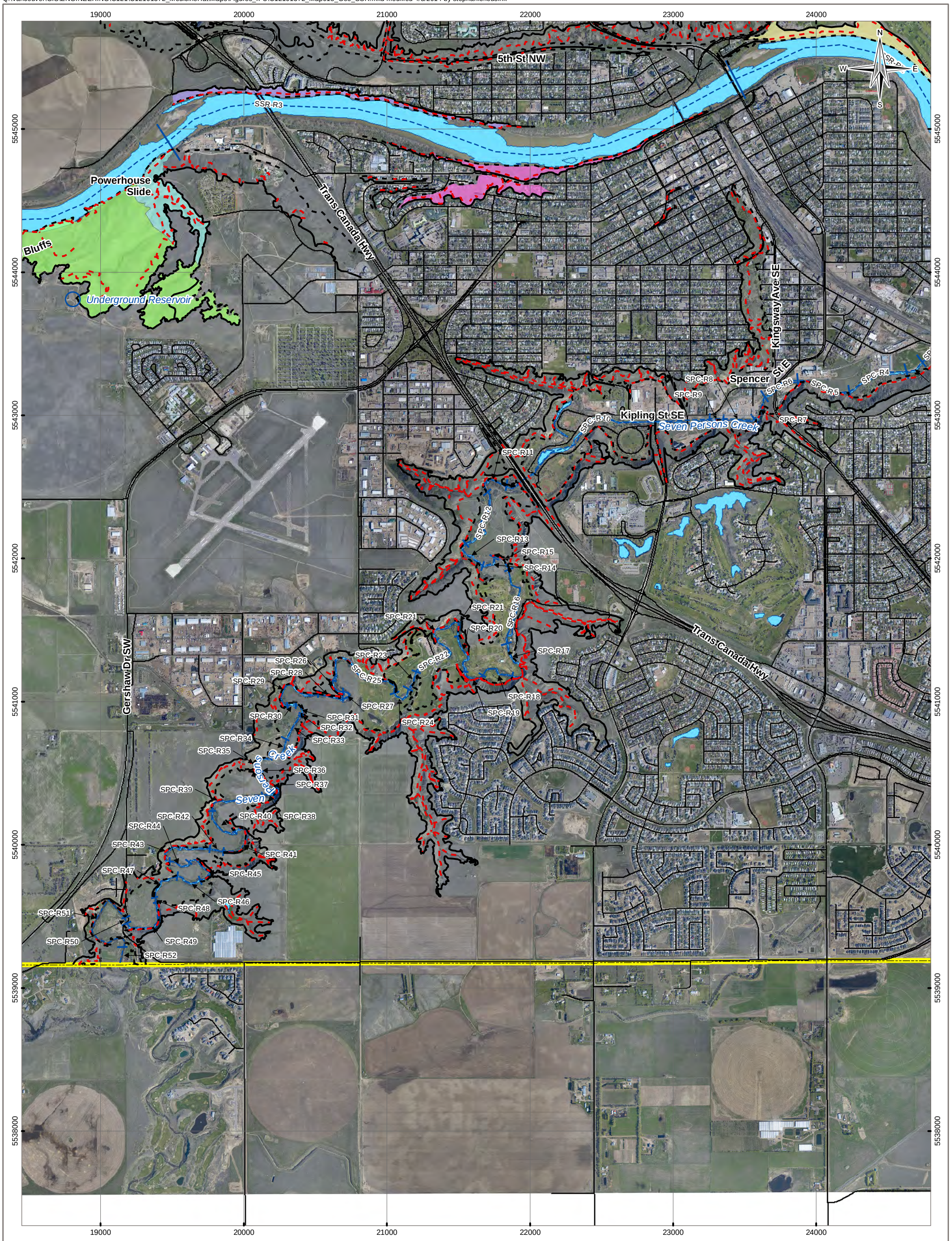
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for the South Saskatchewan River

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map018_Geo_SSR.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 23D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map018_Geo_SSR.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

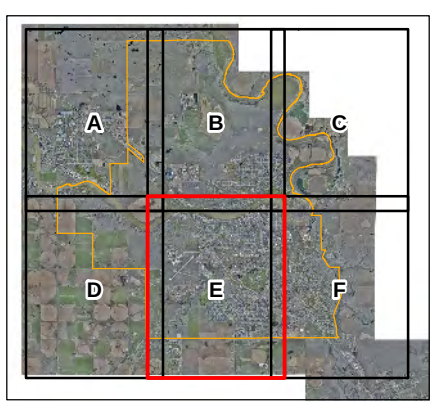
South Saskatchewan River Setback Sector

- SSR-A
- SSR-B
- SSR-C
- SSR-D
- SSR-E
- SSR-F
- SSR-G

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Stream Reach[2]
- Road
- City Boundary
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



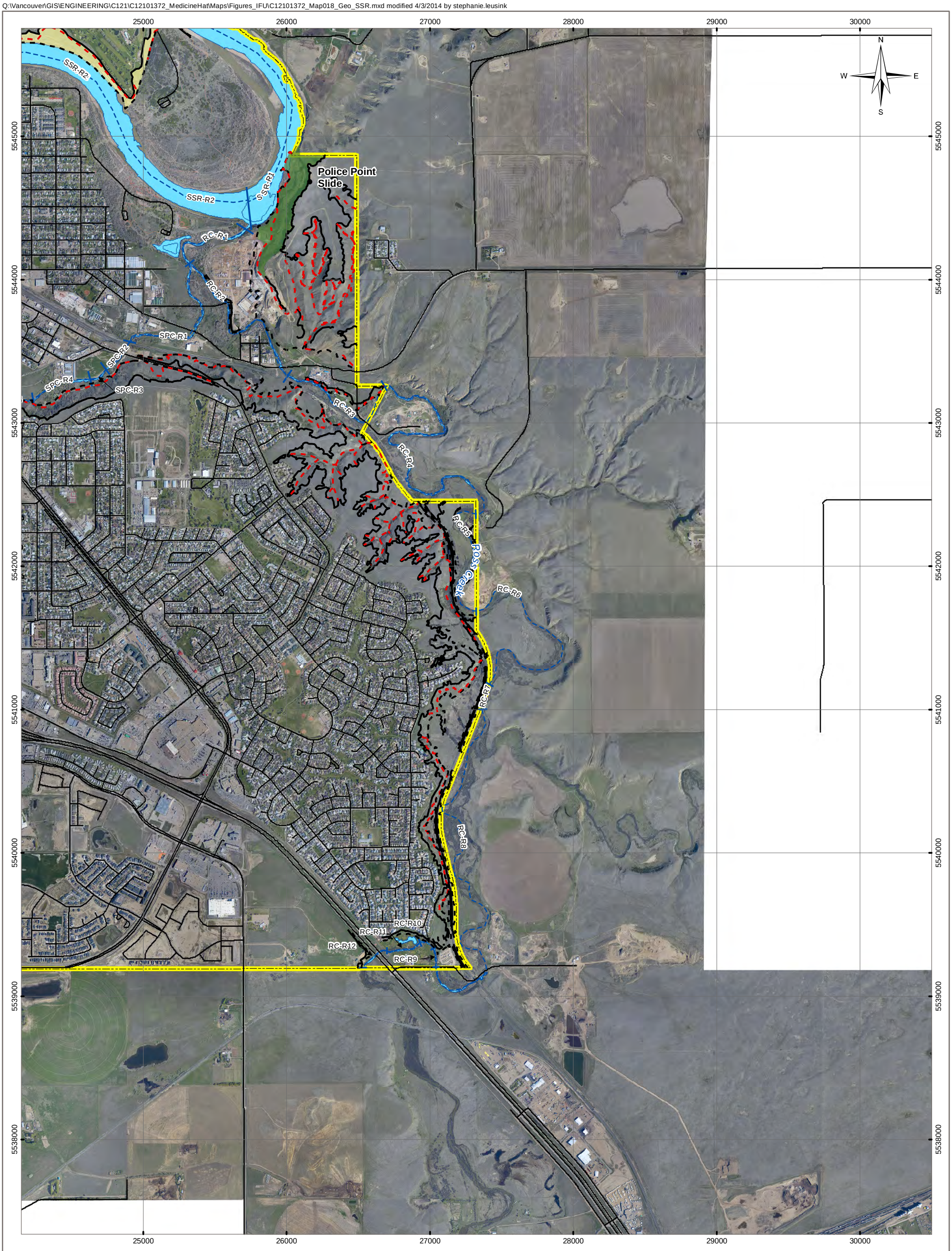
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for the South Saskatchewan River

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map018_Geo_SSR.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 23E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map018_Geo_SSR.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

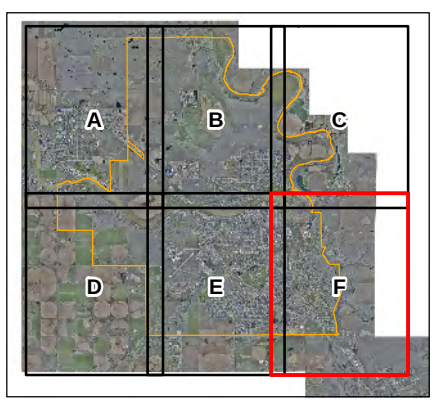
South Saskatchewan River Setback Sector

- SSR-A
- SSR-B
- SSR-C
- SSR-D
- SSR-E
- SSR-F
- SSR-G

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Stream Reach[2]
- Road
- City Boundary
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



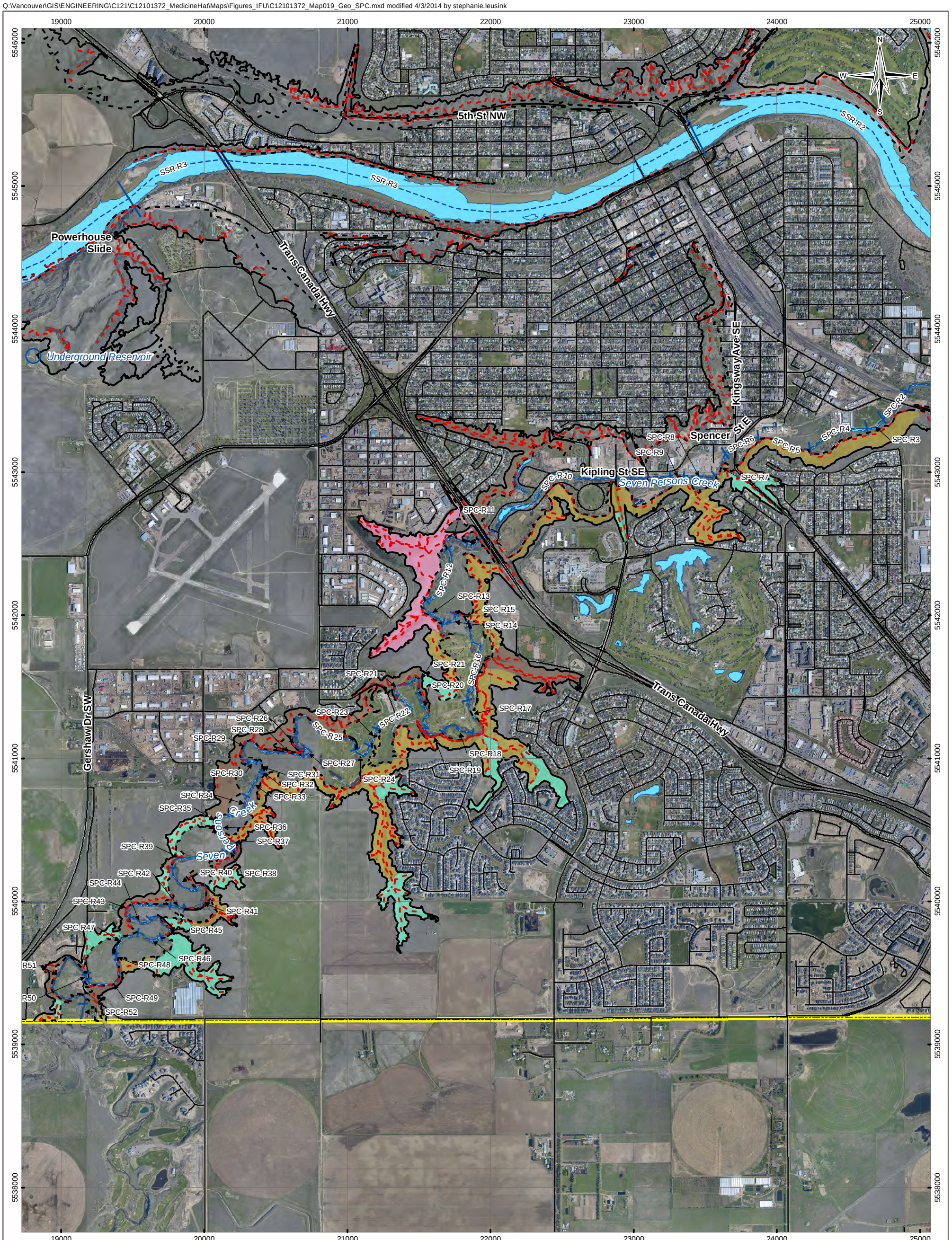
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for the South Saskatchewan River

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map018_Geo_SSR.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 23F**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map019_Geo_SPC.mxd modified 4/3/2014 by stephanie.leusink



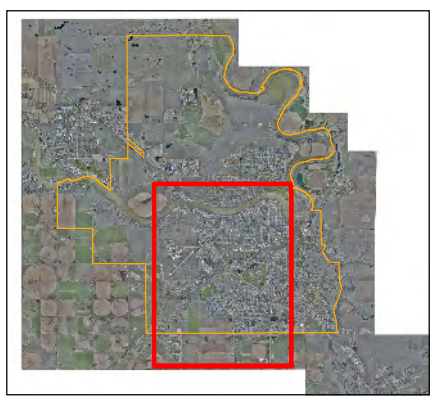
LEGEND

Seven Persons Creek Setback Sector

- SPC-A
- SPC-B
- SPC-C
- SPC-D

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Stream Reach[2]
- Road
- City Boundary
- River / Creek

NOTES
1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



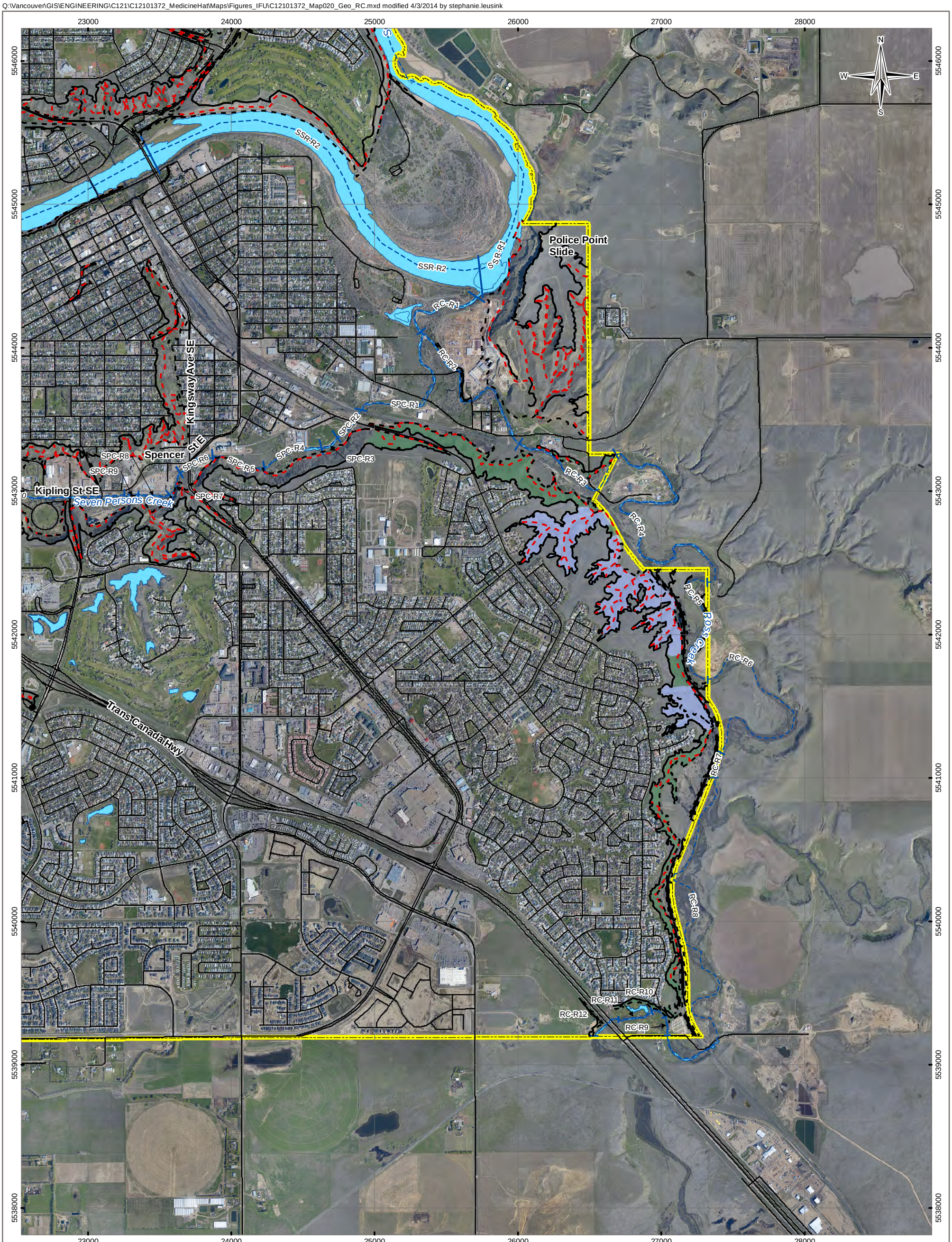
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for Seven Persons Creek

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map019_Geo_SPC.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 24**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map020_Geo_RC.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

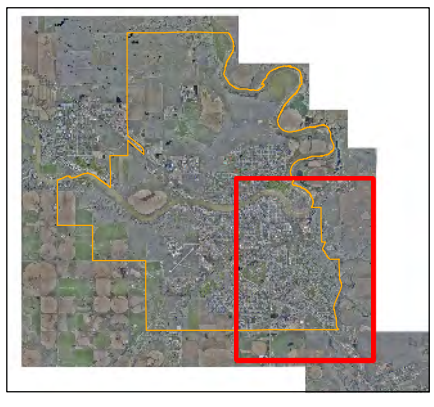
Ross Creek Setback Sector

- RC-A
- RC-B

- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Stream Reach[2]
- Road
- City Boundary
- River / Creek

NOTES

1. Base data source: City of Medicine Hat
2. Stream Reach labels contain the following abbreviations:
   IS - Interior Slopes SPC - Seven Persons Creek
   RC - Ross Creek SSR - South Saskatchewan River



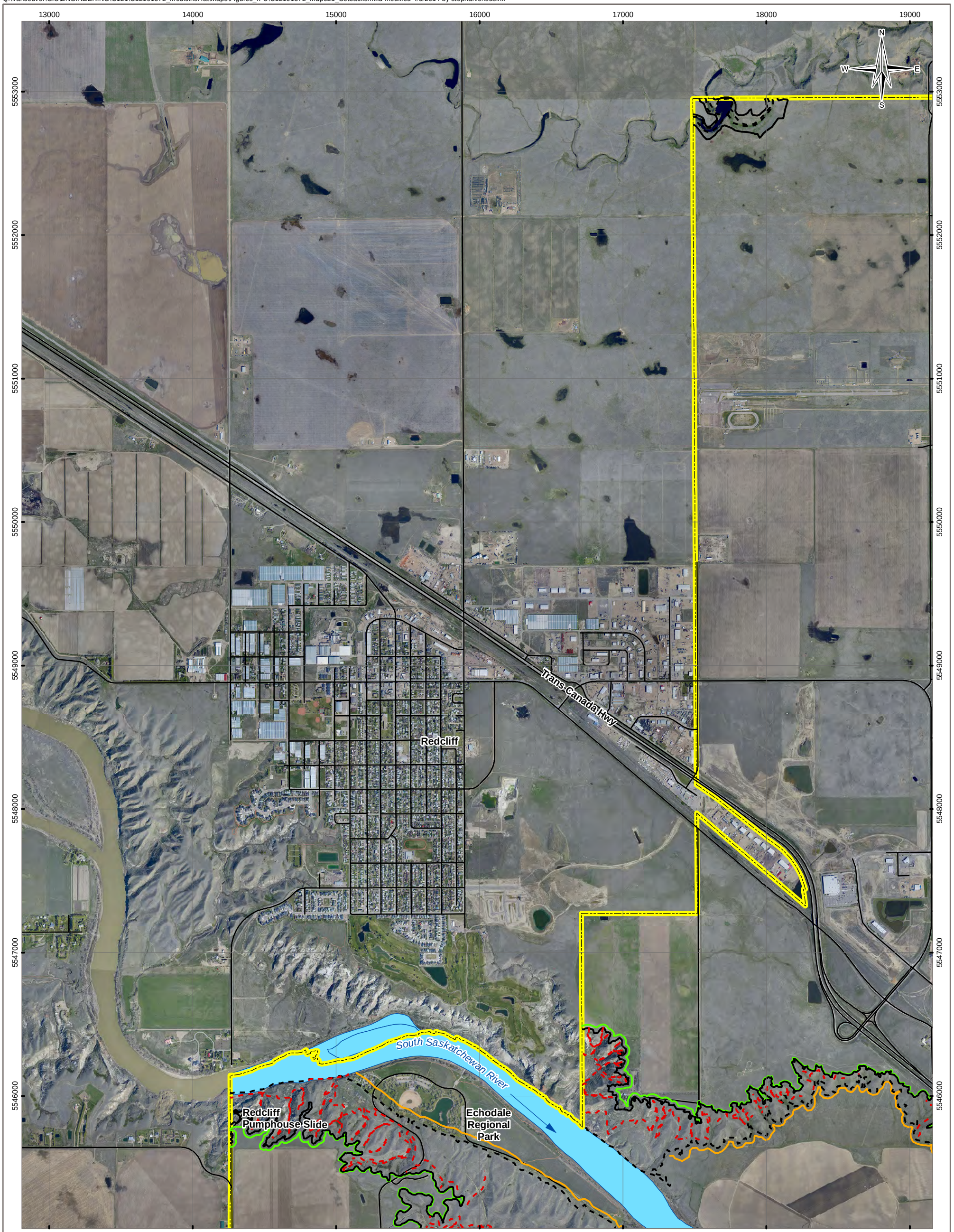
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Geotechnical Setback Sectors for Ross Creek

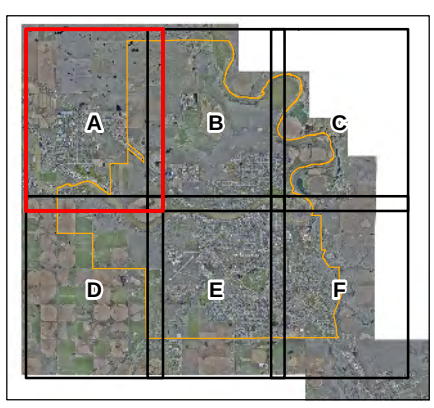
PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map020_Geo_RC.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 25**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map021_Setbacks.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

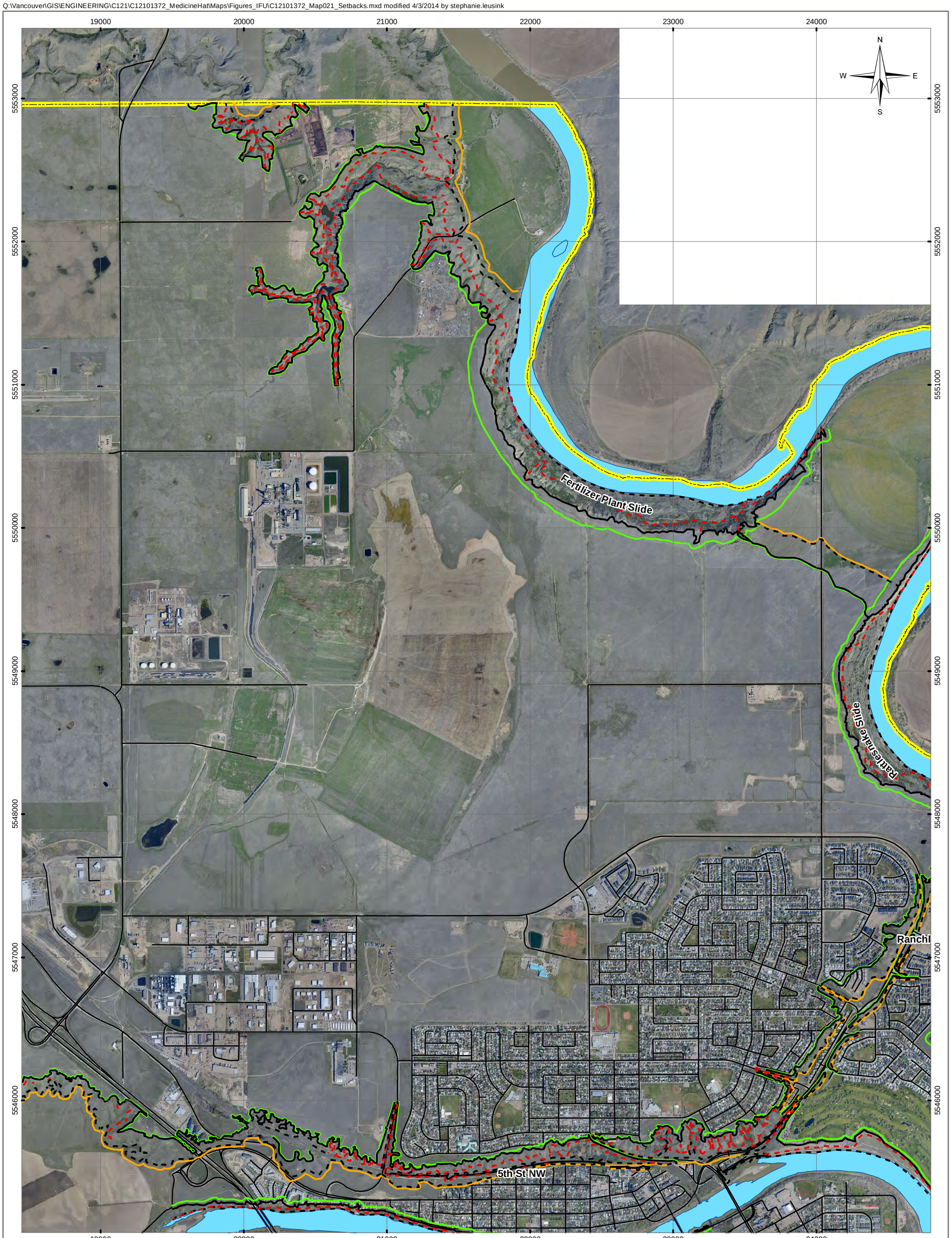
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Setback Lines for Top and Toe of Escarpment

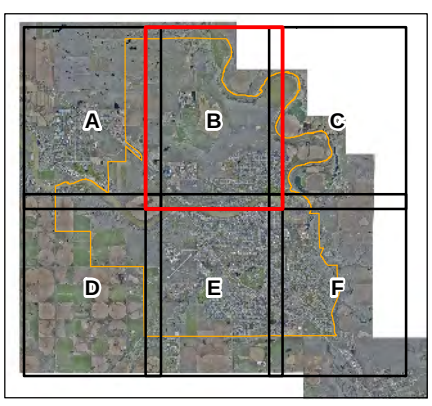
PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map021_Setbacks.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** MG	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 26A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map021_Setbacks.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

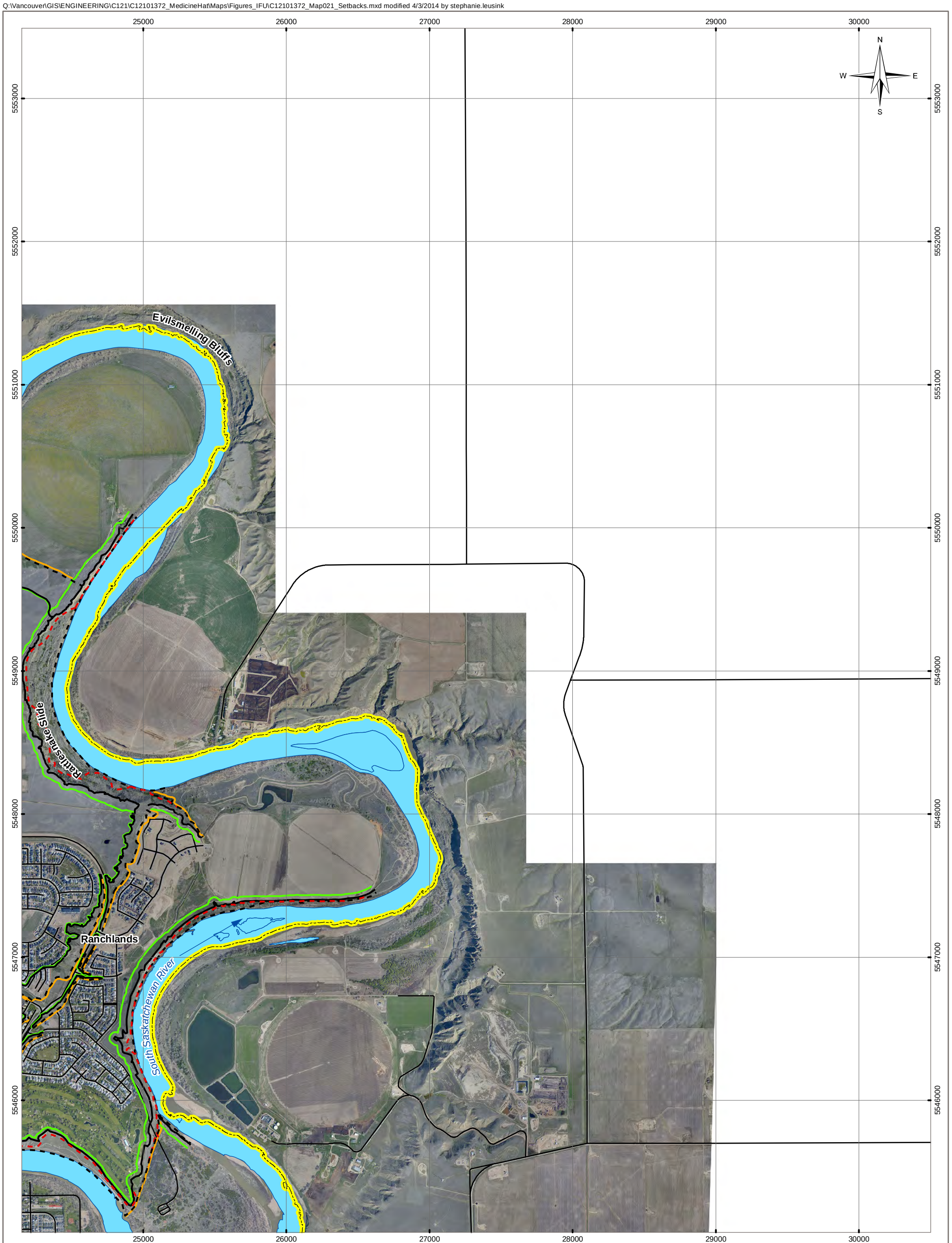
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Setback Lines for Top and Toe of Escarpment

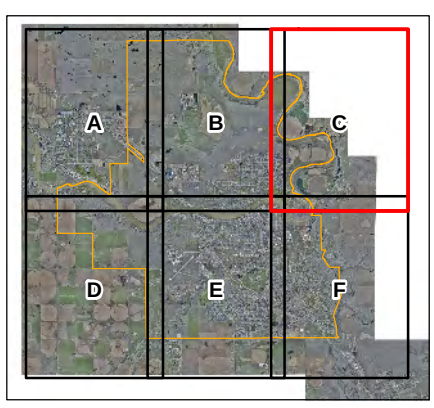
PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map021_Setbacks.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** MG	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 26B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map021_Setbacks.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Setback Lines for Top and Toe of Escarpment

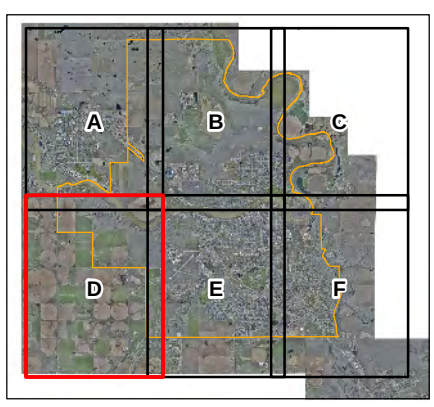
PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83			**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Map021_Setbacks.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** MG	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 26C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map021_Setbacks.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

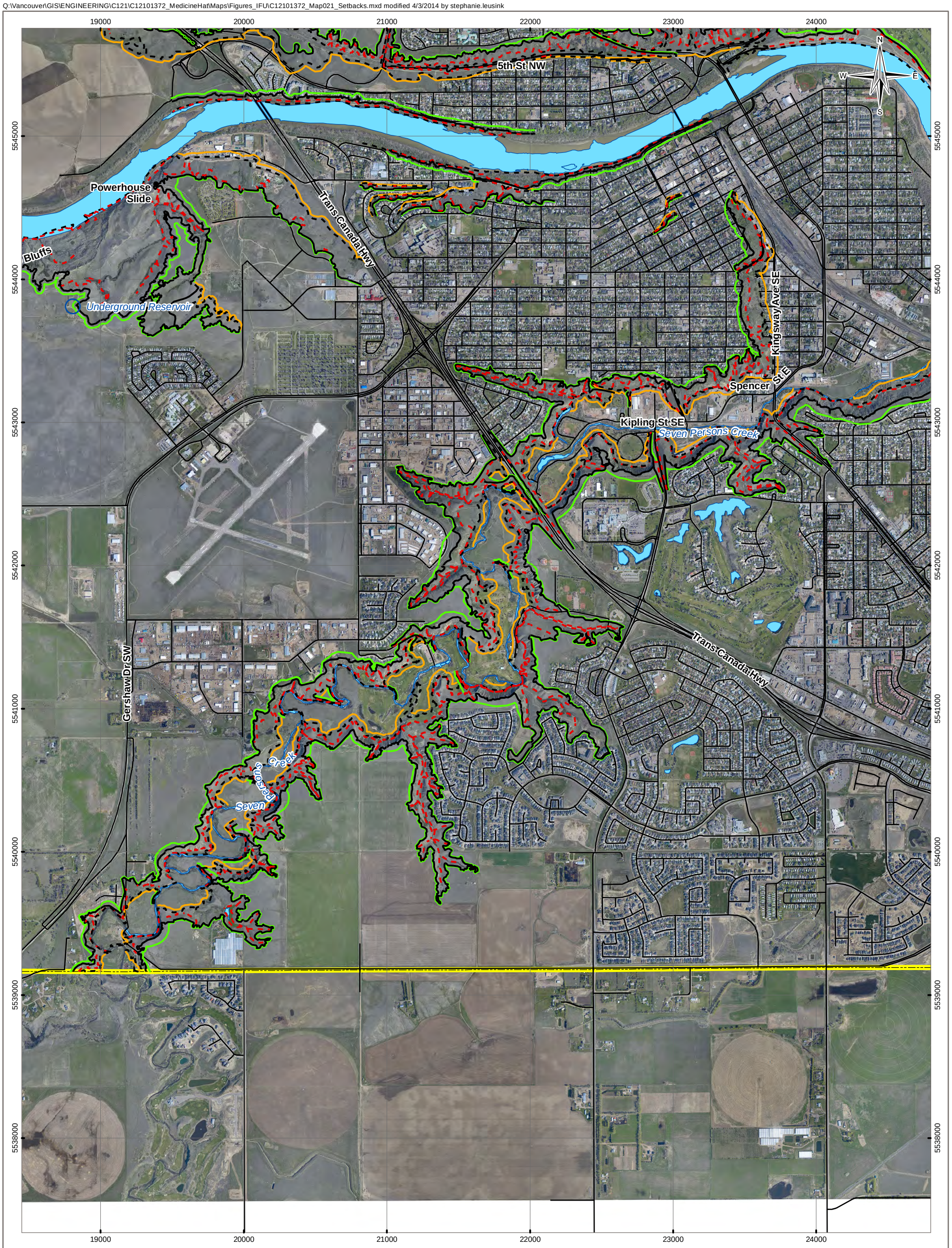
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Setback Lines for Top and Toe of Escarpment

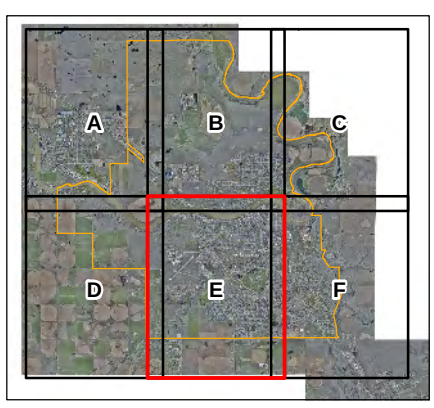
PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map021_Setbacks.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** MG	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 26D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map021_Setbacks.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

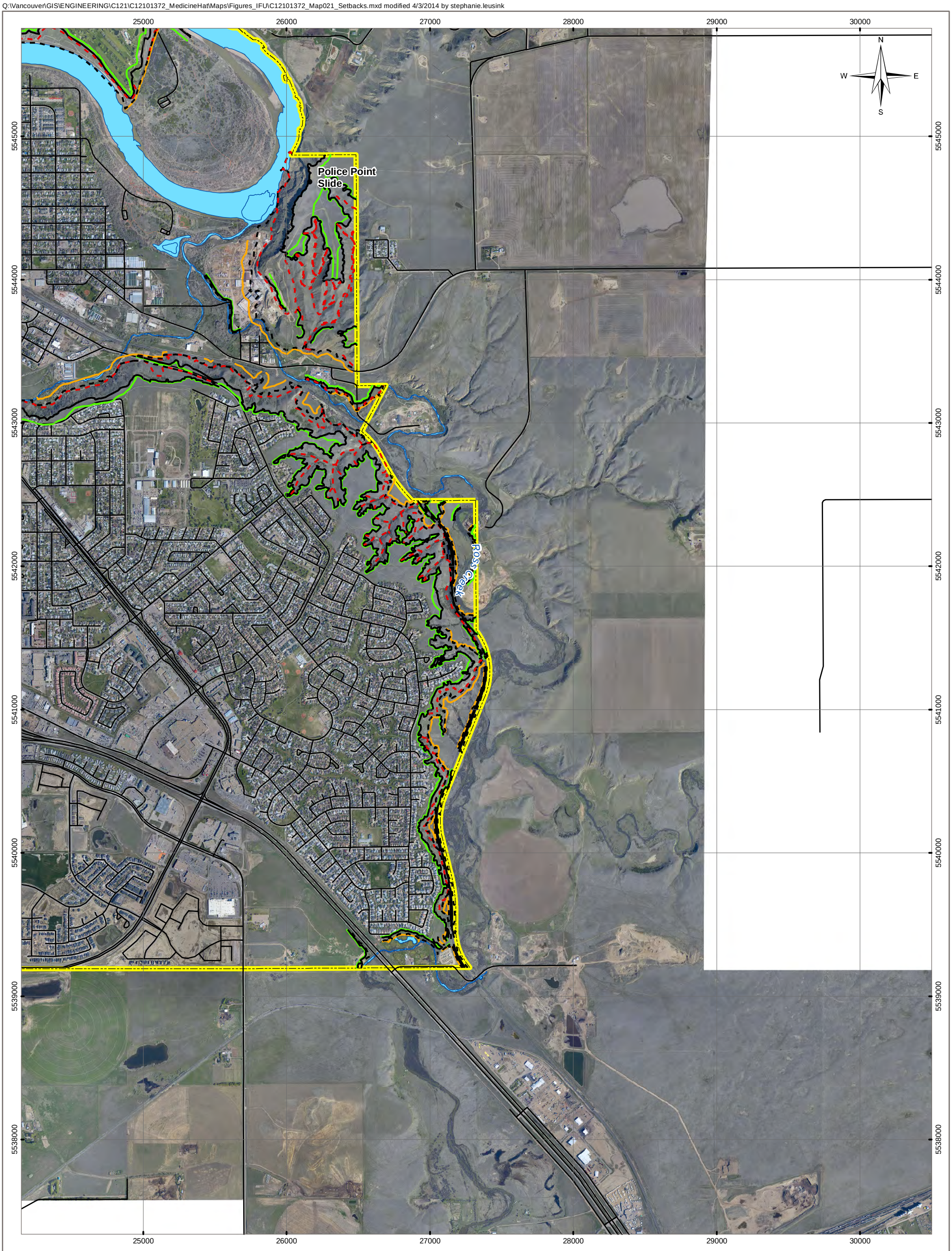
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Setback Lines for Top and Toe of Escarpment

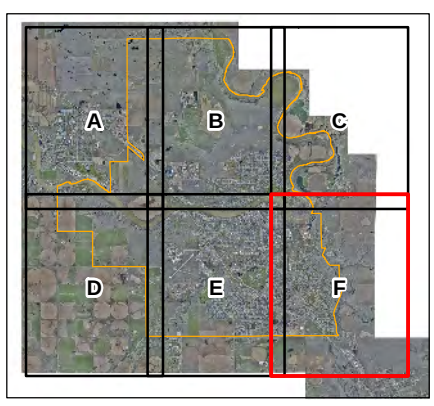
PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map021_Setbacks.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** MG	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 26E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map021_Setbacks.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

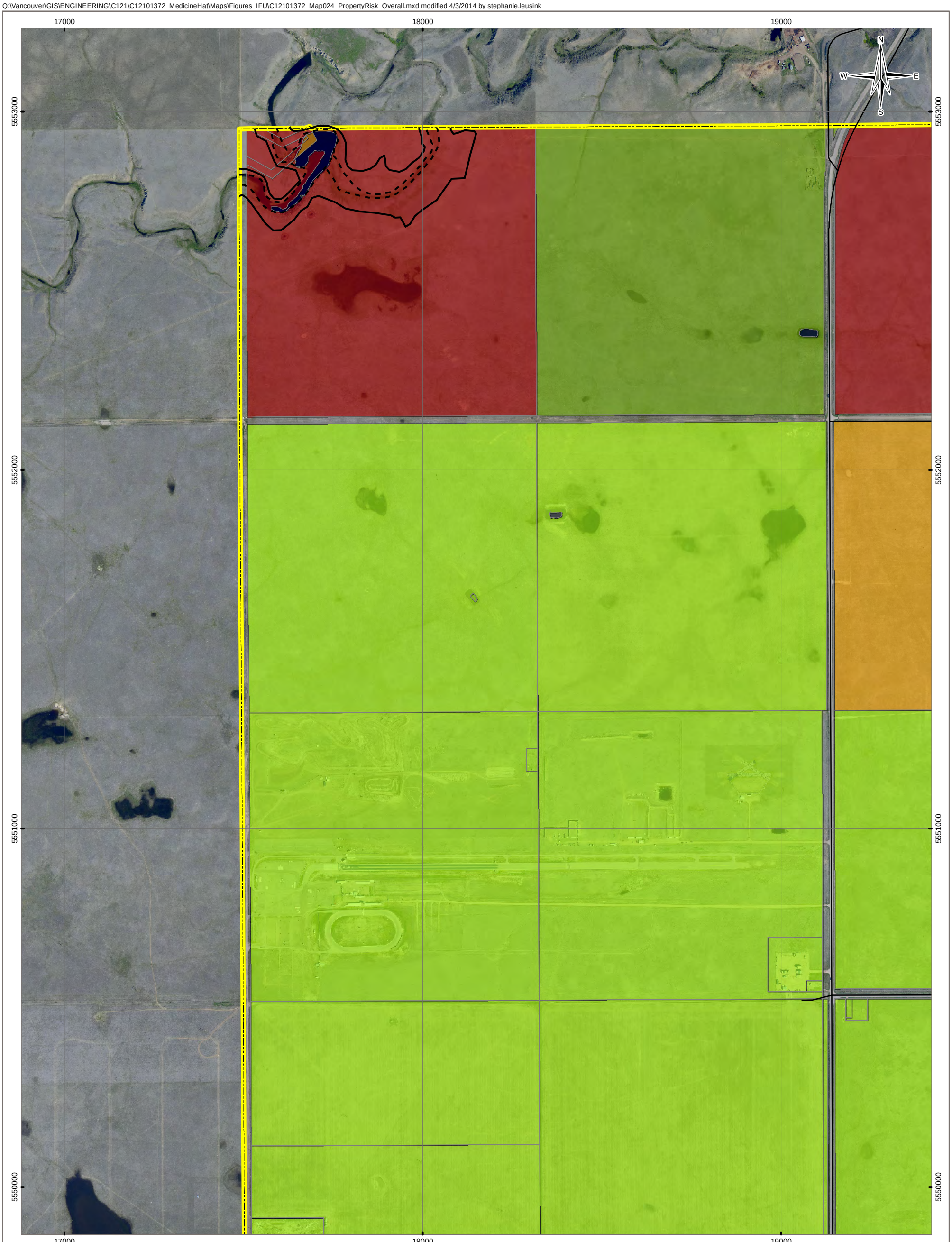
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Setback Lines for Top and Toe of Escarpment

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres			
FILE NO. C12101372_Map021_Setbacks.mxd			A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL / **APVD** MG	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014		**Figure 26F**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

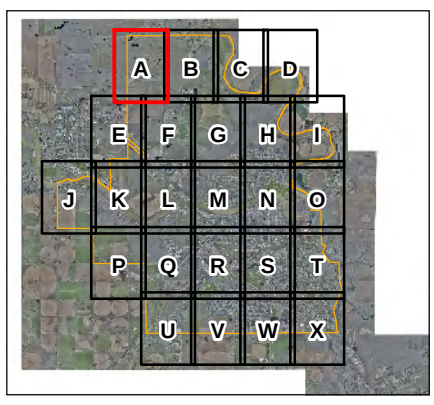


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

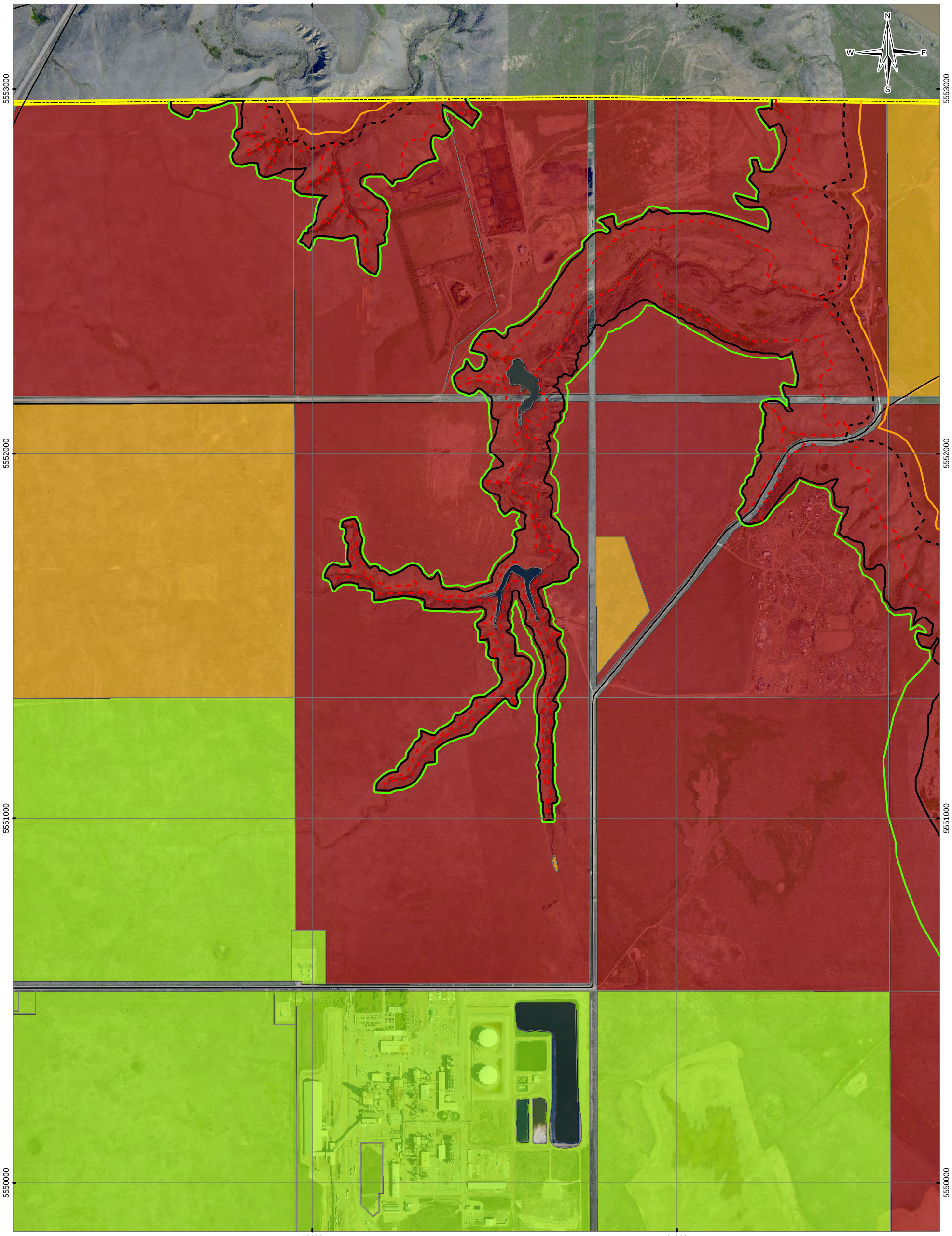
MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat	
Scale: 1:10,000 (200 100 0 200 Metres)					
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd					
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0	**Figure 27A**
OFFICE EBA-VANC	**DATE** April 3, 2014				

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

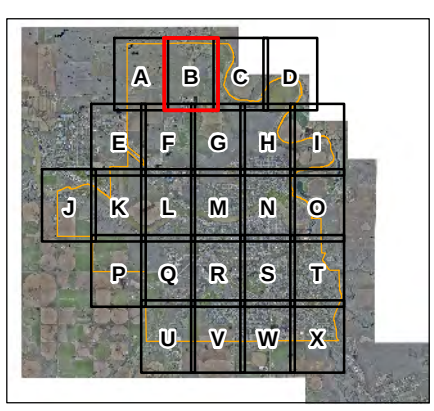


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

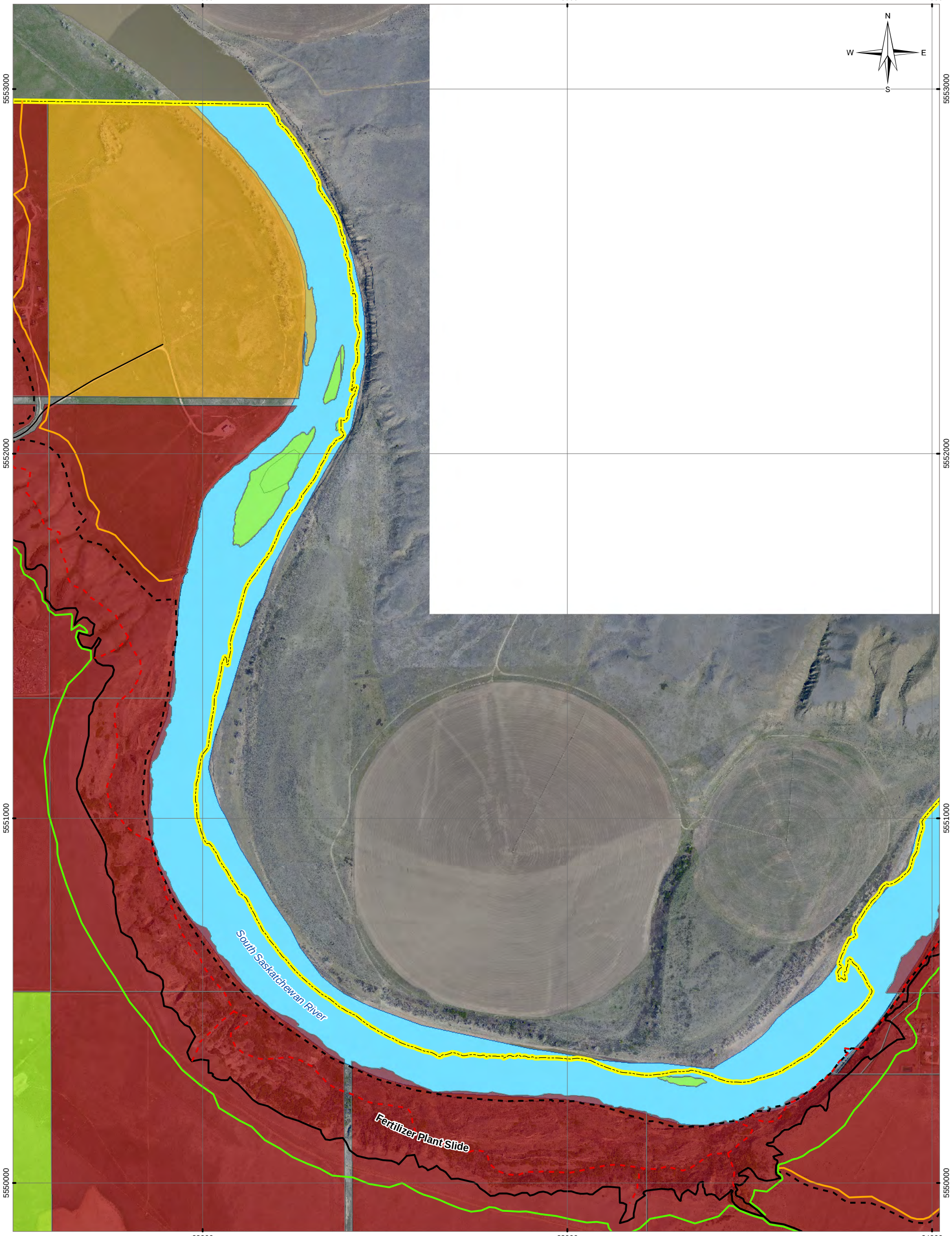
MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat	
Scale: 1:10,000 (200 100 0 200 Metres)					
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd					
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0	**Figure 27B**
OFFICE EBA-VANC	**DATE** April 3, 2014				

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

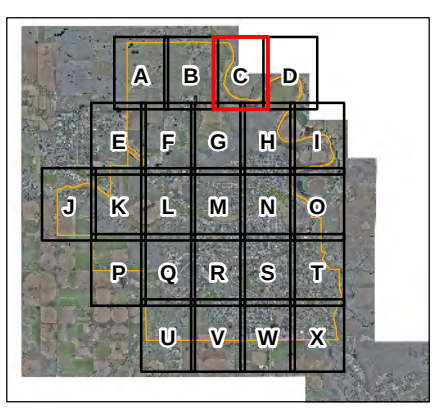


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

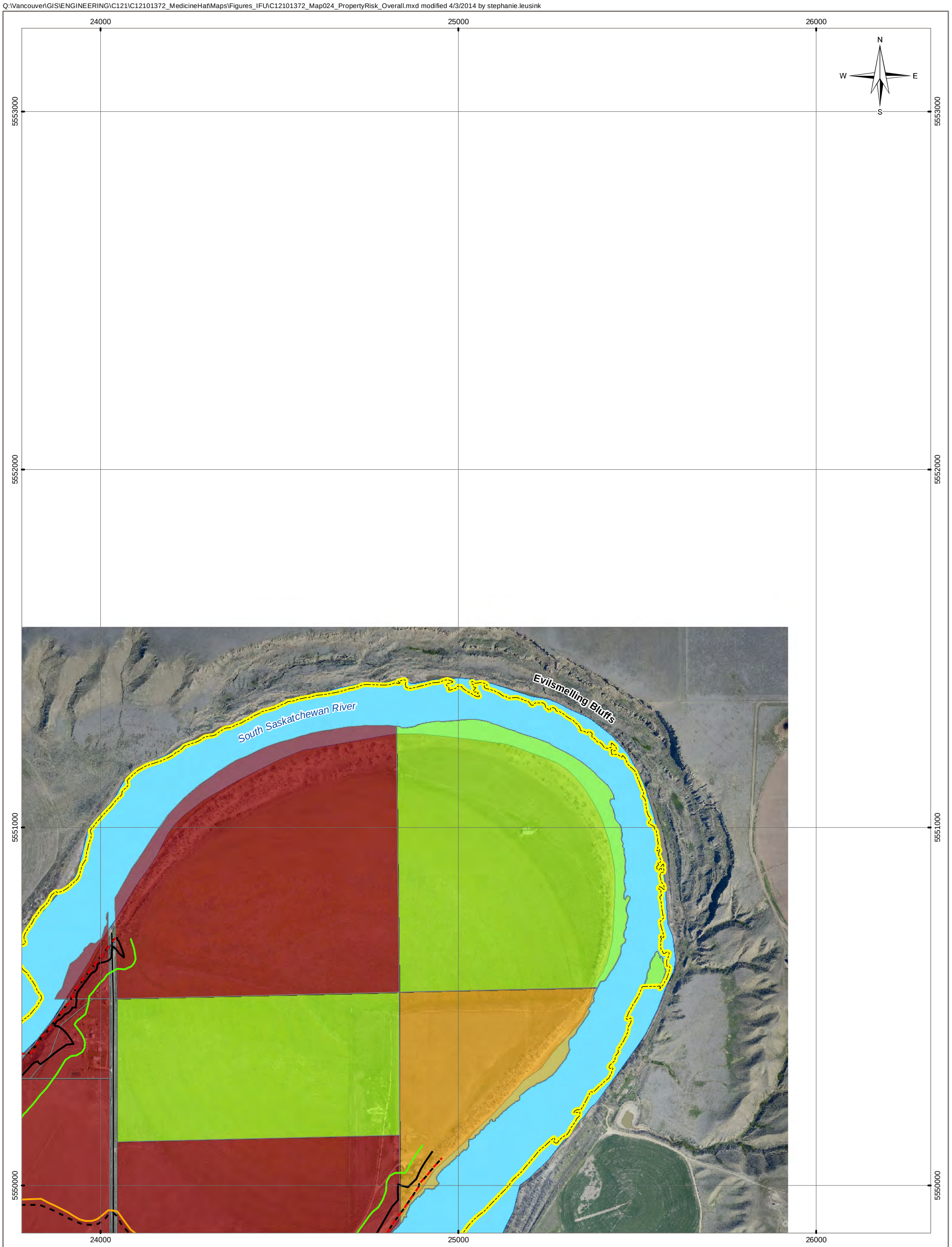
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres				
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

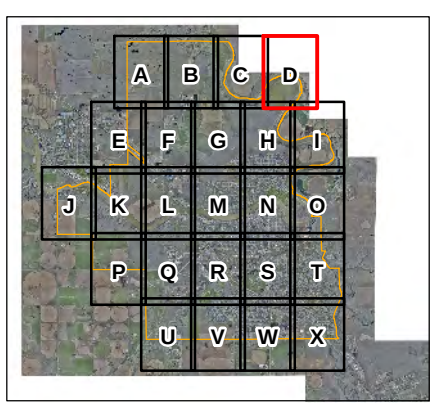


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

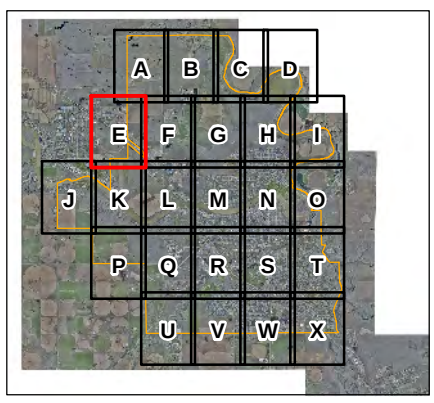


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

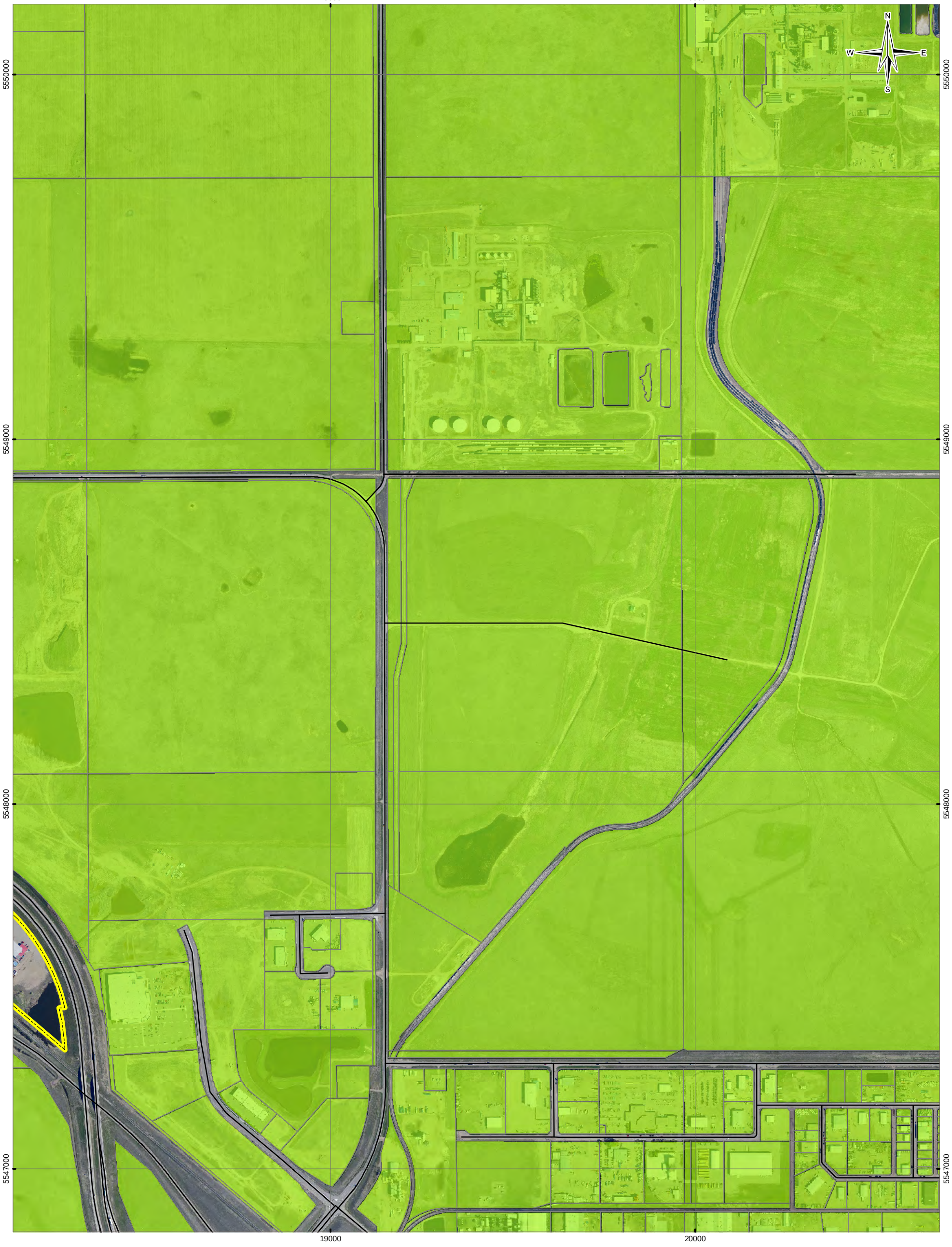
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres				A TETRA TECH COMPANY
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

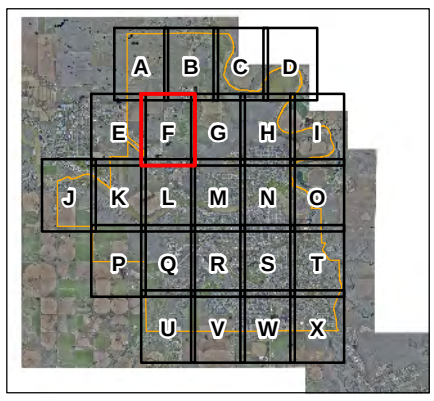


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres					A TETRA TECH COMPANY
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd					
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0	**Figure 27F**
OFFICE EBA-VANC	**DATE** April 3, 2014				

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

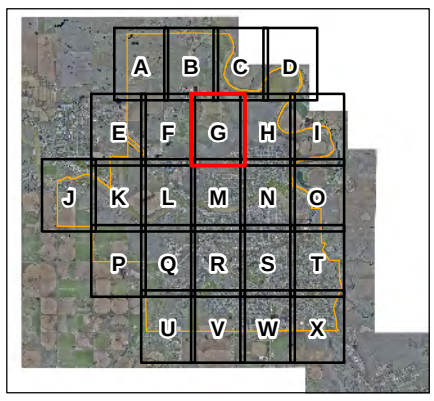


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

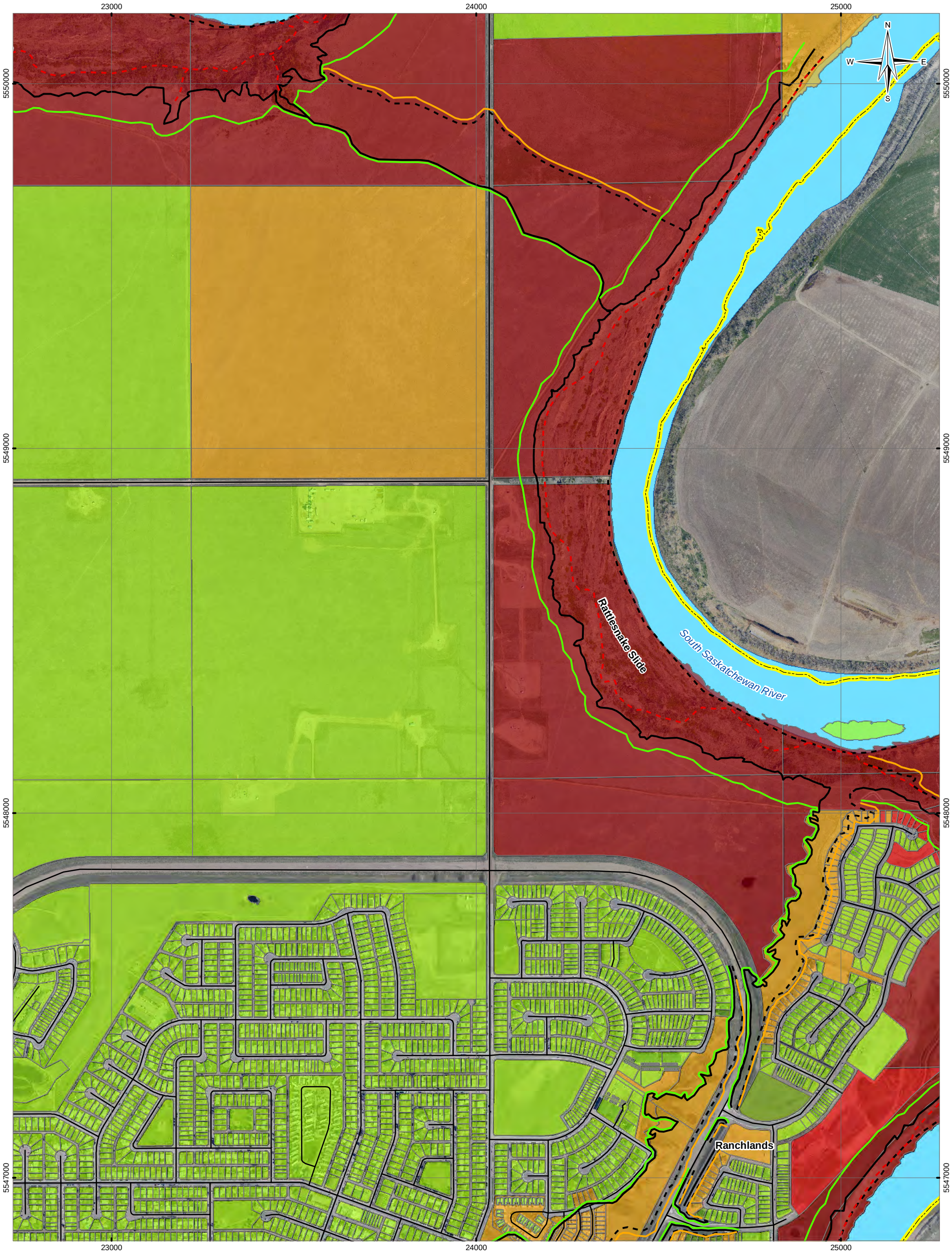
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres				
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27G**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

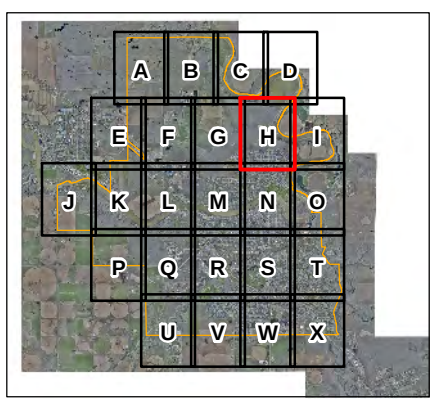


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

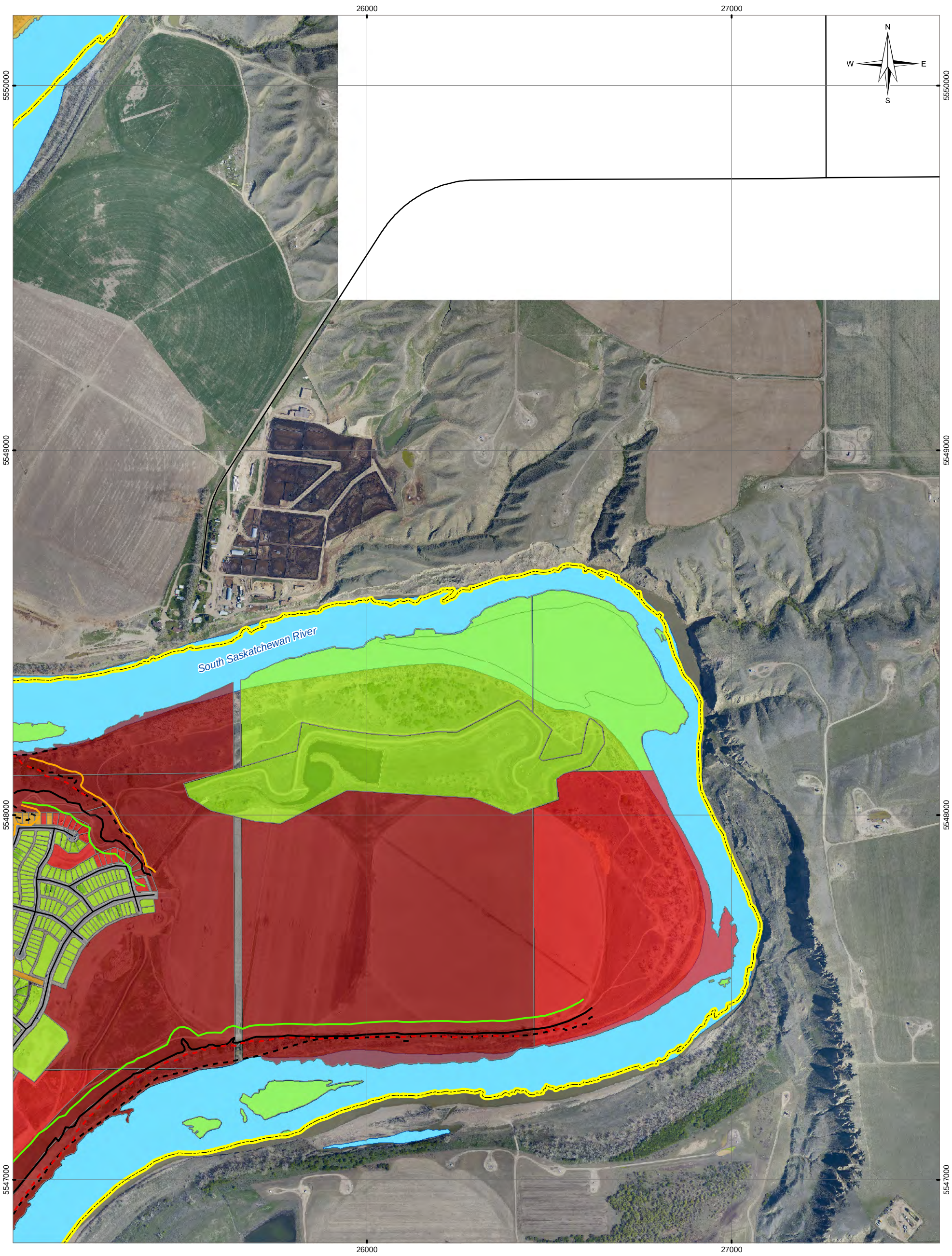
MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres				
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27H**

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

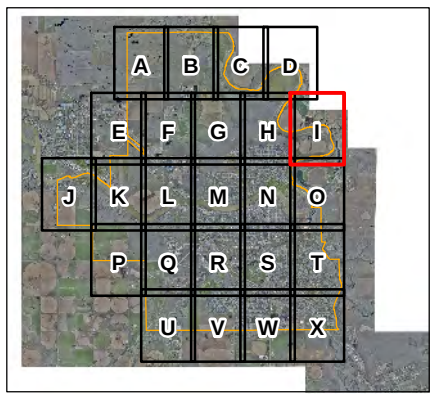


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

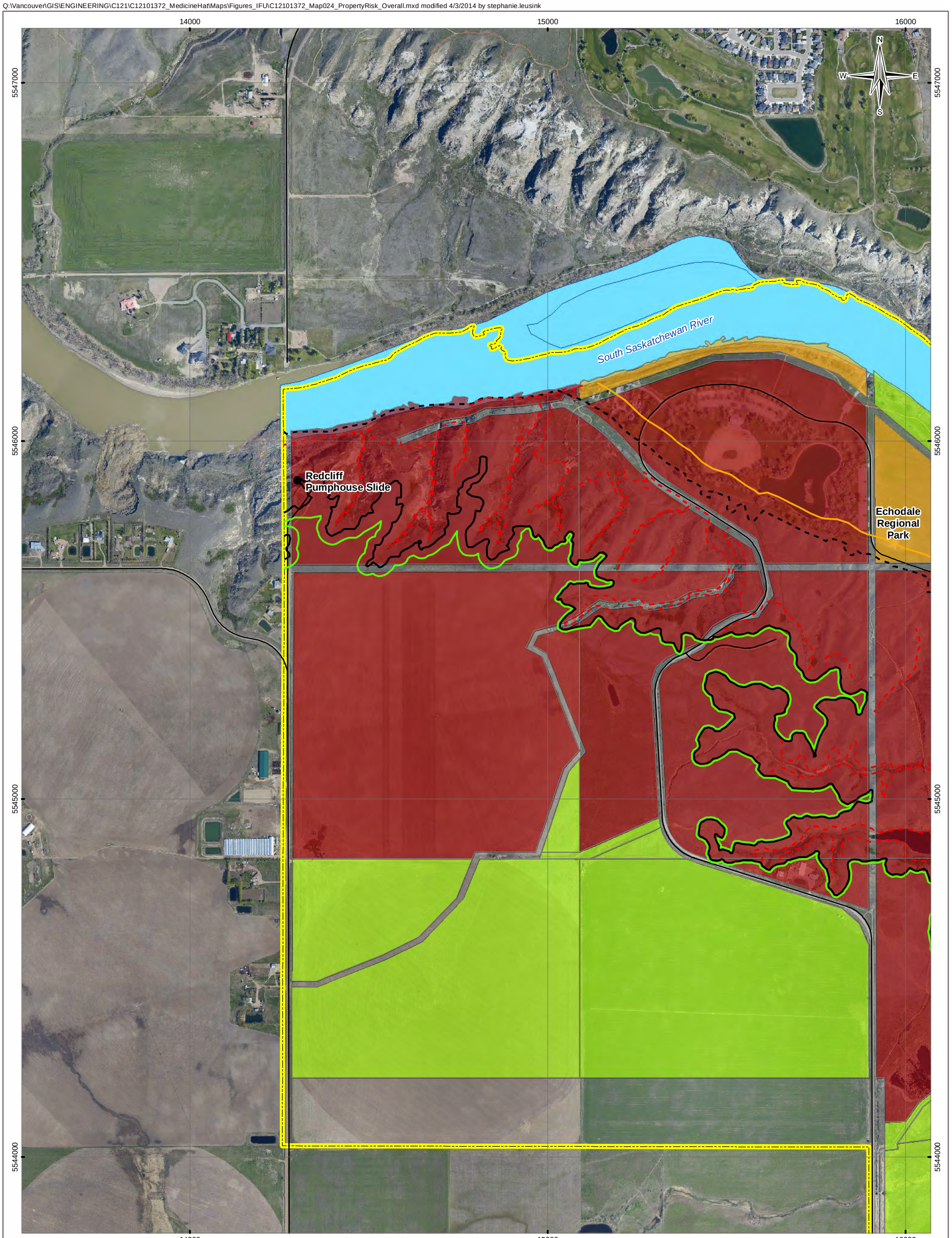
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 Metres				
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27I**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

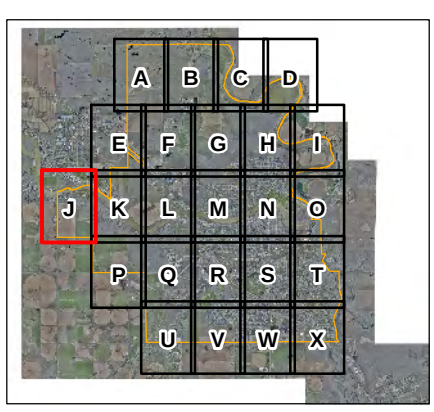


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

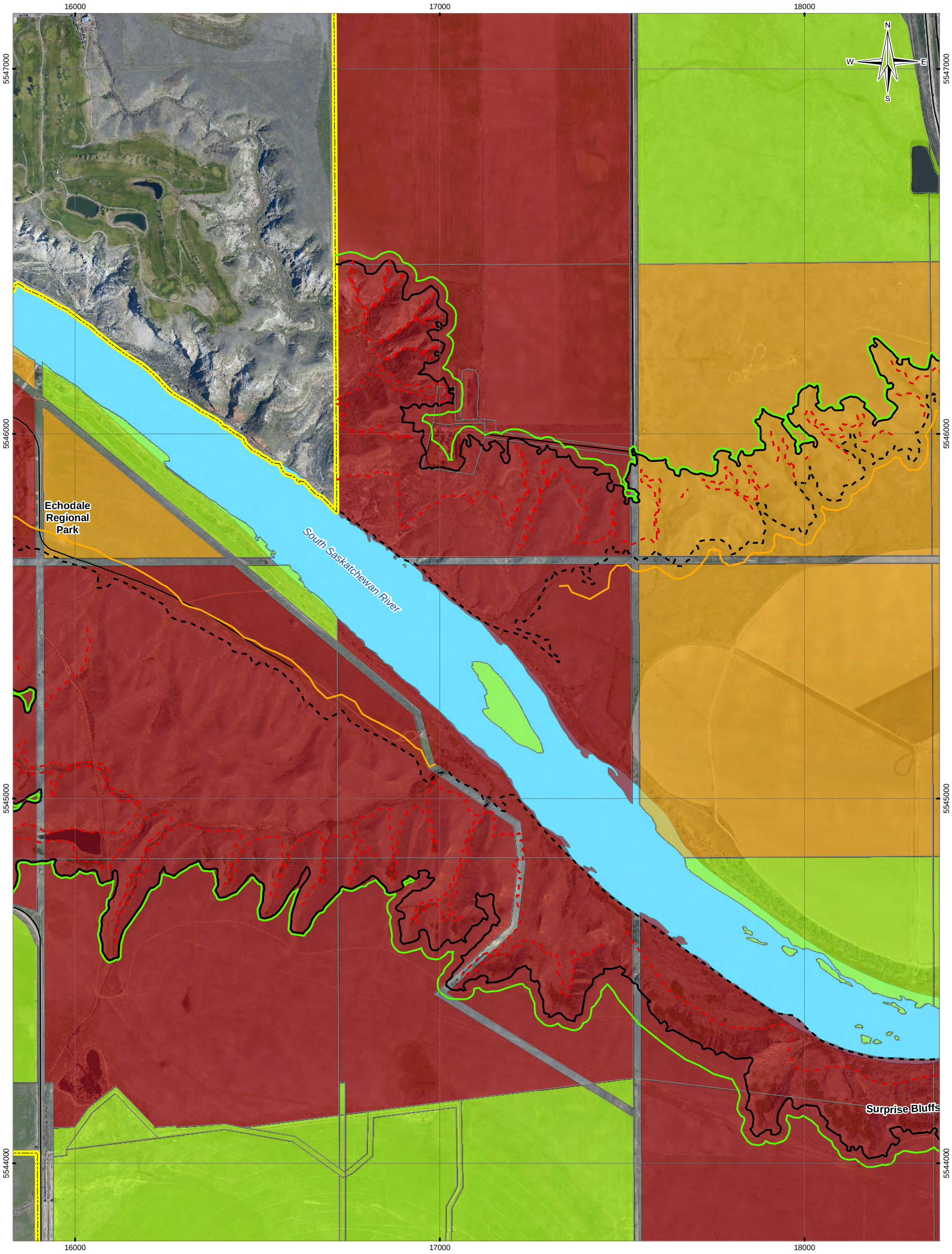
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat	
Scale: 1:10,000 — 200 100 0 200 Metres					
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				A TETRA TECH COMPANY	
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0	**Figure 27J**
OFFICE EBA-VANC	**DATE** April 3, 2014				

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

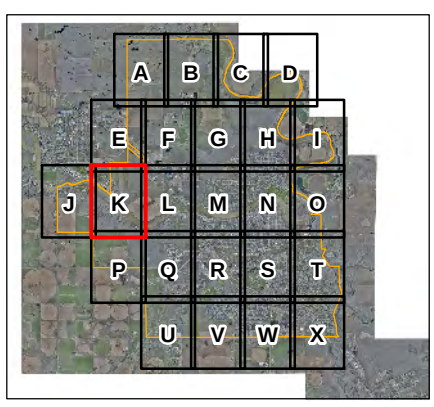


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

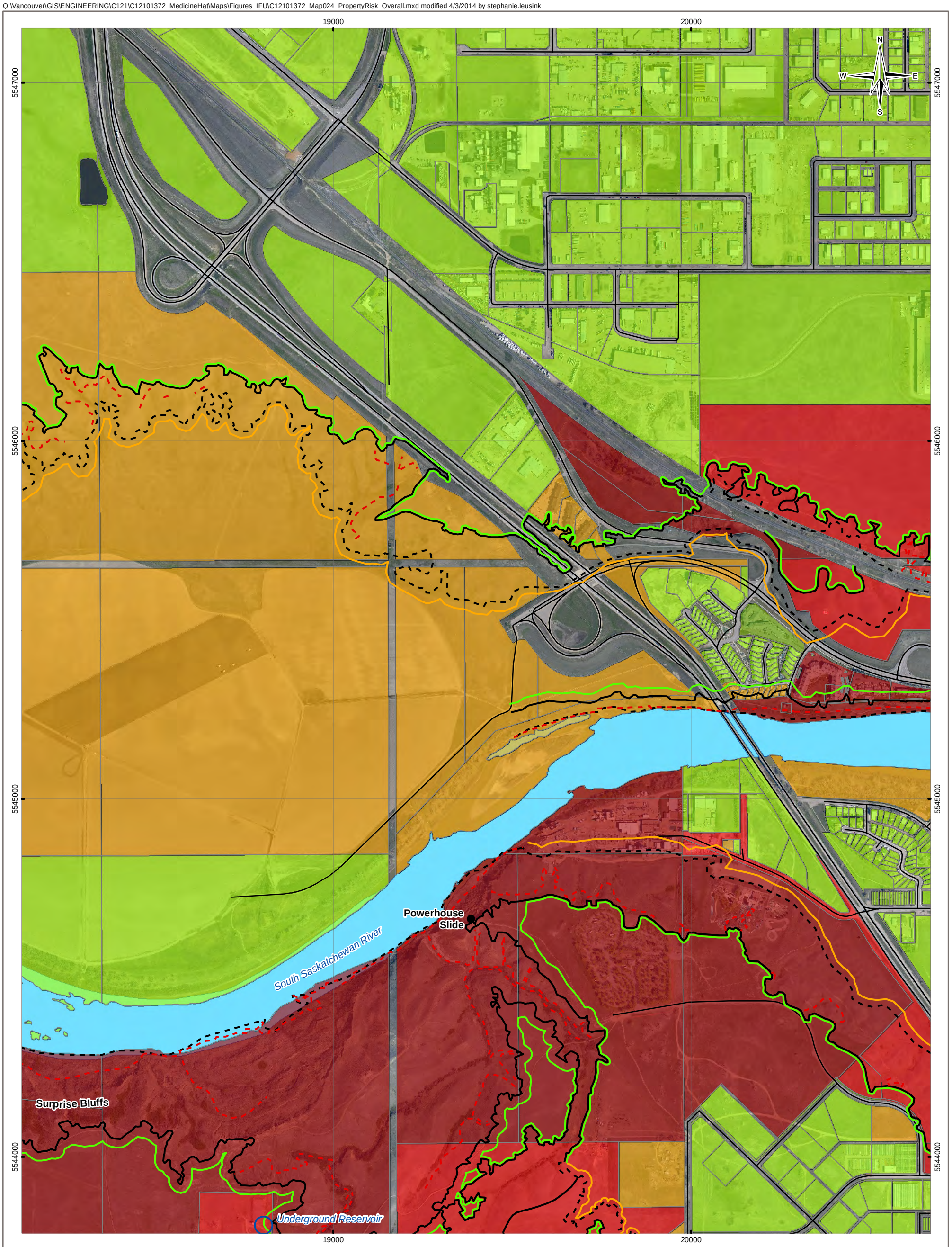
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres				A TETRA TECH COMPANY
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27K**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

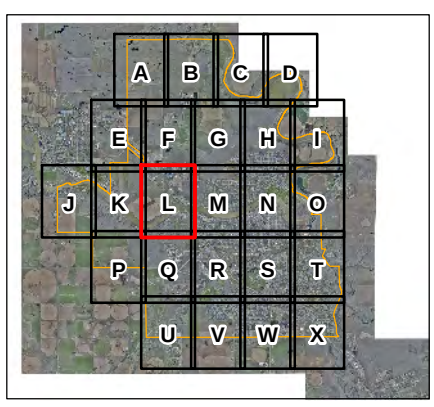


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

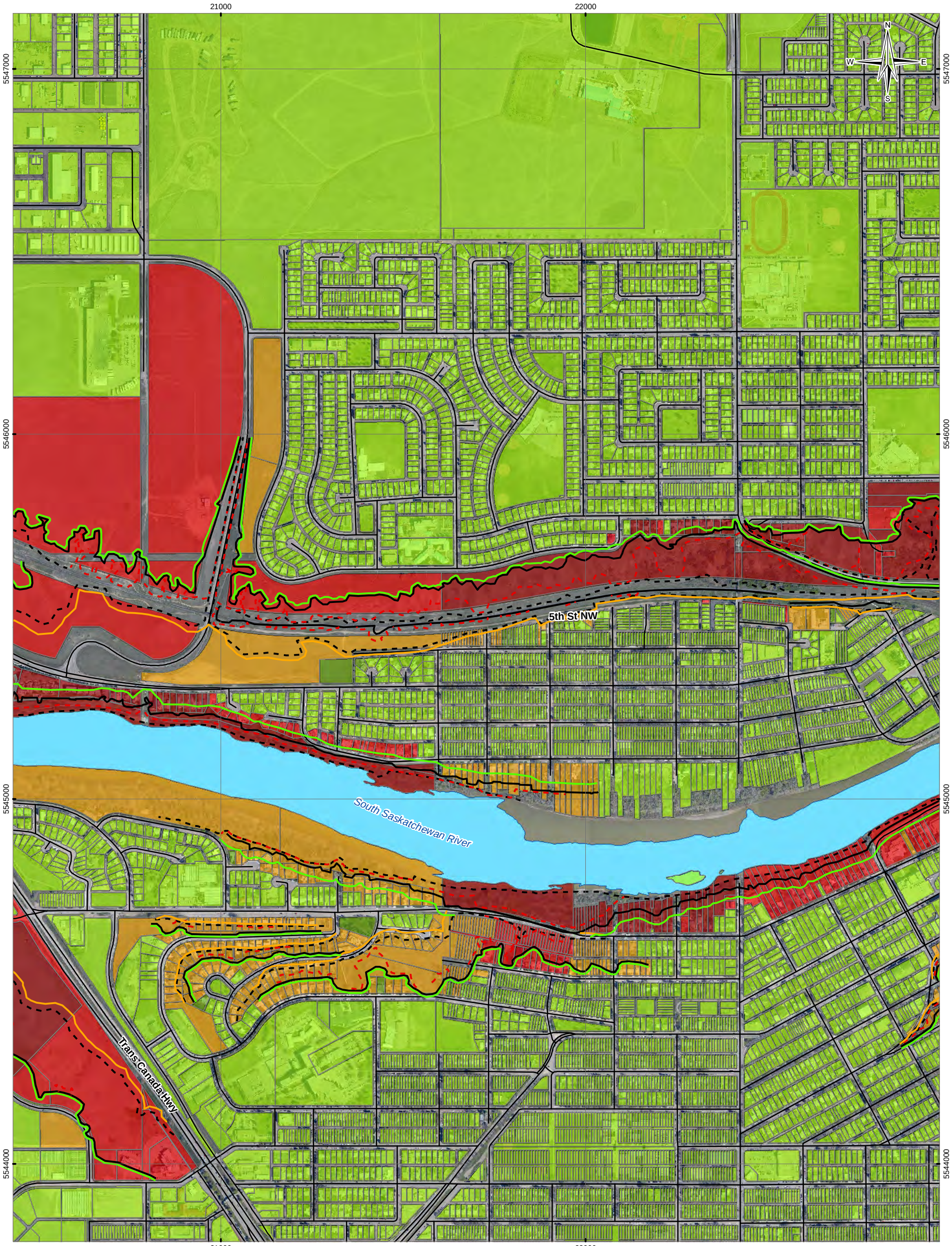
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)	**DATUM** NAD83	**CLIENT** City of Medicine Hat	
Scale: 1:10,000 — 200 100 0 200 Metres			
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd		eba A TETRA TECH COMPANY	
PROJECT NO. C12101372	**DWN** SL / **CKD** MEZ / **APVD** SH / **REV** 0		**Figure 27L**
OFFICE EBA-VANC	**DATE** April 3, 2014		

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

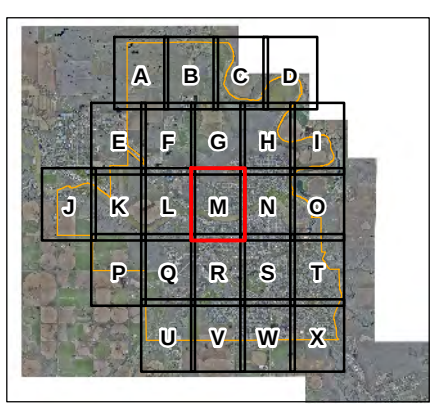


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

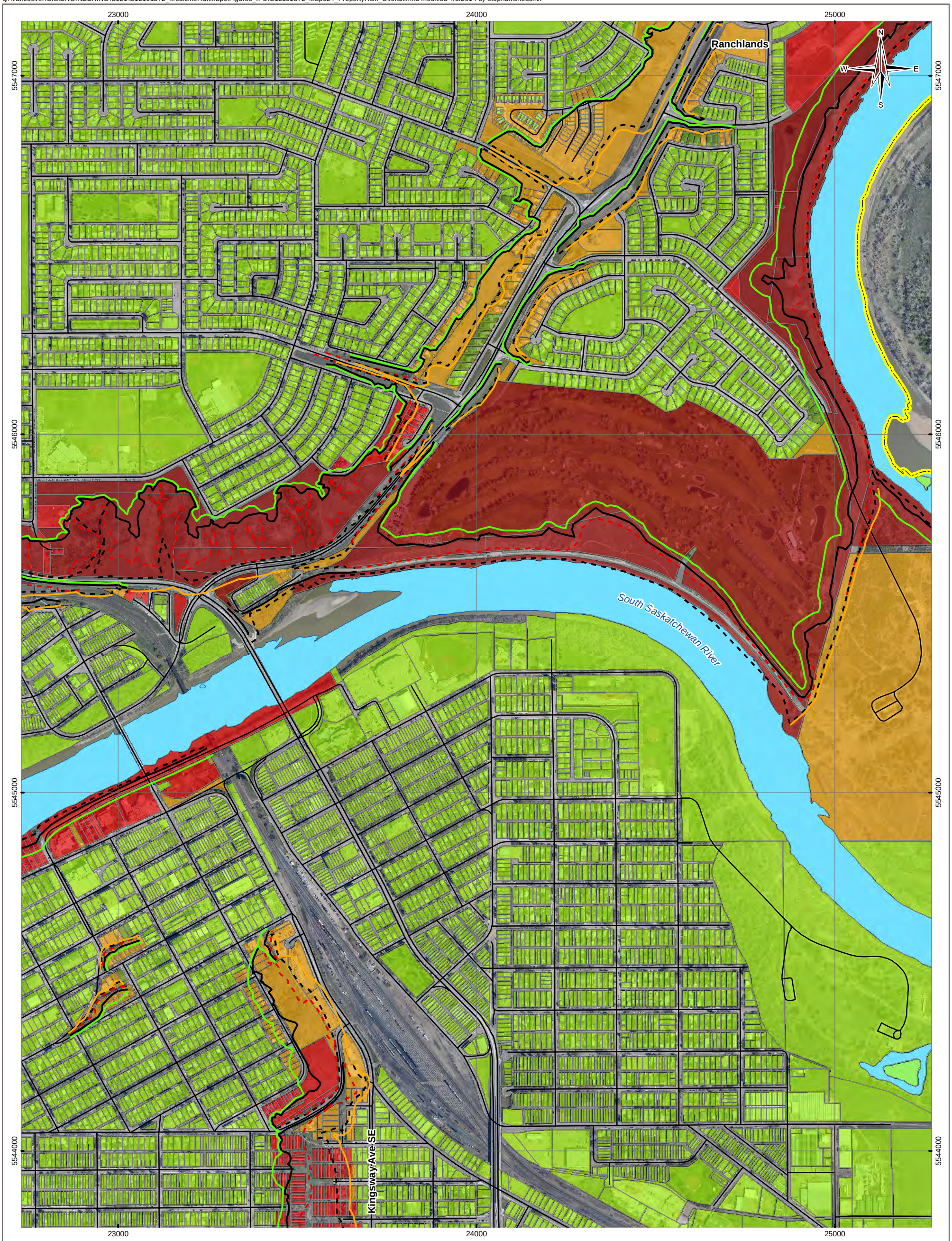
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres				
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27M**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

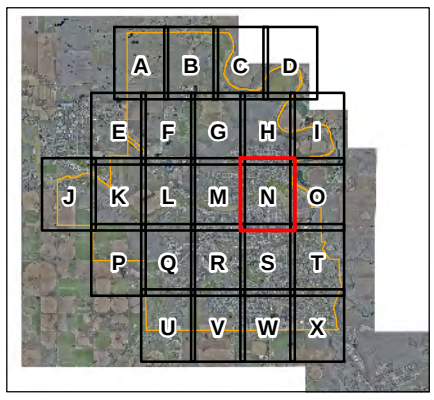


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

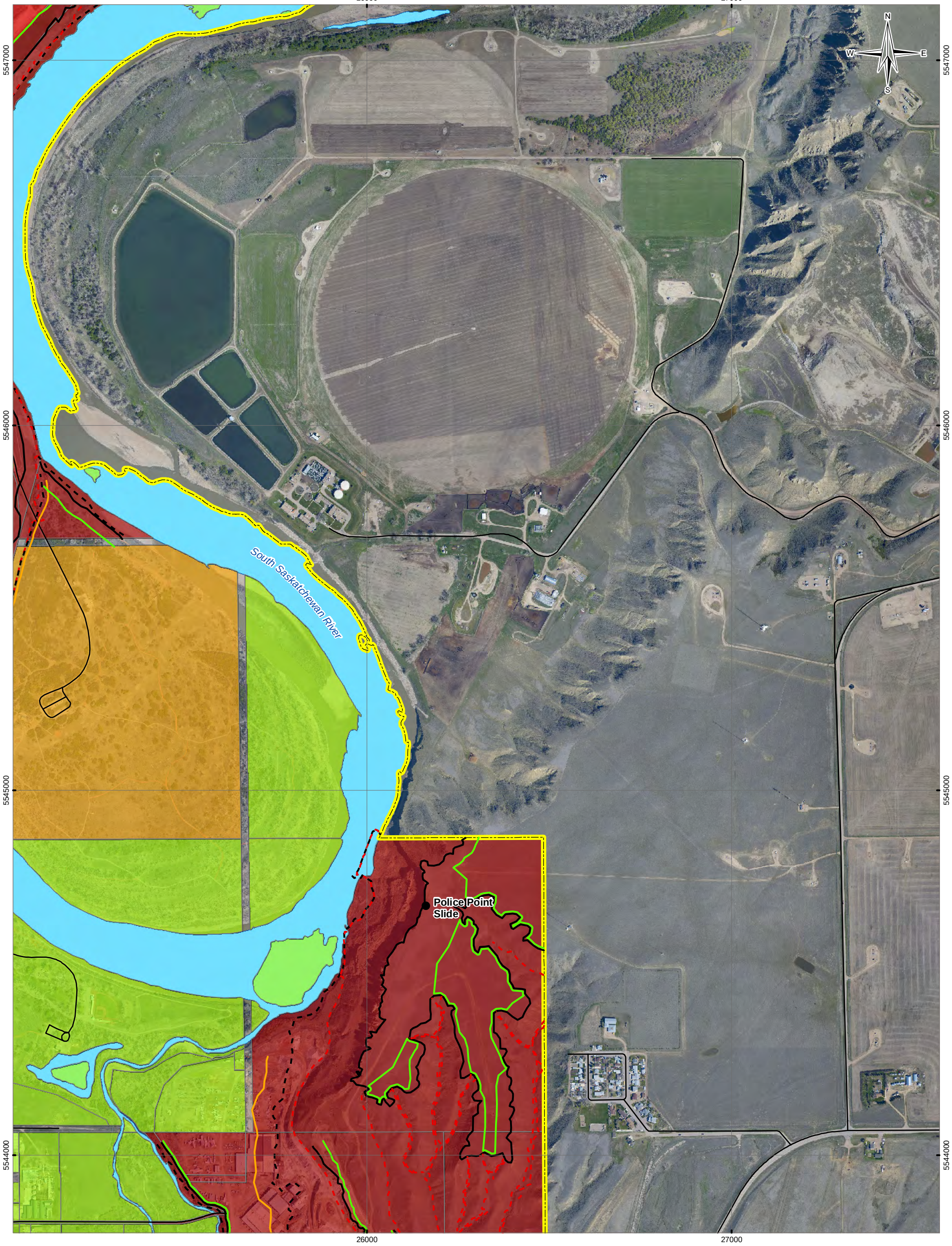
MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat	
Scale: 1:10,000 — 200 100 0 200 — Metres					
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd					
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0	**Figure 27N**
OFFICE EBA-VANC	**DATE** April 3, 2014				

eba A TETRA TECH COMPANY

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

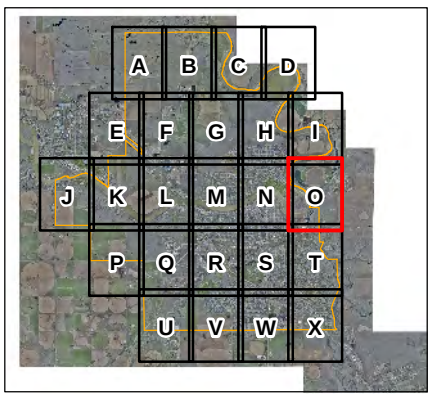


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres					A TETRA TECH COMPANY
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd					
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0	**Figure 27O**
OFFICE EBA-VANC	**DATE** April 3, 2014				

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

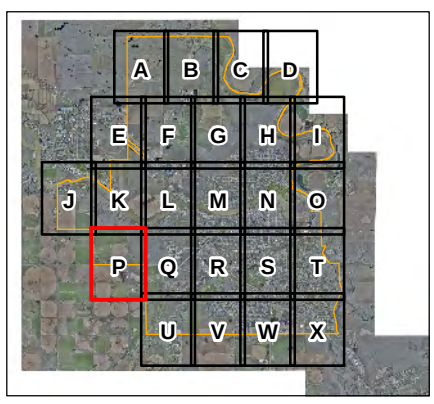


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

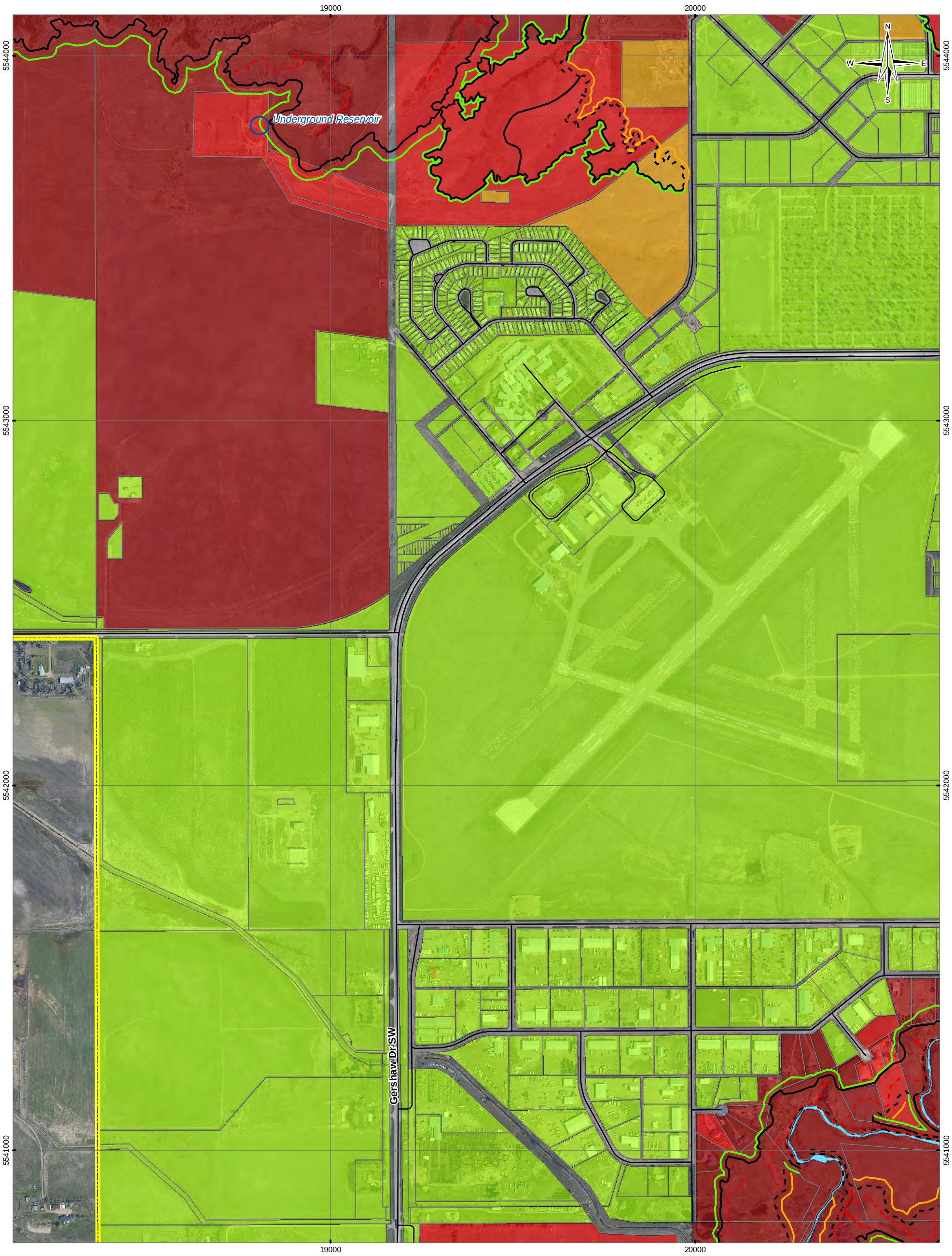
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat	
Scale: 1:10,000 — 200 100 0 200 — Metres					
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				A TETRATECH COMPANY	
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0	**Figure 27P**
OFFICE EBA-VANC	**DATE** April 3, 2014				

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

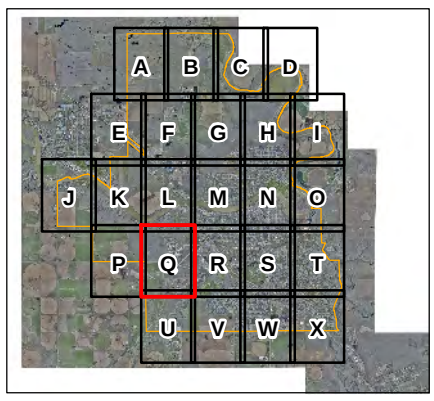


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

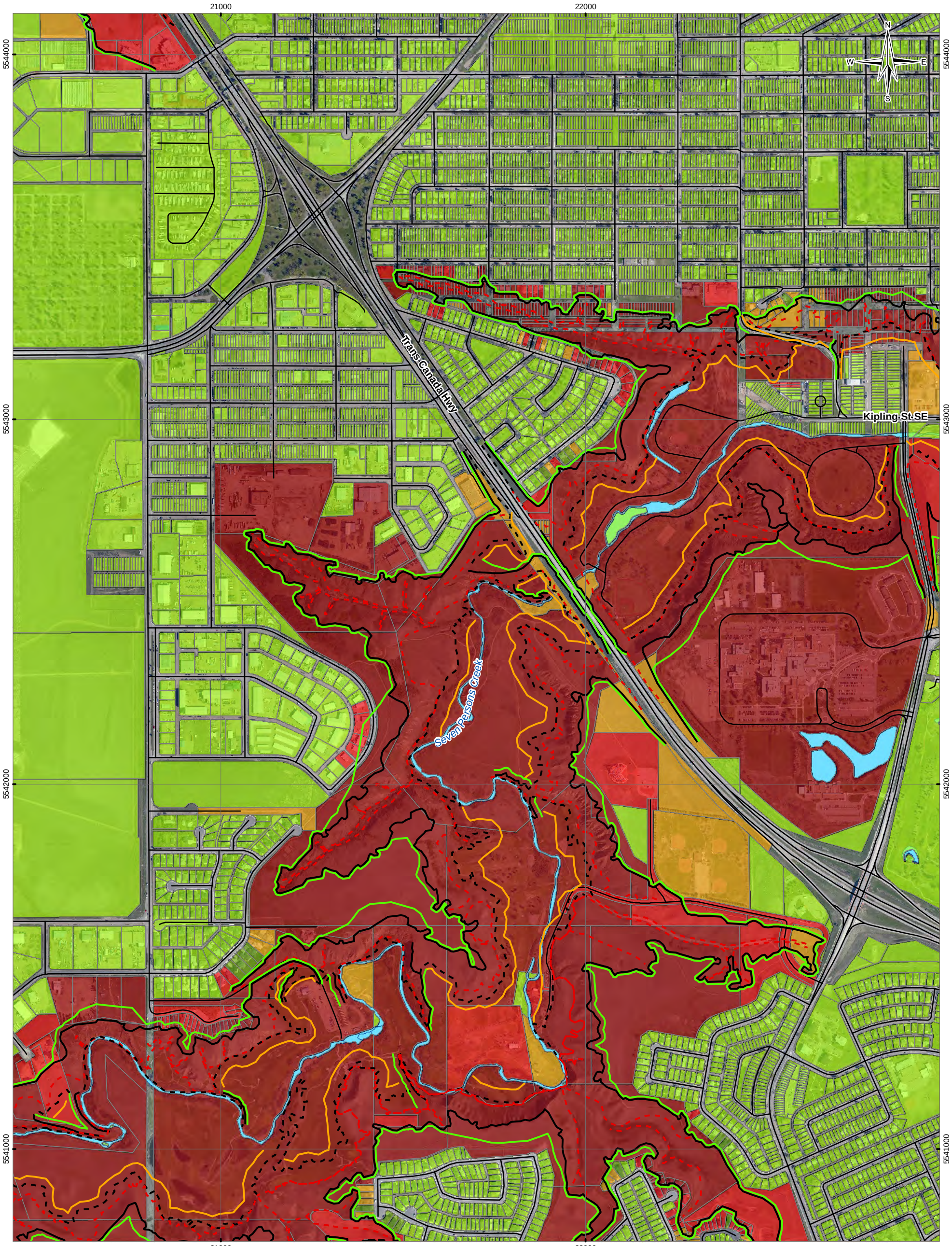
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres				
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27Q**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

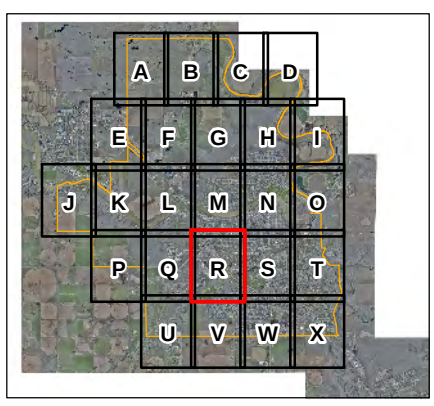


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

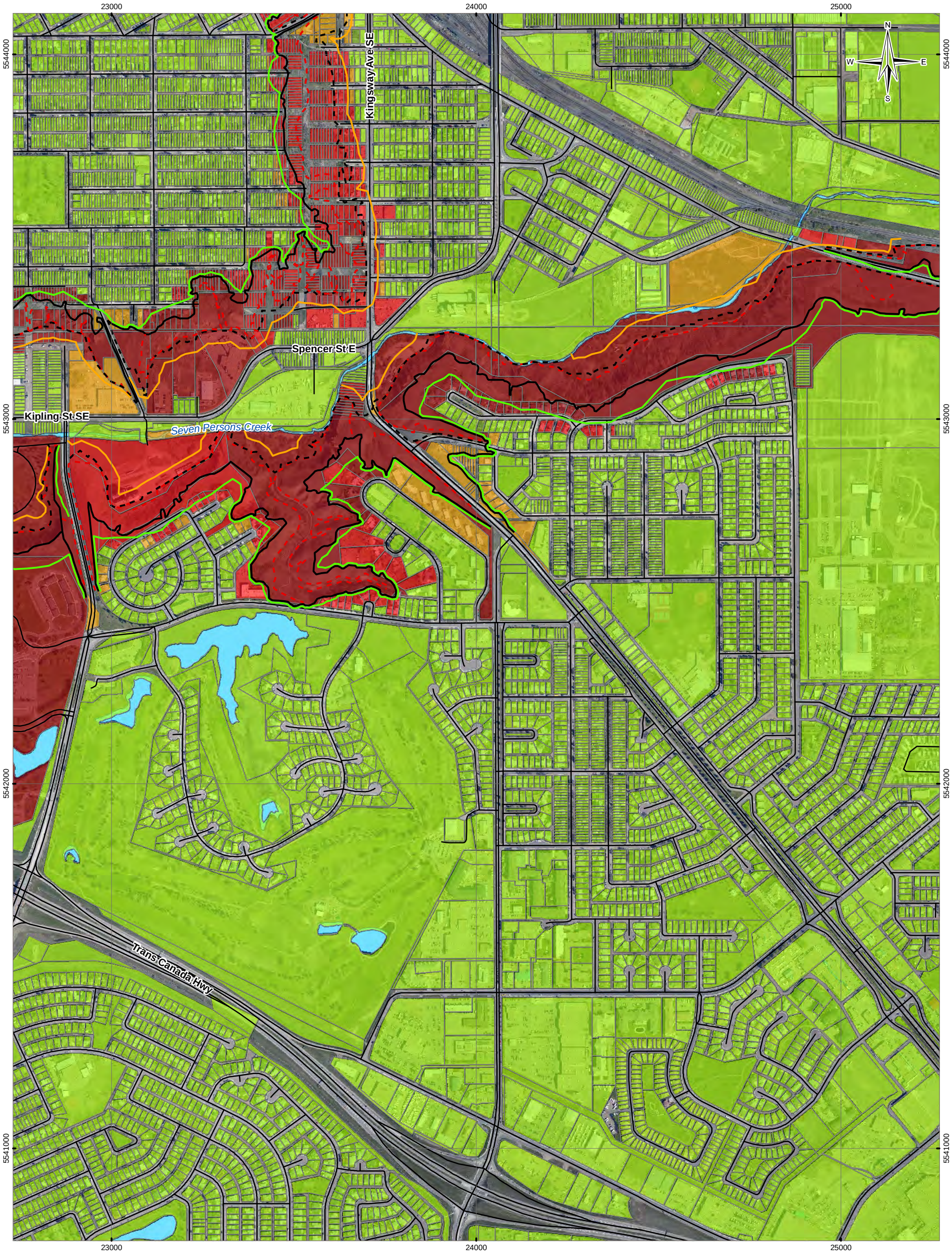
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres				
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27R**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

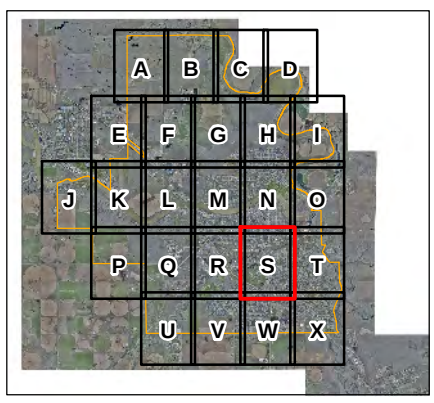


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

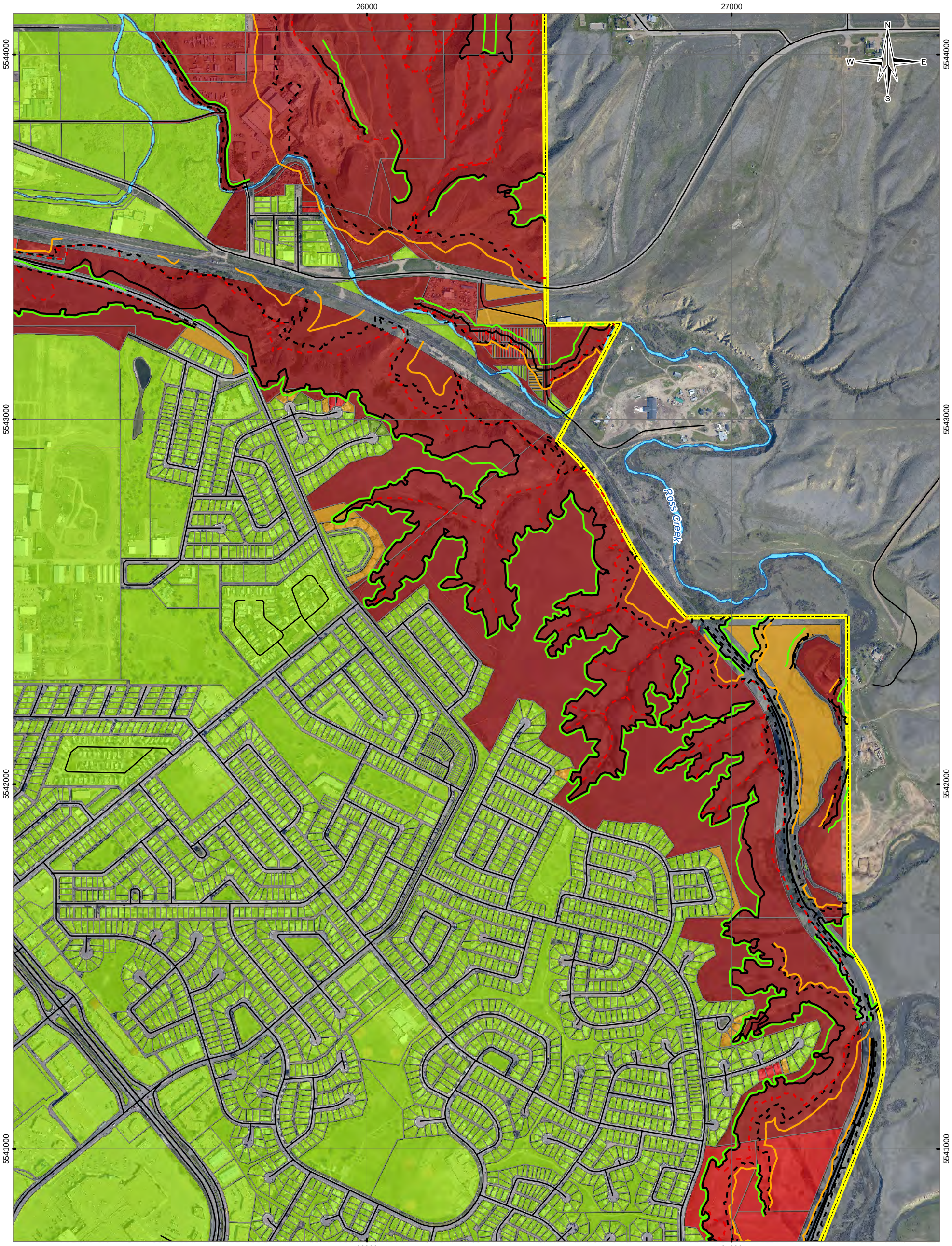
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres				
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27S**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

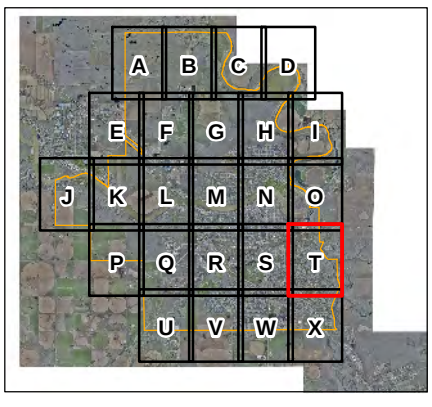


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

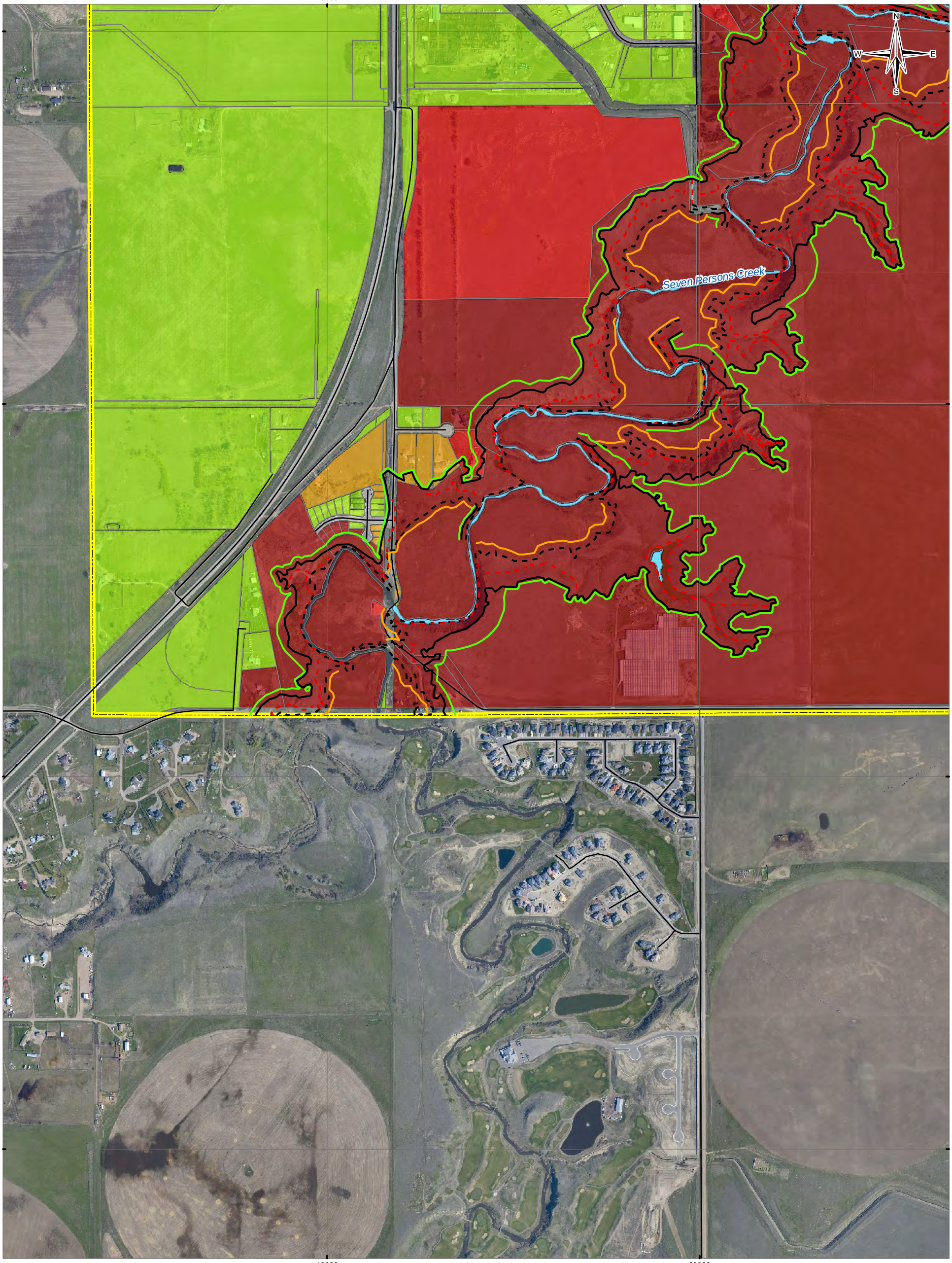
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres				eba A TETRATECH COMPANY
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27T**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

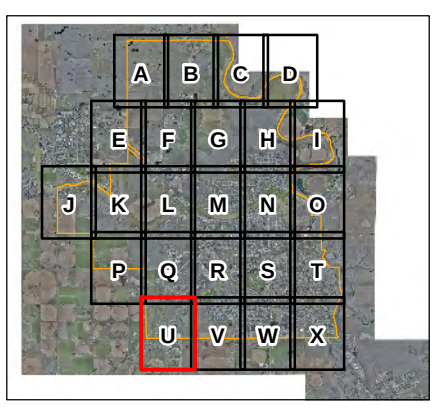


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

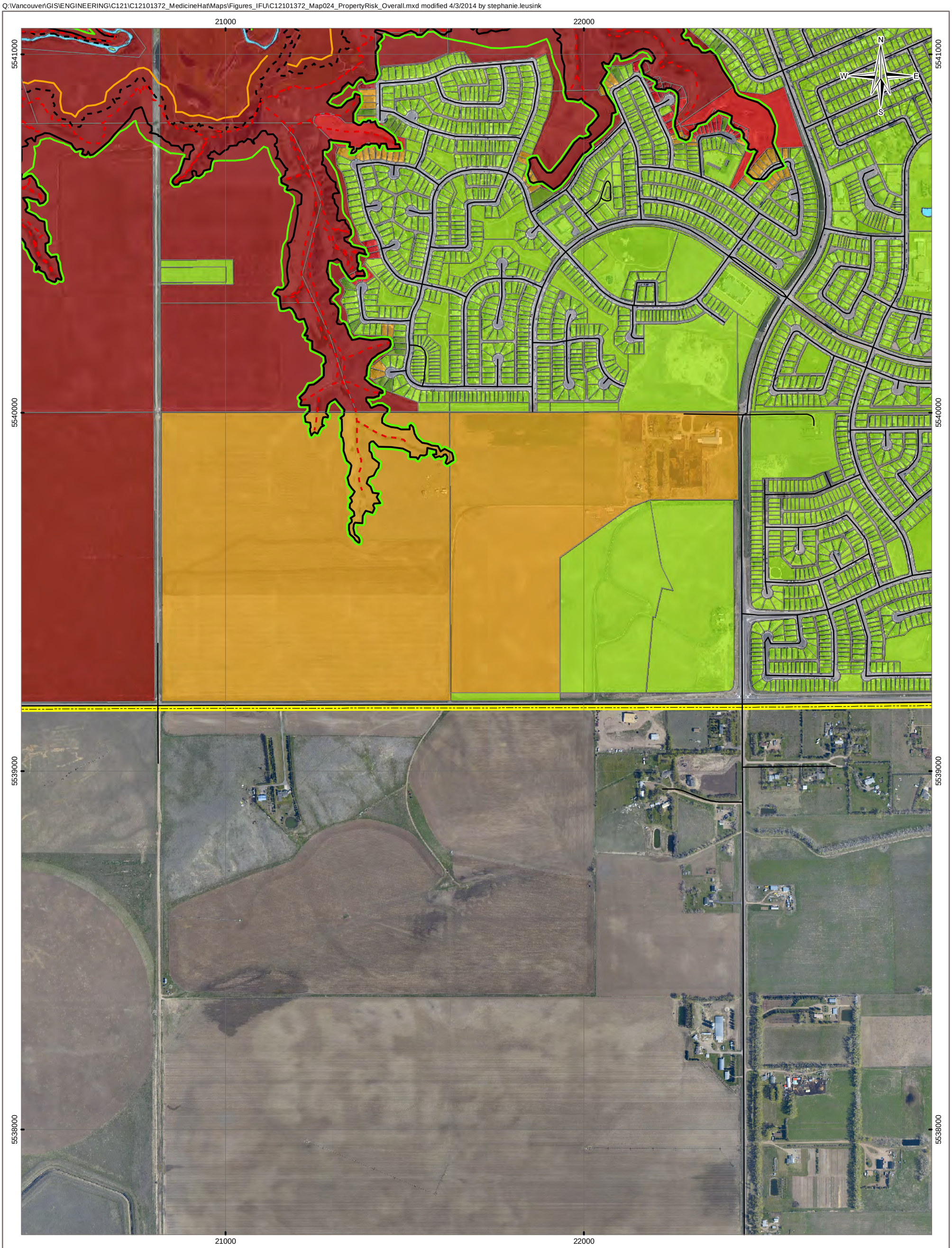
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat	
Scale: 1:10,000 — 200 100 0 200 — Metres					
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				A TETRA TECH COMPANY	
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0	**Figure 27U**
OFFICE EBA-VANC	**DATE** April 3, 2014				

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

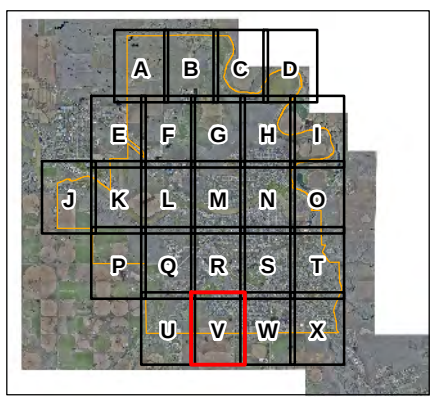


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 — Metres				
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27V**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

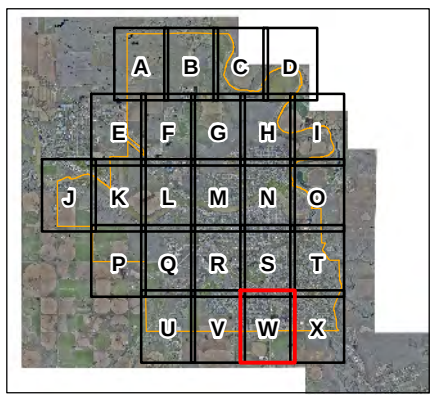


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

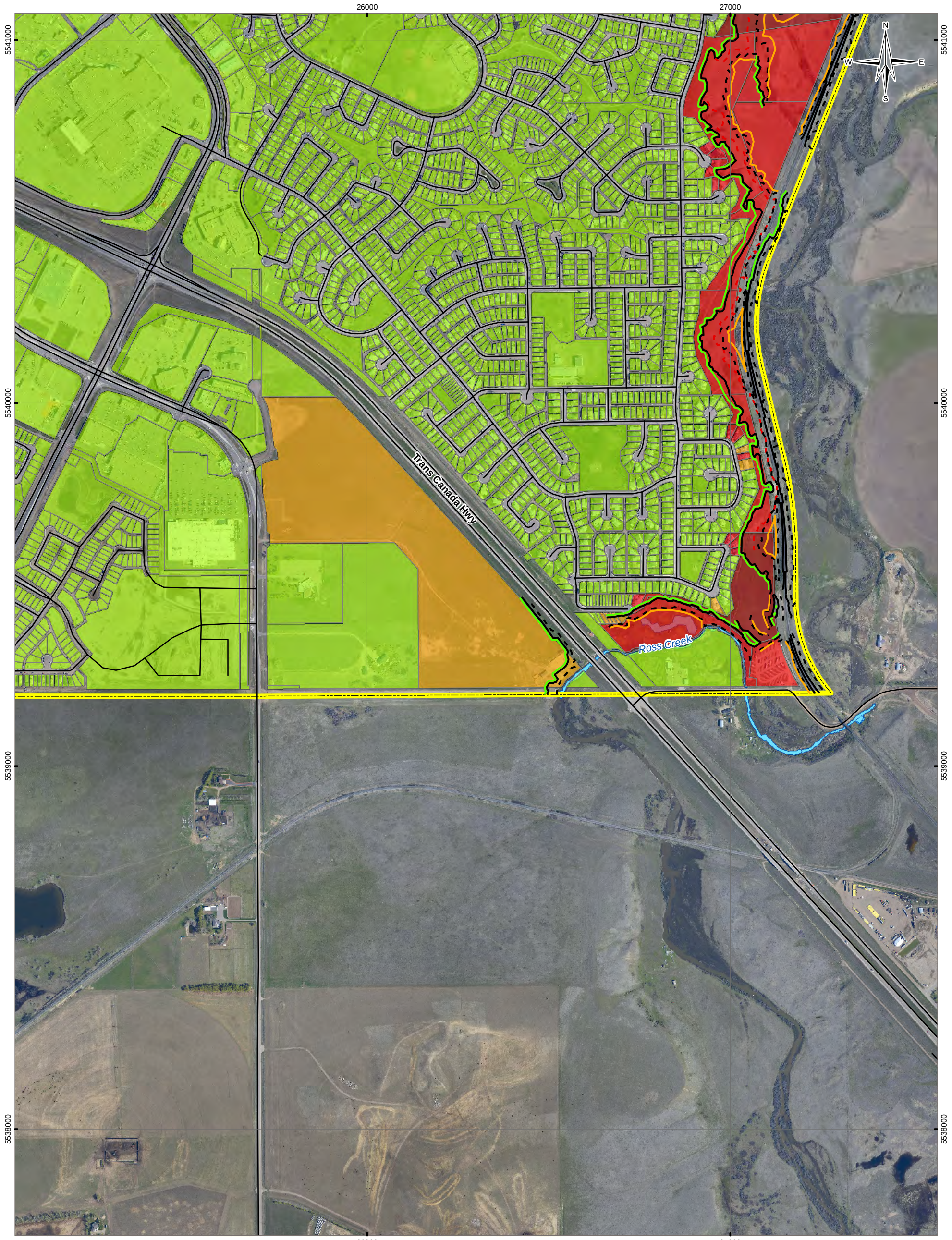
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 Metres				A TETRA TECH COMPANY
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd				
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure 27W**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Map024_PropertyRisk_Overall.mxd modified 4/3/2014 by stephanie.leusink

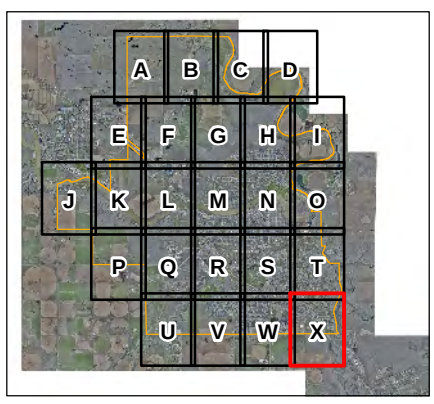


LEGEND

Properties at Risk

- Class A
- Class B
- Class C
- Class D
- Class E

- Top of Escarpment Setback
- Toe of Escarpment Setback
- Top of Escarpment
- Toe of Escarpment (33%)
- Toe of Escarpment (15%)
- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Properties at Risk

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:10,000 — 200 100 0 200 Metres					
FILE NO. C12101372_Map024_PropertyRisk_Overall.mxd					A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** SL	**CKD** MEZ	**APVD** SH	**REV** 0	**Figure 27X**
OFFICE EBA-VANC	**DATE** April 3, 2014				

APPENDIX A

APPENDIX A PROJECT TEAM

PROJECT TEAM

EBA's project manager and discipline leads are as follows:

Michael George, B.E., is EBA's Project Manager and has more than nine years of experience providing geotechnical engineering services for a variety of projects in Canada, New Zealand, and Australia, for both the private and public sectors. Mr. George has experience in project management, geotechnical site investigation, design and construction observation of slope stability, highways, highway redevelopment, commercial and industrial sites, residential subdivisions, foundations, and tunnels.

Mr. George is based in Calgary and is responsible for managing the project deliverables and will serve as the main point of contact.

Marc Sabourin, P.Eng., is the Senior Project Director for the Prairie Region of the Engineering Practice of EBA. He is responsible for overseeing the management, strategic planning, and organizational development for engineering groups in Calgary, Edmonton, and Lethbridge, Alberta. Mr. Sabourin will be responsible to ensure the resources allocated to this project are provided, as required, to meet the deliverables and project schedule assigned.

As a Geotechnical Engineer, he has conducted numerous slope stability assessments in southern Alberta, particularly within the valleys of Lethbridge and Medicine Hat. Mr. Sabourin was also part of EBA's team in a peer review capacity of the Setback Development Assessment conducted for the City of Lethbridge circa 2002, which was similar in scope to the Slope Setback Report proposal being requested by the City.

Tony Ruban, M.Eng., P.Eng., is a Principal Consultant with EBA, and provided support to the project manager. He has over 30 years of experience and has worked on slope stability projects in Lethbridge, Edmonton, and across northern Alberta. Mr. Ruban is the senior review engineer responsible for detailed review of all technical aspects of the project. He liaised with EBA's discipline leads to ensure all facets of the background review, site reconnaissance, slope stability, and report preparation were conducted to the highest technical standards.

Bob Patrick, M.Sc., P.Eng., is the Principal Engineer with EBA for the Engineering Practice, and as such, is responsible for the technical quality of all geotechnical projects undertaken. Mr. Patrick has worked as a consulting geotechnical engineer for more than 30 years, gaining a particular expertise in slope stability. Recently, he has been involved with run-of-river hydroelectric projects, for which assessing and developing mitigation measures for geohazards is a crucial component. Since graduating with his M.Sc. in 1979, Mr. Patrick has been involved in a number of projects in western and northern Canada, as well as in New Zealand and Indonesia.

Shelley Higman, M.Sc., P.Eng., P.Geo., is a Senior Geotechnical Engineer with EBA in Nanaimo, British Columbia. She has experience providing professional expertise in engineering, geoscience, and environmental management. Areas of expertise include slope stability analysis, road design and evaluation, landslide investigation, terrain mapping, hydrology, and watershed assessment. She has recently completed a geological hazard and risk assessment of Testalinden Creek near Oliver, British Columbia, including mitigation options, for the British Columbia Ministry of Environment (BCMOE). She has also recently completed a geohazards mapping study of Gabriola Island for Islands Trust, in which the information will be used in the Official Community Plan and the development permit process.

Ms. Higman led the geohazards team. Her role included review of existing data, aerial photo interpretation, site reconnaissance, hazard and risk assessment, and report preparation.

Mr. Mathew Stephenson, B.A., M.GIS, is the GIS Team Lead with the Calgary Natural Science Group in EBA, A Tetra Tech Company. He has extensive research and practical experience related to Geographic Information Science in Canada. He currently applies his expertise to a variety of projects in the engineering, environment, and transportation groups. Often finding himself a member of interdisciplinary project teams, he brings together spatial data and ideas from disparate sources to provide workable GIS solutions.

Mr. Stephenson was responsible for completing all aspects of the project associated with GIS analysis.

APPENDIX B

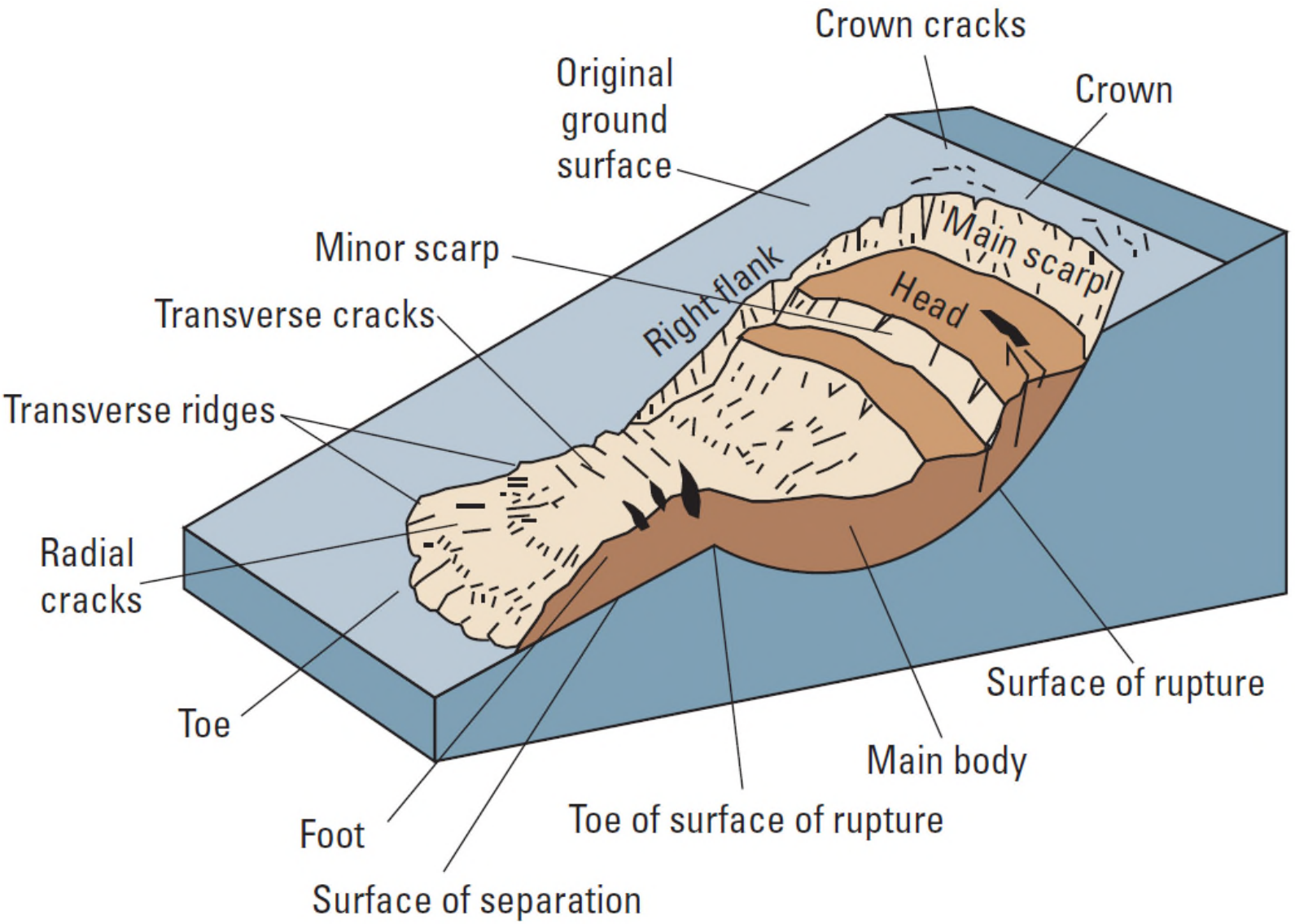
APPENDIX B GLOSSARY

Appendix B: Glossary of Terms

Term	Definition
Ancient	A descriptor of landslide age: assumed to pre-date the earliest air photos of record.
Block Failure	A translational, block shaped landslide with a shallow base angle and a steeper backscarp angle.
Bottom of the Escarpment	The lowermost break-line or topographic discontinuity between the valley wall and the valley bottom, determined by air photo interpretation and/or field survey. It is the point at which the overall slope changes from <15% to >15%.
Bottom of the Escarpment Setback Line	A line, approved by the City of Medicine Hat, defining the minimum setback in meters on the valley floor from the bottom of the escarpment, providing for property integrity and public safety concerns along the bottom of the escarpment. The position of the line (relative to the bottom of the escarpment) will vary in accordance with approved geotechnical study recommendations. It will coincide with the rear lot line.
Colluvium	A general term applied to loose and incoherent deposits, usually at the toe of a slope or cliff and brought there primarily by gravity.
Compound Slide	A slide in which rotational failure occurs in the upper portion of the slide along a steeply curved backscarp (generally in overburden), while the lower slide mass progresses outward along a planar surface at or near the top of bedrock.
Coulee	A long, trench-like gorge that once carried meltwater from an ice sheet.
Creep	The slow, continuously increasing deformation of soil particles or rock under gravity or from a small, constant stress acting over a long period of time.
Degree of Landslide Activity	A set of quantitative terms to define the activity of a landslide, including: **Active**: Landslide is currently moving. **Suspended**: Landslide has moved within the last 12 months but is not active at present. **Reactivated**: Landslide is an active landslide that has been inactive. **Inactive**: Landslide has not moved within the last 12 months, of which there are four sub-states: **Dormant**: Landslide that can be reactivated by its original causes or by other causes. **Abandoned**: Landslide that is no longer affected by its original causes. **Stabilized**: Landslide that has been protected from its original causes by artificial remedial measures. **Relict**: Landslide that developed under climatic or geomorphological conditions considerably different from those at present.
Detrital	Sedimentary rock or particles derived from pre-existing rock through mechanical means such as weathering and erosion, either within or outside the basin of deposition.
Earth/Rock Slide	See "Translational Slide".
Earth/Rock Slump	See "Rotational Slide".
Factor of Safety	The ratio between the forces causing slope movement and the forces resisting slope movement. A Factor of Safety (F.S.) of 1.5 is generally acceptable for buildings.
Glaciofluvial Deposits	Soil deposited by meltwater streams flowing from glaciers.
Glaciolacustrine	Soil derived from or deposited in glacial lakes.
Historic	A descriptor of landslide age: Assumed to have occurred within the period of record represented by the earliest available air photos (typically within the last 100 years).
Landslide Depth	A set of quantitative terms to define the depth of a landslide, including: **Shallow** (<5 m deep), **Intermediate** (5 m to <10 m deep) and **Deep** (>10 m deep).
Landslide Size Class	A set of quantitative terms to define the size of a landslide, including: **Class 1 (Very Small)**: Landslide surface area ≤ 500 m^2. **Class 2 (Small)**: Landslide surface area >500 to 1,000 m^2. **Class 3 (Moderately Small)**: Landslide surface area >1,000 to 2,500 m^2. **Class 4 (Moderate)**: Landslide surface area >2,500 to 5,000 m^2. **Class 5 (Moderately Large)**: Landslide surface area >5,000 to 10,000 m^2 (1 ha). **Class 6 (Large)**: Landslide surface area >10,000 to 100,000 m^2 (10 ha). **Class 7 (Very Large)**: Landslide surface area >100,000 to 1,000,000 m^2 (100 ha). **Class 8 (Extremely Large)**: Landslide surface area >1,000,000 m^2 (100 ha).
Outwash Deposit	Sand and gravel deposited by meltwater streams in front of the end moraine or the margin of an active glacier.
Overall Slope	The slope of a hypothetical section line joining the bottom of the escarpment and top of the escarpment (as defined in this section).
Planar	See "Translational Slide"
Recent	A descriptor of landslide age: movement has occurred within the last five years.
Retrogressive Slide	A rotational, translational or compound slide in which failure begins in a local area and enlarges or retreats with time in a direction that is opposite to that of the initial failed mass.
Rock Fall	A fragment of any size that becomes detached from a steep slope or cliff (along a surface of little or no shear displacement) and descends rapidly by free fall and/or rolling.
Rotational Slide	A slide, generally confined to overburden soils, in which failure occurs along a curved failure plane.
Sinkhole	A depression or hole in the ground surface, likely caused by underground mining activity.
Slope Class	A set of quantitative terms to define the angle of a slope, including: **Level or Plain**: Slopes between 0% and 5% (0 and 3 degrees). **Gentle**: Slopes between 6% and 26% (4 and 15 degrees). **Moderate**: Slopes between 27% and 49% (16 and 26 degrees). **Moderately Steep**: Slopes between 50 and 70 percent (27 and 35 degrees). **Steep**: Slopes steeper than 70% (35 degrees).
Slope Gradient	The overall slope angle from the toe of the slope to the crest of the slope, expressed in % and degrees.
Slope Height	The overall slope height from the toe of the slope to the crest of the slope, expressed in metres.
Slope Length	Overall slope distance from the toe of the slope to the crest of the slope, expressed in metres; Slope Length = (Slope Height)/(sin(Slope Gradient, in degrees))
Thalweg	The line defining the lowest points along the length of a river bed or valley.
Till	Soil deposited directly by a glacier without reworking by meltwater, and consisting of a mixture of clay, silt, sand, gravel, and boulders ranging widely in shape and size.
Top of the Escarpment	The uppermost valley break-line or the slope edge defining the most distinct break or topographic discontinuity in slope between the upper plateau and valley wall as determined by air photo interpretation and/or field survey. It is the point at which the overall slope changes from >15% to <15%.
Top of the Escarpment Setback Line	A line, approved by the City of Medicine Hat, defining the minimum setback in metres on the upper plateau from the top of the escarpment line, providing for property integrity and public safety concerns along the top of the escarpment. The position of the line (relative to the top of the escarpment) will vary in accordance with approved geotechnical study recommendations. It will coincide with the rear lot line.
Topping	Is a mass-movement process characterized by the downslope overturning, either through rotation or flexure of interacting blocks of rock.
Translational Slide	A slide in which the failed mass moves along a more or less planar surface (within overburden soil or bedrock) with little or no rotational component.

Appendix B: Glossary of Terms

Landslide Components (refer to attached diagram for illustration)	
Main (or Back) Scarp	A steep surface on the undisturbed ground around the periphery of the slide, caused by the movement of slide material away from undisturbed ground. The projection of the scarp surface under the displaced material becomes the surface of the rupture.
Minor Scarp	A steep surface on the displaced material produced by differential movements within the sliding mass.
Head	The upper parts of the slide material along the contact between the displaced material and the main scarp.
Top	The highest point of contact between the displaced material and the main scarp.
Toe of Surface of Rupture	The intersection (sometimes buried) between the lower part of the surface of rupture and the original ground surface.
Toe	The margin of displaced material most distant from the main scarp.
Tip	The point of the toe most distant from the top of the slide.
Foot	That portion of the displaced material that lie downslope from the toe of the surface of rupture.
Main Body	That part of the displaced material that overlie the surface of rupture between the main scarp and toe of the surface of rupture.
Flank	The side of the landslide.
Crown	The material that is still in place, practically undisplaced and adjacent to the highest parts of the main scarp.
Original Ground Surface	The slope that existed before the movement which is being considered took place.
Surface of Separation	The surface separating displaced material from stable material but not known to have been a surface on which failure occurred.
Displaced Material	The material that has moved away from its original position on the slope. It may be in a deformed or undeformed state.
Zone of Depletion	The area within which the displaced material lies below the original ground surface.
Zone of Accumulation	The area within which the displaced material lies above the original ground surface.


Crown cracks
Original ground surface
Crown
Minor scarp
Main scarp
Right flank
Head
Transverse cracks
Transverse ridges
Radial cracks
Toe
Surface of rupture
Main body
Foot
Toe of surface of rupture
Surface of separation

APPENDIX C

APPENDIX C EXERPT FROM CITY OF MEDICINE HAT'S LAND USE BYLAW

(2) If there is a conflict between the provisions of a district overlay and the provisions contained in this Part or Part V, the provisions of the district overlay shall govern to the extent of the inconsistency.

40 AIRPORT VICINITY PROTECTION OVERLAY

(1) In addition to the regulations contained in this Part and Part V, a development proposed on a site located within the protection area, defined in the Airport Vicinity Protection Overlay attached as Schedule "B" to this Bylaw, shall be subject to the regulations set out in the Overlay.

(2) If there is a conflict between the regulations set out in the Airport Vicinity Protection Overlay and the regulations contained in this Part or Part V, the regulations set out in the Airport Vicinity Protection Overlay shall govern to the extent of the inconsistency.

Amended by: Bylaw 3502 Nov. 5, 2003

41 Deleted.

42 NOISE ATTENUATION

(1) Where residential development is proposed adjacent to an arterial road or highway designated under the City's Transportation Bylaw, the applicant shall provide the Development Authority with a noise attenuation study satisfactory to the Planning and Development Engineer.

(2) Following consideration of the noise attenuation study, the Development Authority may impose a condition on the development permit requiring the applicant to

(a) construct a noise barrier satisfactory to the Planning and Development Engineer, or

(b) pay to the City a sum of money equal to the present estimated cost of constructing a noise barrier as determined by the Planning and Development Engineer.

43 RIVER VALLEY SYSTEM

(1) Purpose

The purpose of these regulations is to preserve environmentally sensitive areas, establish a public open space system, minimize environmental deterioration of the river valley system and prohibit, regulate and control development within the flood risk area.

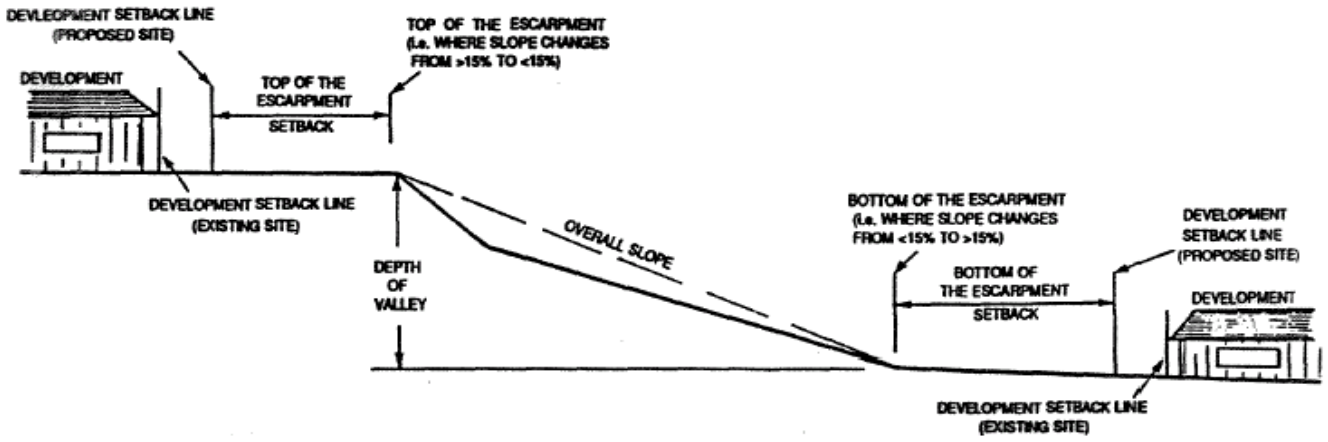
(2) Definitions

(a) **Average Annual High Water Line** means a line which represents the average of past records of the annual high water line of the South Saskatchewan River.

(b) **Bottom of the Escarpment** means the lowest break line or topographic discontinuity between the river valley system wall and the river valley system bottom. It is the point at which the overall slope changes from less than 15 percent (8.5 degrees) to greater than 15 percent. (Fig.2)

(c) **Depth of Valley** means the vertical distance between the elevation of the top of the escarpment and the elevation of the bottom of the escarpment. (Fig.2)

FIGURE 2 - TYPICAL RIVER VALLEY PROFILE



(d) **Development Setback Line** means a line which defines the closest point to the top of the escarpment where:

(i) a development may be safely erected, in the case of an existing site; or

(ii) a property line can be safely established in the case of a proposed subdivision (Fig. 2)

(e) **Factor of Safety or FS** means the ratio between forces causing slope movement and the forces resisting slope movement. A Factor of Safety (FS) of 1.5 or more is recommended for building construction.

(f) **Flood Fringe** means that part of the flood risk area where water is shallower and moves more slowly. (Fig. 3)

(g) **Flood Risk Area** means the area which would be inundated by a 1 in 100 year flood (i.e. a flood which has a one percent chance of being equalled or exceeded in any year). (Fig. 3)

(h) **Floodway** means that part of the flood risk area where the waters are deepest, fastest, and most destructive. (Fig. 3)

(i) **Overall Slope** means the slope of a hypothetical section line joining the Top of the Escarpment and the Bottom of the Escarpment.

(j) **River Valley System** means the South Saskatchewan River and its tributaries and the valleys of the South Saskatchewan River and its tributaries.

(k) **Top of the Escarpment** means the uppermost river valley system break-line or the slope edge defining the most distinct break or topographic discontinuity in slope between the upper plateau and the river valley system wall. It is the point at which the overall slope changes from greater than 15 percent (8.5 degrees) to less than 15 percent (Fig 2).

(3) Regulations

(a) In order to prevent development on unstable or potentially unstable lands and to provide access should remedial work be required, the following top of the escarpment development setback requirements shall apply to developments in or adjacent to the river valley system:

(i) Where the overall slope is less than or equal to 15 percent (8.5 degrees), no development setback shall be required;

(ii) Where the overall slope exceeds 15 percent (8.5 degrees) but is less than or equal to 33 percent (18 degrees), a development setback of 6m will be required; and

(iii) Where the overall slope exceeds 33 percent (18 degrees), see Table 1.

(b) In order to provide protection to developments adjacent to the bottom of the escarpment and to provide access should remedial work be required, the following bottom of the escarpment development setback requirements shall apply to developments in or adjacent to the river valley system:

(i) Where the overall slope is less than or equal to 15 percent (8.5 degrees), no development setback shall be required;

(ii) Where the overall slope exceeds 15 percent (8.5 degrees) but is less than or equal to 33 percent (18 degrees), a development setback of 4m will be required; and

(iii) Where the overall slope exceeds 33 percent (18 degrees), see Table 1.

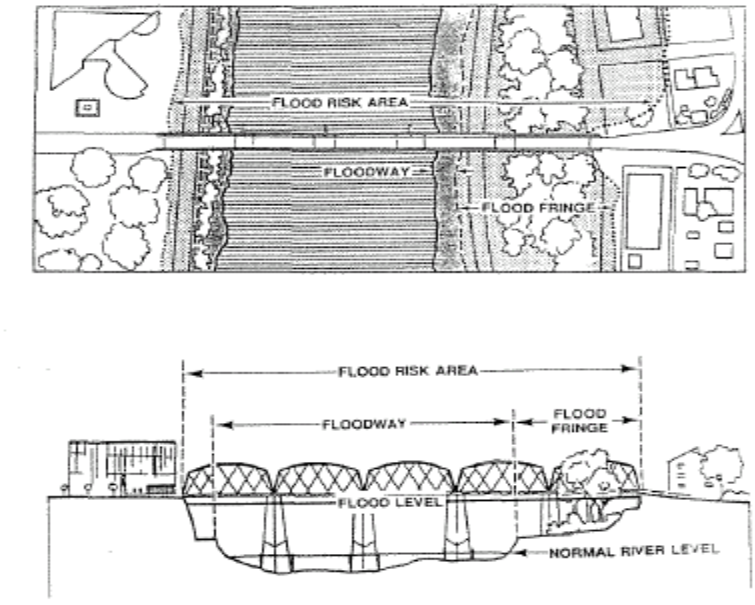
TABLE 1

DEVELOPMENT SETBACKS FOR OVERALL SLOPES EXCEEDING 33 PERCENT (18 DEGREES)

Sector *	Geotechnical Subsector	Setback (x slope height)
A		1.25
	A1	1.5
B		1.5
	B1	1.25
C		1.0
	C1	1.0
	C2	**
	C3	**
	C4	1.0
D		1.0
	D1	1.25

* See Development Setback Sectors Map - Schedule "D"
** Overall slope angle not exceeding 33 percent (18 degrees) - see clauses (3)(a) and (b).

FIGURE 3 - FLOOD AREAS



(c) The Development Authority may require a detailed, site specific, geotechnical investigation by a qualified engineer if, in the opinion of the Development Authority, there is a risk of slope instability.

(d) The Development Authority may increase or decrease the development setback requirements that would otherwise apply based on the results of a geotechnical investigation carried out pursuant to clause 3(c).

(e) The report of the geotechnical investigation carried out pursuant to clause (c) shall include the following:

(i) A plan, determined by field survey, showing the top of the escarpment and bottom of the escarpment;

(ii) Information on subsoil and groundwater conditions;

(iii) A plan of the proposed development including:

(A) For single family detached dwellings, duplex dwellings, triplex dwellings and accessory buildings a property outline showing building locations and providing for support on soils with FS greater than or equal to 1.5 under highest expected moisture conditions;

(B) For all other developments, structural locations and foundation designs. These should be developed from structural working drawings and shall provide for support on soils with FS greater than or equal to 1.5 under highest expected moisture conditions. The effects of subdrains shall not be considered.

(iv) A plan showing the top of the escarpment and bottom of the escarpment development setback lines, using a minimum slope stability Factor of Safety of 1.5. The effect of subdrains may be considered provided the subdrains are included in the design recommendations.

(v) Information as to the effect of the development on other properties in the area and recommendations for the protection of such other properties.

(vi) Evidence that provision has been made for disposal of storm water runoff and excess irrigation water in a manner that is acceptable to the Planning and Development Engineer.

(f) The following guidelines shall apply to the review and processing of reports of geotechnical investigations carried out pursuant to clause (c):

(i) If the investigation report indicates that no corrective engineering work is required, the Development Authority may issue a development permit for the proposed development;

(ii) If the investigation report indicates that corrective engineering work is required, the Development Authority may issue a

development permit for the proposed development, subject to the following conditions:

(A) during development of the site, all recommendations of the geotechnical investigation report shall be adhered to;

(B) upon completion, the engineer who prepared the report shall certify to the Commission that all recommendations of the report have been adhered to; and

(C) such other conditions as the Development Authority deems advisable.

(g) Flood Hazards

(i) Low intensity recreational land use may be allowed in any portion of the floodway.

(ii) No building shall be allowed in the floodway. Fences, retaining walls and other minor structures may be allowed in the floodway if the Development Authority is of the opinion that damage to the structure in the event of a flood is not likely to be significant.

(iii) No development in the floodway shall be allowed which may, in the Development Authority's opinion, adversely alter the floodway hydraulics to the extent that flood frequency is increased.

(iv) No filling shall be allowed in the floodway. Filling in the flood fringe shall not be allowed without the approval of Alberta Environmental Protection and the Development Authority.

(v) The Development Authority shall require that a building in the flood fringe be flood proofed as a condition of issuing a development permit for the building.

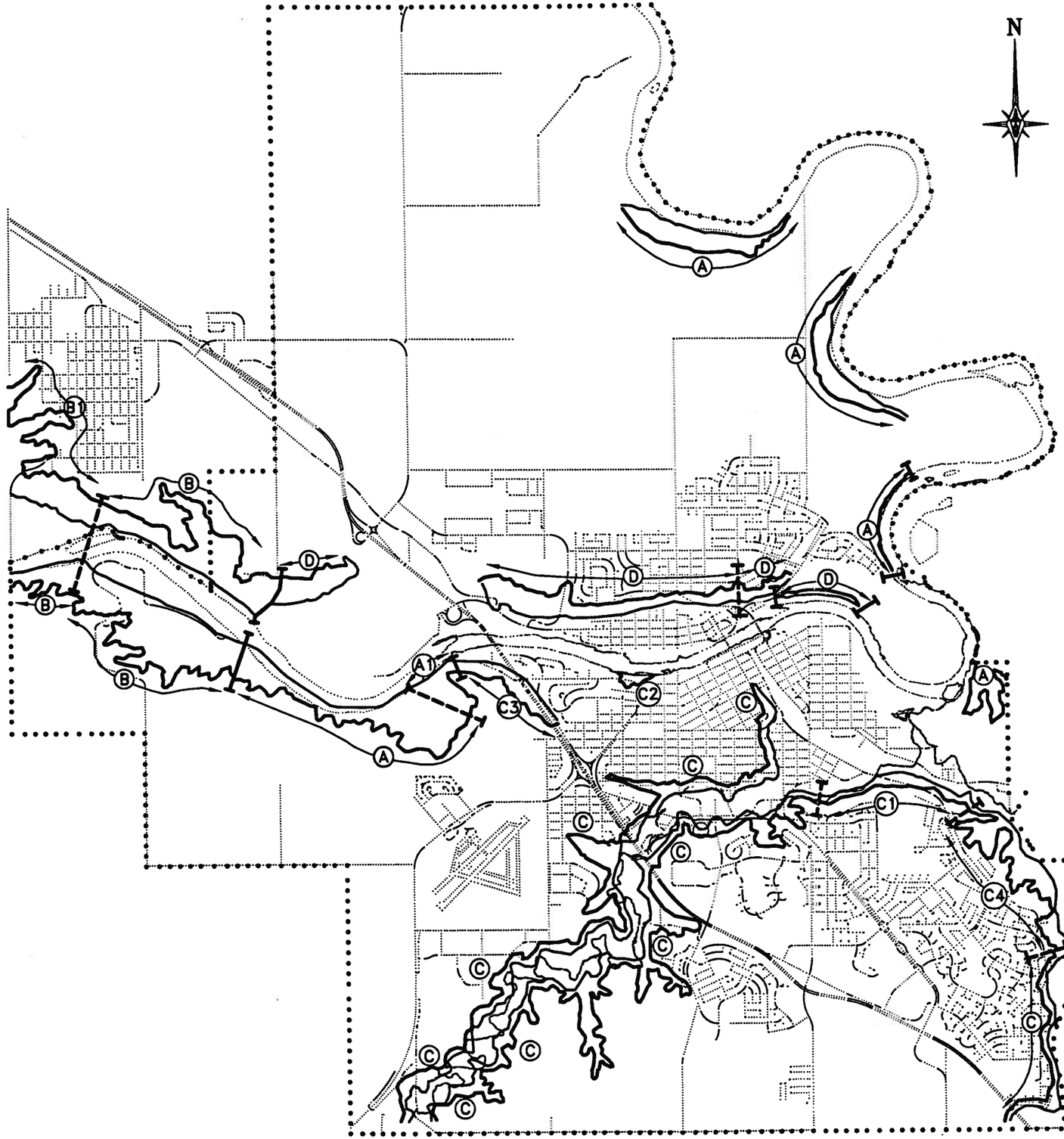
(vi) Council may by resolution establish standards for flood proofing.

44 ENVIRONMENTAL IMPACT ASSESSMENT

(1) An environmental impact assessment or environmental audit, or both, may be required:

(a) with respect to a development permit application, whether for a permitted or a discretionary use, by the Development Authority; or

DEVELOPMENT SETBACK SECTORS MAP



Sector Boundary

Subsector Boundary

Top of the Escarpment

Bottom of the Excarpment

City Limits

PDEMI97019

APPENDIX D

APPENDIX D BOREHOLE LOGS

SLOPE SETBACK REPORT	CITY OF MEDICINE HAT	PROJECT NO. - BOREHOLE NO.
POWER POINT SLIDE	SOLID STEM AUGER	C12101372-BH05
MEDICINE HAT, ALBERTA		

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

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SPT (N)
0	CLAY (FILL) - silty, sandy, trace gravel, damp, light brown, trace rootlets.		B1	
1			B2	
2	CLAY (TILL) - silty, some sand to sandy, trace gravel, low plastic, firm, damp to moist, brown, trace oxides, trace white precipitates, trace coal specks.		S1	10
3			B3	
	- increase in precipitates		S2	18
4			B4	
	- sandy		B5	
5	SILT - some sand, some clay, damp, brown.		S3	30/50mm
	SAND - medium grained, moist, brown.		B6	
6			B7	
			S4	41
7	CLAY (TILL) - silty, sandy, trace gravel, low plastic, very stiff, damp, brown, trace oxides, trace coal specks.		B8	
8			S5	49
9			B9	
	SAND - medium grained, dense, damp to moist, brown.		S6	45
10	- trace silt, trace clay		B10	
11	CLAY (TILL) - silty, some sand to sandy, trace gravel, low plastic, stiff to very stiff, damp to moist, brown, trace oxides, trace coal specks.		B11	
12			B12	
13	SAND - medium grained, trace silt, trace clay, moist to wet.		B13	
			S7	38
14	CLAY (TILL) - silty, some sand to sandy, trace gravel, low plastic, stiff to very stiff, moist, brown, trace coal specks, trace oxides.		B14	
15			B15	
16	- increase in gravel content, highly carbonaceous, brown to black		B16	
17	SAND - medium to fine grained, poorly graded, moist to wet.		B17	
18	CLAY (TILL) - silty, some sand to sandy, trace gravel, low plastic, stiff to very stiff, moist, brown, trace coal, trace oxides			
19				
20	AUGER REFUSAL - END OF HOLE AT 16.76 m.			
	Standpipe installed to 13.2 m.			
	Dry upon completion.			
21	Groundwater at 12.9 m on November 19, 2011.			
22				
23				
24				
25				
26				
27				
28				
29				
30				

MOISTURE CONTENT: PLASTIC — M.C. — LIQUID (20 40 60 80)

STANDARD PENETRATION (N) 20 40 60 80

UNCONFINED (kPa) 50 100 150 200

POCKET PEN. (kPa) 100 200 300 400

/50

Slotted Piezometer

Nov. 19/11

Depth (ft): 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 98

eba A TETRA TECH COMPANY	LOGGED BY: KL	COMPLETION DEPTH: 16.76 m
	REVIEWED BY: MG	COMPLETE: 10/11/2011
	DRAWING NO:	Page 1 of 1

SLOPE SETBACK REPORT	CITY OF MEDICINE HAT	PROJECT NO. - BOREHOLE NO.
POWER POINT SLIDE	SOLID STEM AUGER	C12101372-BH19
MEDICINE HAT, ALBERTA		

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

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SPT (N)
0	CLAY (GLACIOLACUSTRINE) - silty, trace sand, damp, light brown.			
1			B1	
2	- very stiff		S1	17
			B2	
3				
	- some sand, white precipitates, trace oxides		S2	30
4			B3	
5	- hard		S3	41
	- sandy to some sand			
6	CLAY (TILL) - silty, sandy to some sand, trace gravel, low		B4	
	plastic, hard, damp, brown, trace oxides, trace white		S4	50
7	precipitates?		B5	
8	CLAY (GLACIOLACUSTRINE) - silty, some sand, damp, light brown, trace oxides, trace white precipitates.		S5	46
9	CLAY (TILL) - silty, sandy, trace gravel, low plastic, hard, damp, brown, trace oxides, trace coal specks, trace white precipitates.		B6	
			S6	43
10			B7	
11				
12			B8	
			SH1	
13			B9	
14				
15			B10	
16	- brown to grey		S7	48
			B11	
17				
18	- increase in oxides		B12	
19				
20	- trace white crystals		B13	
			B14	
21				
22				
23			B15	
24	- slight increase in gravel content		B16	
25			B17	
26				
27			B18	
28				
29			B19	
30				

MOISTURE CONTENT: PLASTIC — M.C. — LIQUID (20 40 60 80)

STANDARD PENETRATION (N) (20 40 60 80)

UNCONFINED (kPa) (50 100 150 200)

POCKET PEN. (kPa) (100 200 300 400)

Slotted Piezometer

Depth (ft): 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 98

eba A TETRA TECH COMPANY

LOGGED BY: KL	COMPLETION DEPTH: 54.86 m
REVIEWED BY: MG	COMPLETE: 08/11/2011
DRAWING NO:	Page 1 of 2

SLOPE SETBACK REPORT	CITY OF MEDICINE HAT	PROJECT NO. - BOREHOLE NO.
POWER POINT SLIDE	SOLID STEM AUGER	C12101372-BH19
MEDICINE HAT, ALBERTA		

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

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SPT (N)	MOISTURE CONTENT	Depth (ft)
30			B20			100
31			B21			
32						105
33			B22			
34			B23			110
35						
36			B24			115
37						
38			B25			120
39			B26			
40	CLAY - trace silt, trace sand, medium plastic, hard to very stiff, damp, grey.					125
41			B27			
42			B28			130
43						
44			B29			135
45						
46			B30			140
47			B31			
48	- trace gravel		B32			145
49						
50			B33			150
51						
52			B34			155
53			B35			
54						160
55			B36			
56	END OF HOLE AT 54.86 m. Standpipe installed to 54.86 m. Dry upon completion. Dry on November 29, 2011.					165
57						
58						170
59						
60						175
						180
						185
						190
						195
						197

PLASTIC — M.C. — LIQUID (20 40 60 80)

STANDARD PENETRATION (N) (20 40 60 80)

UNCONFINED (kPa) (50 100 150 200)

POCKET PEN. (kPa) (100 200 300 400)

Slotted Piezometer

LOGGED BY: KL	COMPLETION DEPTH: 54.86 m
REVIEWED BY: MG	COMPLETE: 08/11/2011
DRAWING NO:	Page 2 of 2

eba A TETRA TECH COMPANY

SLOPE SETBACK REPORT	CITY OF MEDICINE HAT	PROJECT NO. - BOREHOLE NO.
POWER POINT SLIDE	SOLID STEM AUGER	C12101372-BH20
MEDICINE HAT, ALBERTA		

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

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SPT (N)	MOISTURE CONTENT (PLASTIC / M.C. / LIQUID)	STANDARD PENETRATION (N) / UNCONFINED (kPa) / POCKET PEN. (kPa)	Backfill	Depth (ft)
0	CLAY (TILL) - silty, some sand to sandy, trace gravel (max. size 5 cm), low plastic, stiff to very stiff, damp, brown, trace oxides, trace white precipitates, trace coal.		B1					0
1								5
2			B2					
3								10
4			B3					
5								15
6	- moist		B4					20
7			S1	23				
8			B5					25
9			S2	25				
10			B6					30
11			S3	25				
12			B7					35
13			B8					
14			B9					40
15			S4	69				
16	CLAY - some silt, trace sand, trace gravel, low to medium plastic, stiff, moist, grey.		B10					45
17								
18			B11					50
19			B12					
20	SAND - medium grained, poorly graded, moist to wet, grey to brown.		B13					55
21			S5	15				
22	CLAY - silty, trace sand to some sand, trace gravel, low plastic, firm to stiff, moist, brown to grey.		B14					60
23			B15					
24			B16					65
25			S6	19				
26	SAND - medium grained, poorly graded, moist to wet, grey, possible groundwater seepage.		B17					70
27	CLAY - some silt, trace sand, medium plastic, moist, grey.		B18					
28			S7	18				75
29	SAND - medium grained, poorly graded, wet, brown.							
30	END OF HOLE AT 26.37 m. Dry upon completion. Groundwater at 26.0 m on November 29, 2011.							80
								85
								90
								95
								98

Nov. 29/11 (Depth (m) and Depth (ft))

eba A TETRA TECH COMPANY	LOGGED BY: KL	COMPLETION DEPTH: 26.37 m
	REVIEWED BY: MG	COMPLETE: 10/11/2011
	DRAWING NO:	Page 1 of 1

SLOPE SETBACK REPORT	CITY OF MEDICINE HAT	PROJECT NO. - BOREHOLE NO.
POWER POINT SLIDE	SOLID STEM AUGER	C12101372-BH23
MEDICINE HAT, ALBERTA		

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

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SPT (N)
0	SAND AND GRAVEL - silty, trace clay, damp, light brown.			
1			B1	
2			S1	15
	- some clay		B2	
3				
			S2	18
4				
	CLAY (FILL) - silty, sandy, trace gravel, low plastic, firm, moist to wet, rootlets, white precipitates, trace oxides.		B3	
5			S3	5
6	- some organics		B4	
			S4	16
7	- groundwater seepage		B5	
	CLAY (TILL) - silty, some sand to sandy, trace gravel, low to medium plastic, moist, brown, trace oxides, trace coal specks.		S5	15
8			B6	
9			SH1	
10			B7	
11	- some sand, slight increase in plasticity			
			B8	
12				
13	- trace grey - very stiff, medium plastic		B9	
14			S6	29
15			B10	
16			B11	
17				
	- grey brown		B12	
18				
19	SAND - medium grained, damp to moist, brown to light brown.		S7	24
			B13	
20				
21			B14	
22				
			B15	
23			S8	32
24			B16	
25				
			B17	
26	END OF HOLE AT 25.91 m. Standpipe installed to 25.91 m. Dry upon completion. Groundwater at 24.6 m on November 29, 2011.			
27				
28				
29				
30				

Nov. 29/11

MOISTURE CONTENT: PLASTIC | M.C. | LIQUID; 20 40 60 80

STANDARD PENETRATION (N) 20 40 60 80

UNCONFINED (kPa) 50 100 150 200

POCKET PEN. (kPa) 100 200 300 400

Slotted Piezometer

Depth (ft): 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 98

Nov. 29/11

eba A TETRA TECH COMPANY

LOGGED BY: KL	COMPLETION DEPTH: 25.91 m
REVIEWED BY: MG	COMPLETE: 09/11/2011
DRAWING NO:	Page 1 of 1

SLOPE SETBACK REPORT	CITY OF MEDICINE HAT	PROJECT NO. - BOREHOLE NO.
POWER POINT SLIDE	SOLID STEM AUGER	C12101372-BH26
MEDICINE HAT, ALBERTA		

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

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SPT (N)
0	SILT - some sand, trace clay, damp to dry, light brown.			
1	- white brown		B1	
	- brown			
2	- damp to moist		S1	8
	- some sand to sandy		B2	
3			S2	13
4			B3	
5	- sandy, moist to wet		S3	10
	- increase in clay cover		B4	
6	Nov. 29/11			
			S4	5
7	- some sand		B5	
			B6	
	CLAY (TILL) - silty, some sand to sandy, low plastic, firm,			
8	moist, brown, trace oxides, trace coal specks.		S5	11
9			B7	
			S6	12
10	- grey		B8	
11				
12	- trace gravel		B9	
13	- medium to high plastic		B10	
14			SH1	
15			B11	
16			B12	
17			S7	18
18			B13	
19			B14	
20			S8	20
	END OF HOLE AT 20.27 m.			
21	Standpipe installed to 20.27 m.			
	Dry upon completion.			
22	Groundwater at 5.5 m on November 29, 2011.			
23				
24				
25				
26				
27				
28				
29				
30				

MOISTURE CONTENT: PLASTIC | M.C. | LIQUID; 20 40 60 80

STANDARD PENETRATION (N) ■ 20 40 60 80

UNCONFINED (kPa) ◆ 50 100 150 200

POCKET PEN. (kPa) ▲ 100 200 300 400

Slotted Piezometer

Depth (ft): 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 98

Nov. 29/11

LOGGED BY: KL	COMPLETION DEPTH: 20.27 m
REVIEWED BY: MG	COMPLETE: 09/11/2011
DRAWING NO:	Page 1 of 1

eba A TETRA TECH COMPANY

SLOPE SETBACK REPORT	CITY OF MEDICINE HAT	PROJECT NO. - BOREHOLE NO.
POWER POINT SLIDE	SOLID STEM AUGER	C12101372-BH28
MEDICINE HAT, ALBERTA		

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

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SPT (N)
0	CLAY (FILL) - silty, some sand to sandy, low plastic, firm, damp to moist, brown, white precipitates, trace rootlets, trace oxides.		B1	
1			B2	
2	SAND (FILL) - medium grained, compact, damp to moist, brown, trace rootlets.		S1	6
			B3	
3	CLAY (FILL) - silty, some sand, trace gravel, low plastic, stiff, moist, brown, trace rootlets.		B4	
			S2	14
4	CLAY (GLACIOLACUSTRINE) - silty, some sand, trace gravel, stiff to very stiff, low plastic, moist, brown, trace oxides, trace coal specks.		B5	
5			S3	16
	- increase in silt, increase in sand		B6	
6				
	Nov. 29/11		S4	21
7			B7	
8			S5	18
			B8	
9				
	SAND SEAM - possible groundwater seepage.		S6	55
10			B9	
11				
12			B10	
			SH1	
13	SAND - medium grained, wet, brown, groundwater seepage.		B11	
			B12	
14	CLAY (TILL) - silty, some sand to sandy, trace gravel, low plastic, very stiff, moist, brown, trace oxides, trace coal specks.			
15			B13	
	CLAY - silty, trace sand, medium plastic, stiff, moist, grey.			
16			B14	
	SAND - medium grained, wet, grey.		B15	
17	CLAY - some silt to trace silt, trace sand, medium plastic, stiff to very stiff, moist, grey.			
18			B16	
			S7	50
19	SAND - medium grained, wet, grey.		B17	
20				
21			B18	
22				
	CLAY - silty, sandy to some sand, low plastic, stiff, moist, grey.		B19	
23				
24			B20	
25				
26			B21	
			S8	50
27	END OF HOLE AT 26.37 m. Standpipe installed to 18.29 m. Dry upon completion. Groundwater at 5.9 m on November 29, 2011.			
28				
29				
30				

MOISTURE CONTENT: PLASTIC | M.C. | LIQUID (20 40 60 80)

STANDARD PENETRATION (N) ■ (20 40 60 80)

UNCONFINED (kPa) ◆ (50 100 150 200)

POCKET PEN. (kPa) ▲ (100 200 300 400)

Slotted Piezometer

Depth (ft): 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 98

Nov. 29/11

LOGGED BY: KL	COMPLETION DEPTH: 8.53 m
REVIEWED BY: MG	COMPLETE: 09/11/2011
DRAWING NO:	Page 1 of 1

eba A TETRA TECH COMPANY

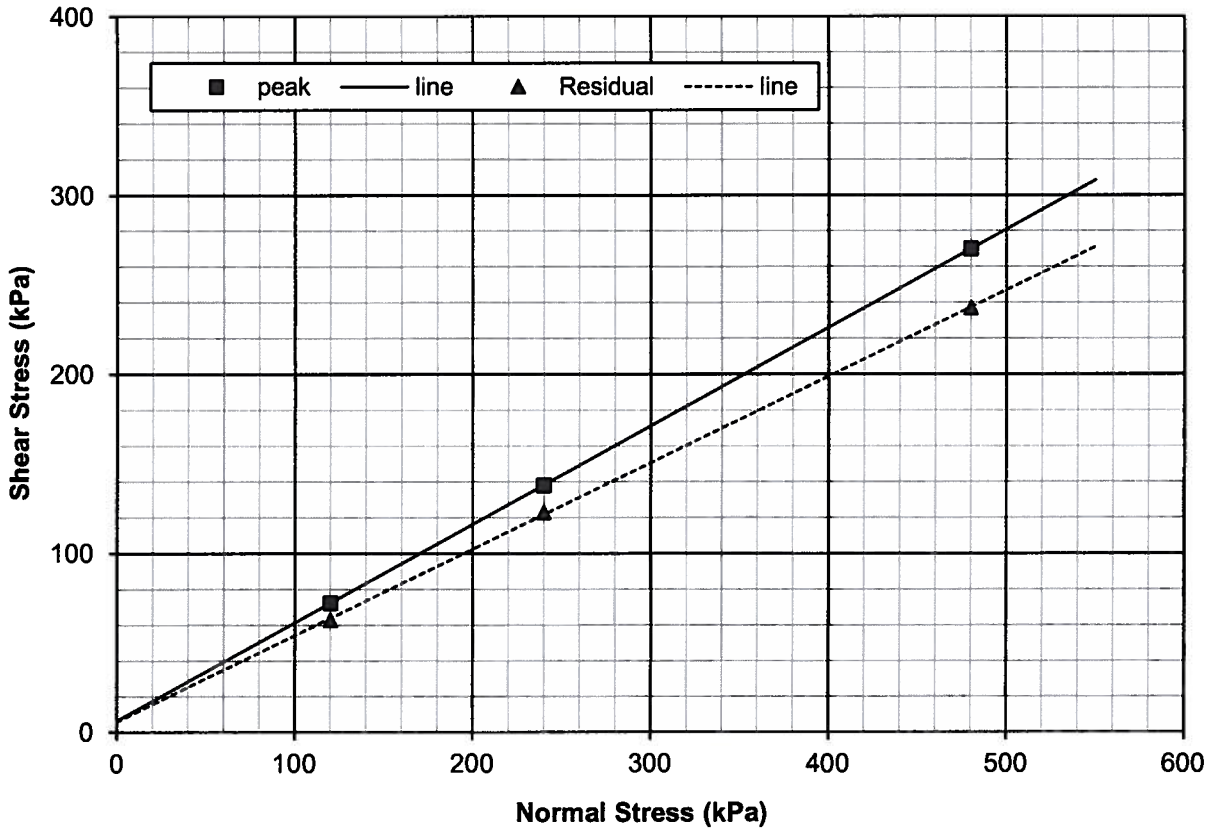
APPENDIX E

APPENDIX E LABORATORY DATA

SUMMARY of DIRECT SHEAR TEST RESULTS

ASTM D3080

Project :	City of Medicine Hat Slope Setback	Test Hole :	BH 19
Project No. :	**C12101372**	Depth:	12.2-12.4m
Client:	**City of Medicine Hat**	Date :	12-01-13
Attention:		Tested By:	SK



Inferred Shear Strength Parameters :-

	Cohesion Intercept (kPa)	Inferred Angle of Shearing Resistance (Degrees)
Peak Strength:	6.4	28.8
Residual Strength:	6.0	25.7

Reviewed By: _____ P.Eng.

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

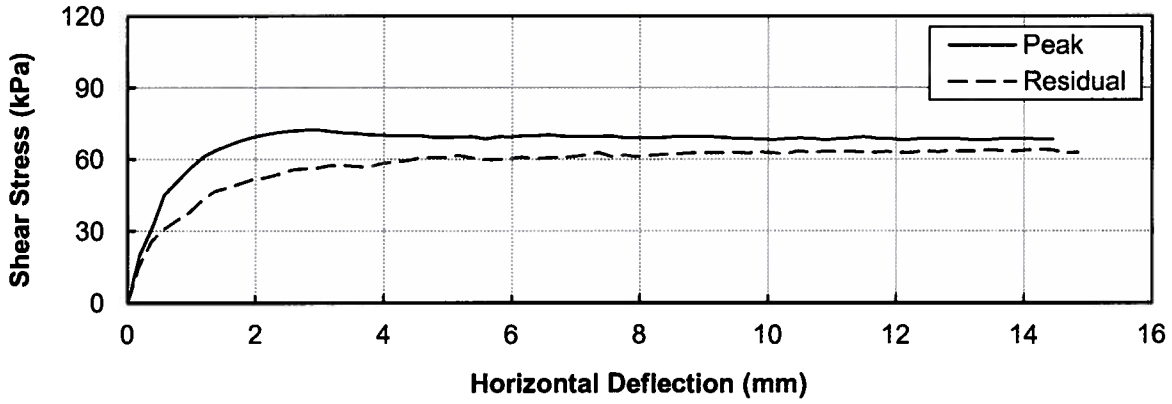
eba
A TETRA TECH COMPANY

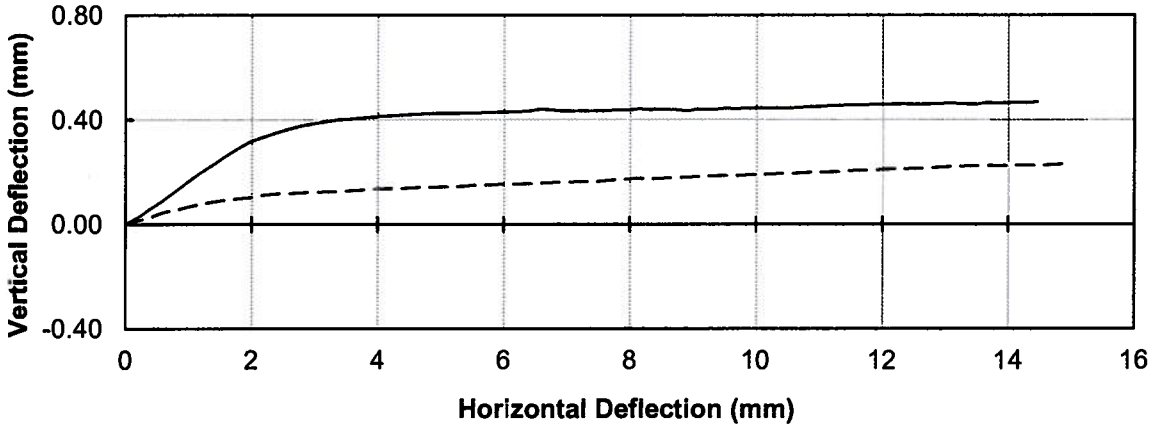
DIRECT SHEAR TEST

ASTM D3080

Project:	City of Medicine Hat Slope Setback	Test Hole No.:	BH 19
Project No.:	C12101372	Depth:	12.2-12.4 m
Client:	City of Medicine Hat	Test No.:	DS-1
Date Tested:	11-12-05	Machine:	1
Descrition:	CLAY TILL	Preparation:	Undisturbed

Normal Stress (kPa) =	120	Moisture Content (%) =	11.0
Peak Stress (kPa) =	72	Wet Density (Mg/m^3) =	1.929
Residual Stress (kPa) =	63	Dry Density (Mg/m^3) =	1.737





Remarks:

Reviewed By: _____ P.Eng.

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability.

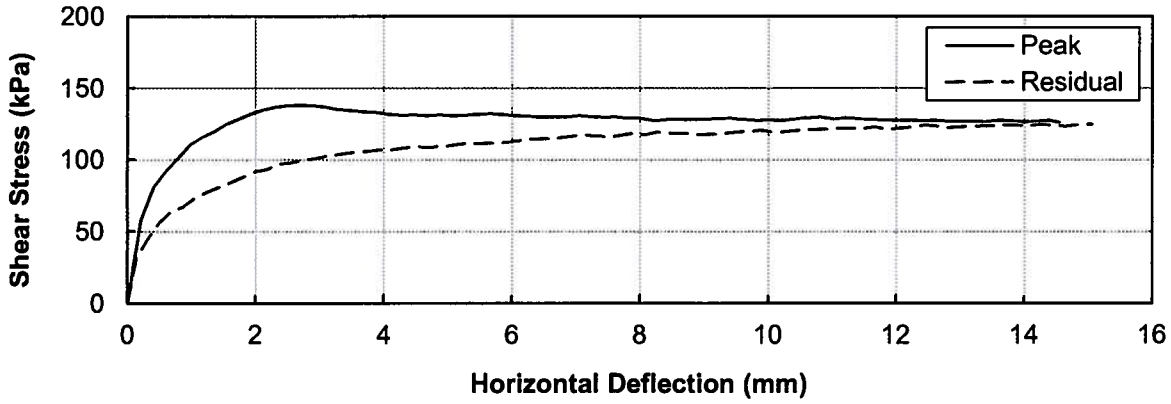
eba
A TETRA TECH COMPANY

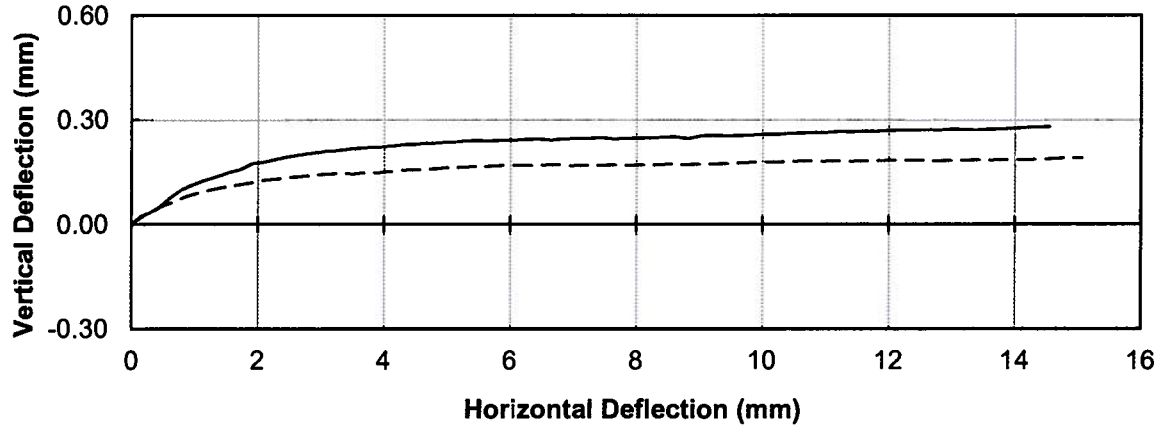
DIRECT SHEAR TEST

ASTM D3080

Project:	City of Medicine Hat Slope Setback	Test Hole No.:	BH 19
Project No.:	C12101372	Depth:	12.2-12.4 m
Client:	City of Medicine Hat	Test No.:	DS-2
Date Tested:	11-12-05	Machine:	3
Descrition:	CLAY TILL	Preparation:	Undisturbed

Normal Stress (kPa) =	240	Moisture Content (%) =	10.7
Peak Stress (kPa) =	138	Wet Density (Mg/m^3) =	2.024
Residual Stress (kPa) =	123	Dry Density (Mg/m^3) =	1.829





Remarks:

Reviewed By: _____ P.Eng.

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability.

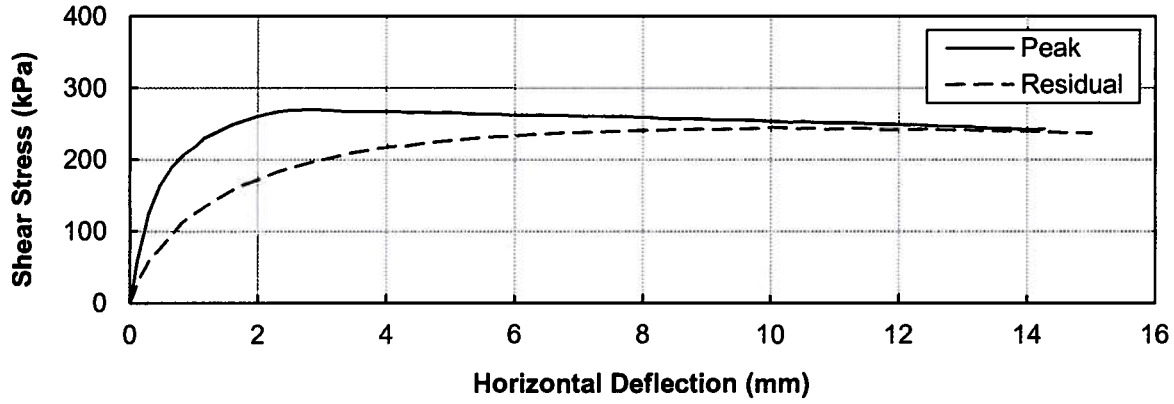
eba
A TETRA TECH COMPANY

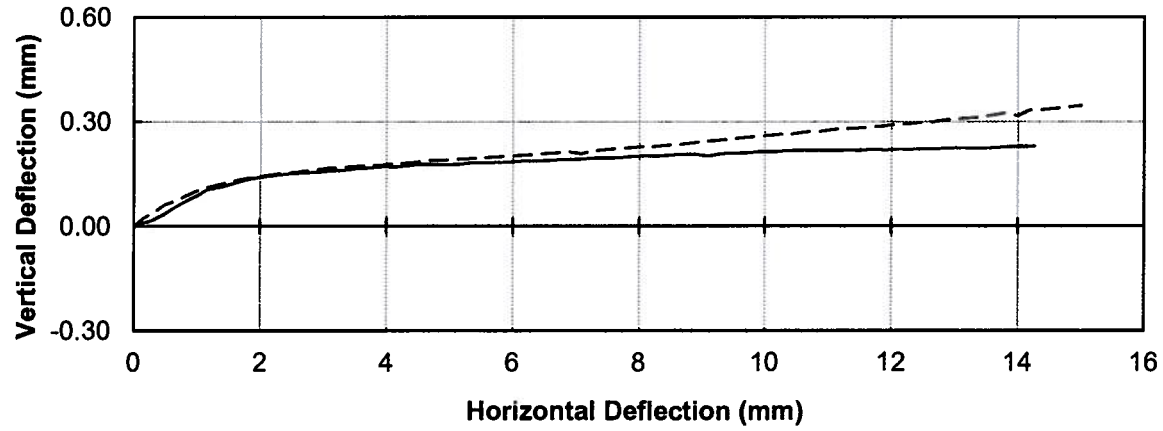
DIRECT SHEAR TEST

ASTM D3080

Project:	City of Medicine Hat Slope Setback	Test Hole No.:	BH 19
Project No.:	C12101372	Depth:	12.2-12.4 m
Client:	City of Medicine Hat	Test No.:	DS-3
Date Tested:	11-12-07	Machine:	3
Descrition:	CLAY TILL	Preparation:	Undisturbed

Normal Stress (kPa) =	480	Moisture Content (%) =	10.4
Peak Stress (kPa) =	270	Wet Density (Mg/m^3) =	2.064
Residual Stress (kPa) =	237	Dry Density (Mg/m^3) =	1.870





Remarks:

Reviewed By: _____ P.Eng.

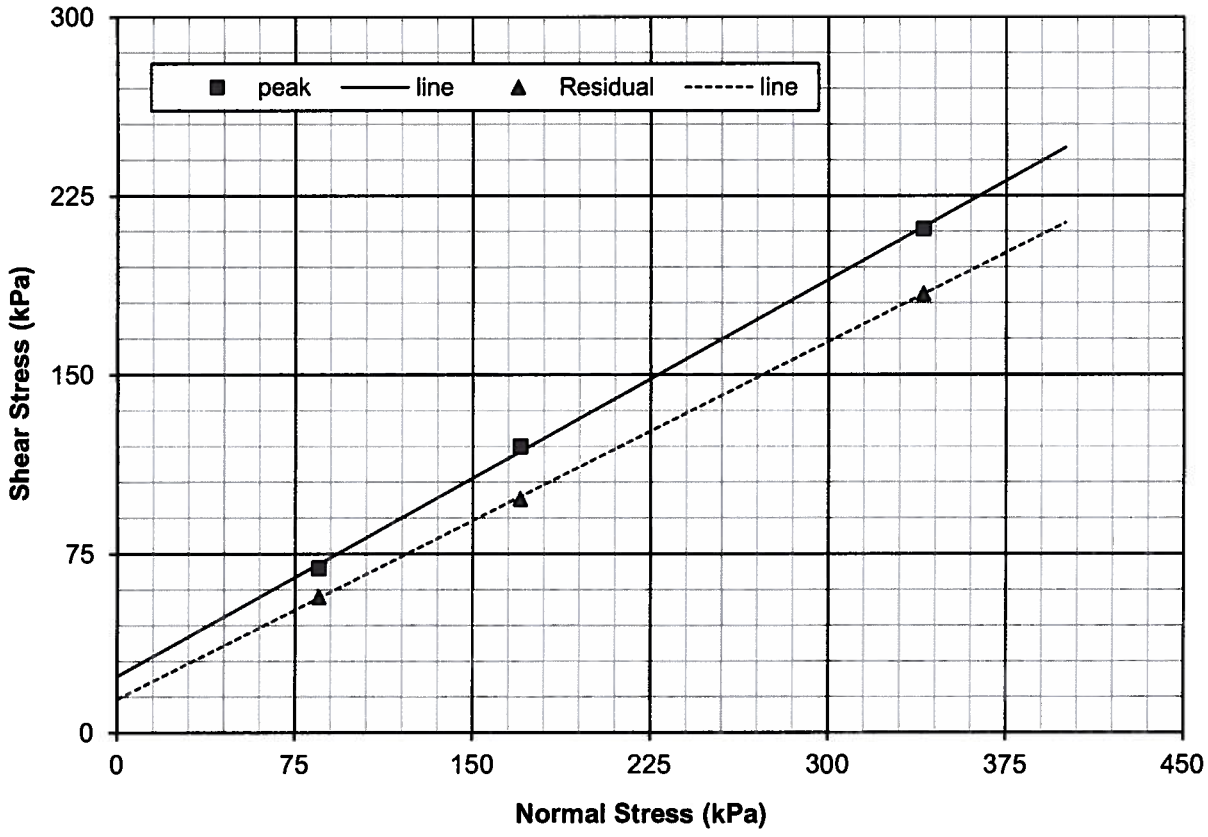
Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability.

eba
A TETRA TECH COMPANY

SUMMARY of DIRECT SHEAR TEST RESULTS

ASTM D3080

Project :	City of Medcine Hat Slope Setback	Test Hole :	BH 23
Project No. :	**C12101372**	Depth:	9.1-9.4 m
Client:	**CIty of Medcine Hat**	Date :	12-01-14
Attention:		Tested By:	SK



Inferred Shear Strength Parameters :-

	Cohesion Intercept (kPa)	Inferred Angle of Shearing Resistance (Degrees)
Peak Strength:	23.5	29.0
Residual Strength:	14.0	26.5

Reviewed By: _____ P.Eng.

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

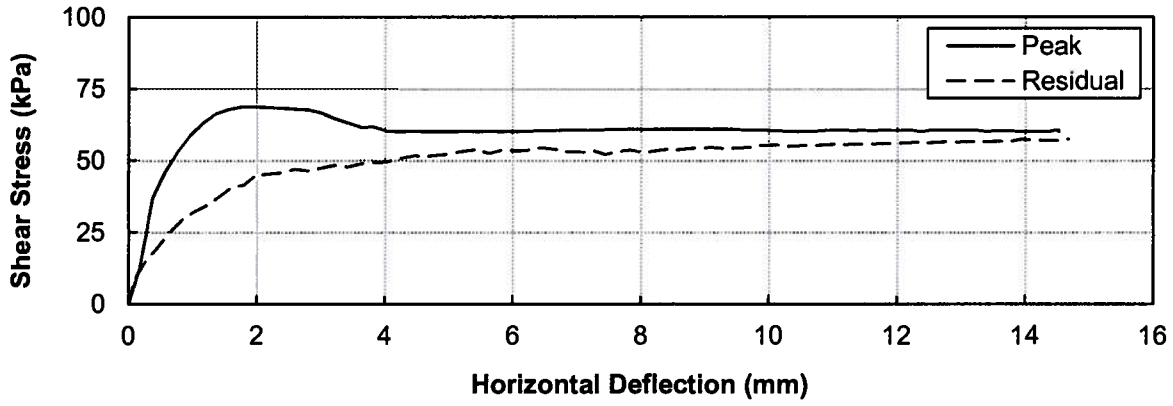
eba
A TETRA TECH COMPANY

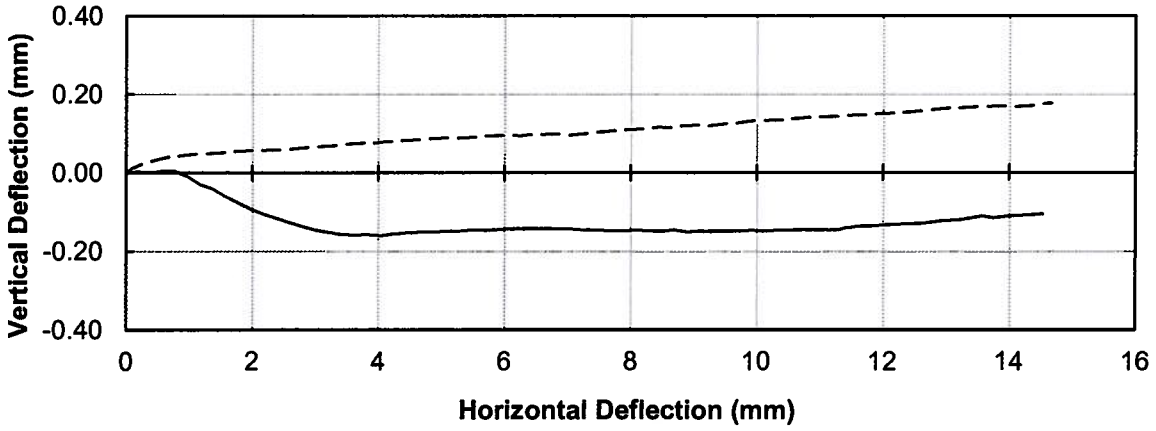
DIRECT SHEAR TEST

ASTM D3080

Project:	City of Medicine Hat Slope Setback	Test Hole No.:	BH 23
Project No.:	C12101372	Depth:	9.1-9.4 m
Client:	City of Medicine Hat	Test No.:	DS-4
Date Tested:	11-12-12	Machine:	2
Descrition:	CLAY TILL	Preparation:	Undisturbed

Normal Stress (kPa) =	85	Moisture Content (%) =	16.4
Peak Stress (kPa) =	69	Wet Density (Mg/m^3) =	2.105
Residual Stress (kPa) =	57	Dry Density (Mg/m^3) =	1.808





Remarks:

Reviewed By: _____ P.Eng.

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability.

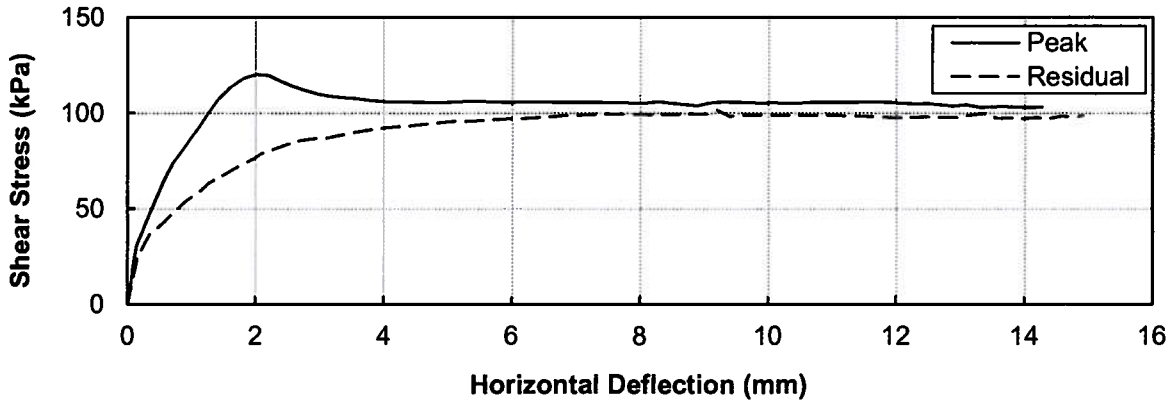
eba
A TETRA TECH COMPANY

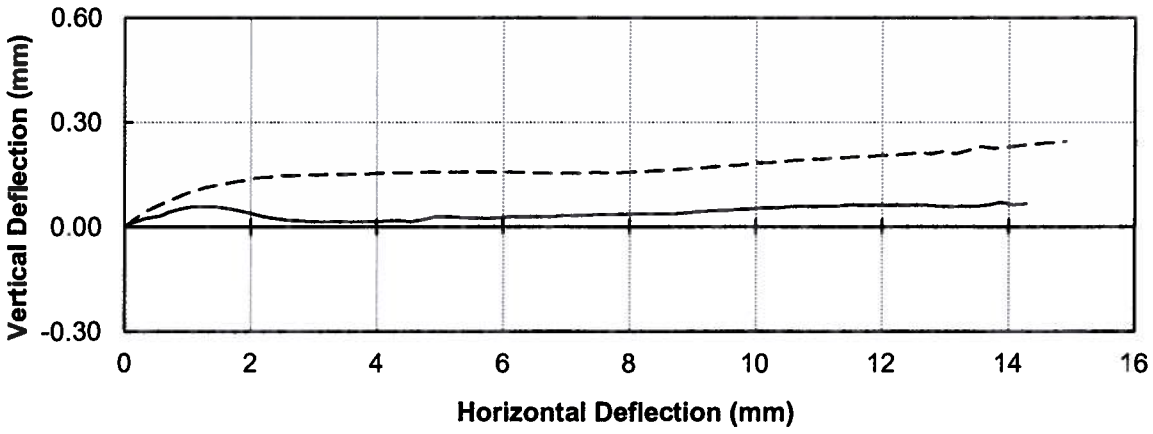
DIRECT SHEAR TEST

ASTM D3080

Project:	City of Medicine Hat Slope Setback	Test Hole No.:	BH 23
Project No.:	C12101372	Depth:	9.1-9.4 m
Client:	City of Medicine Hat	Test No.:	DS-5
Date Tested:	11-12-12	Machine:	3
Descrition:	CLAY TILL	Preparation:	Undisturbed

Normal Stress (kPa) =	170	Moisture Content (%) =	16.7
Peak Stress (kPa) =	120	Wet Density (Mg/m^3) =	2.126
Residual Stress (kPa) =	99	Dry Density (Mg/m^3) =	1.822





Remarks:

Reviewed By: _____ P.Eng.

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability.

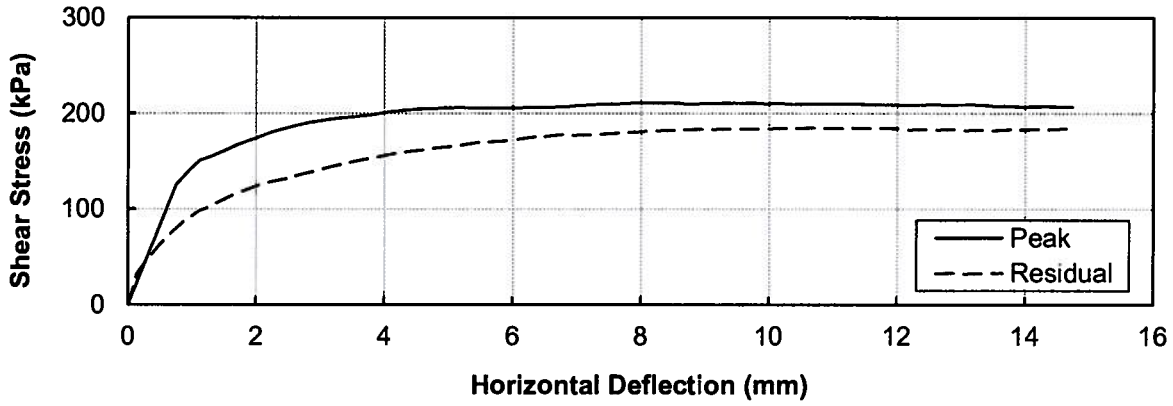
eba
A TETRA TECH COMPANY

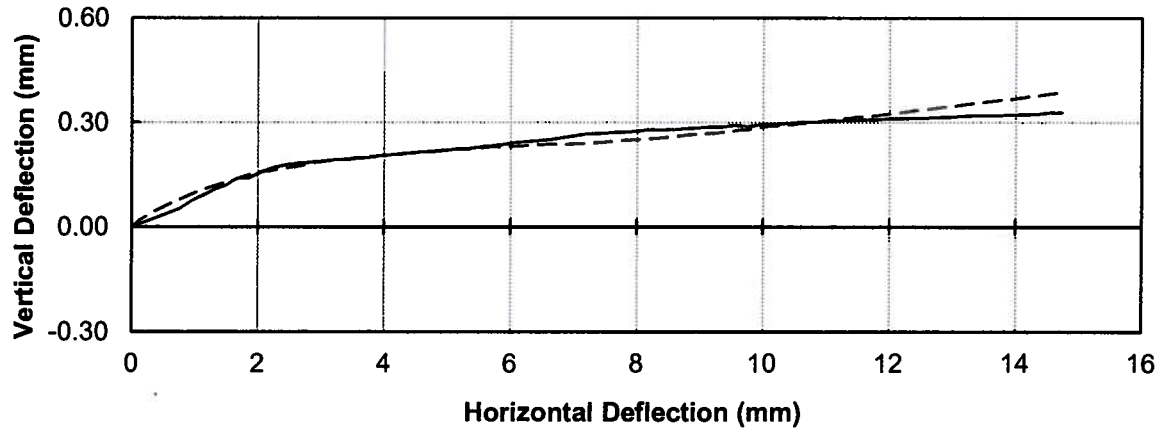
DIRECT SHEAR TEST

ASTM D3080

Project:	City of Medicine Hat Slope Setback	Test Hole No.:	BH 23
Project No.:	C12101372	Depth:	9.1-9.4 m
Client:	City of Medicine Hat	Test No.:	DS-6
Date Tested:	11-12-12	Machine:	3
Descrition:	CLAY TILL	Preparation:	Undisturbed

Normal Stress (kPa) =	340	Moisture Content (%) =	17.9
Peak Stress (kPa) =	211	Wet Density (Mg/m^3) =	2.100
Residual Stress (kPa) =	184	Dry Density (Mg/m^3) =	1.781





Remarks:

Reviewed By: _____ P.Eng.

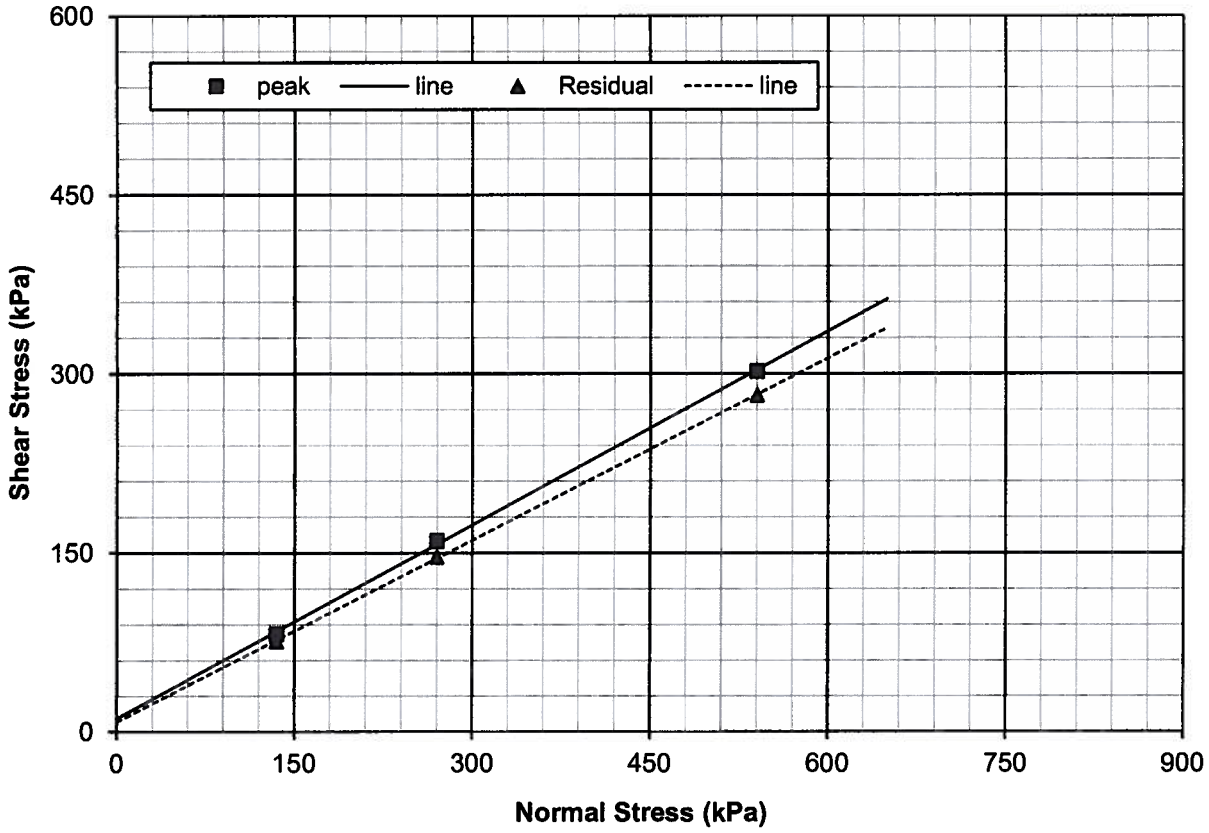
Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability.

eba
A TETRA TECH COMPANY

SUMMARY of DIRECT SHEAR TEST RESULTS

ASTM D3080

Project :	City of Medcine Hat Slope Setback	Test Hole :	BH 23
Project No. :	**C12101372**	Depth:	13.7-14.1 m
Client:	**City of Medcine Hat**	Date :	12-01-14
Attention:		Tested By:	SK



Inferred Shear Strength Parameters :-

	Cohesion Intercept (kPa)	Inferred Angle of Shearing Resistance (Degrees)
Peak Strength:	11.0	28.4
Residual Strength:	8.5	26.9

Reviewed By: _____ P.Eng.

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

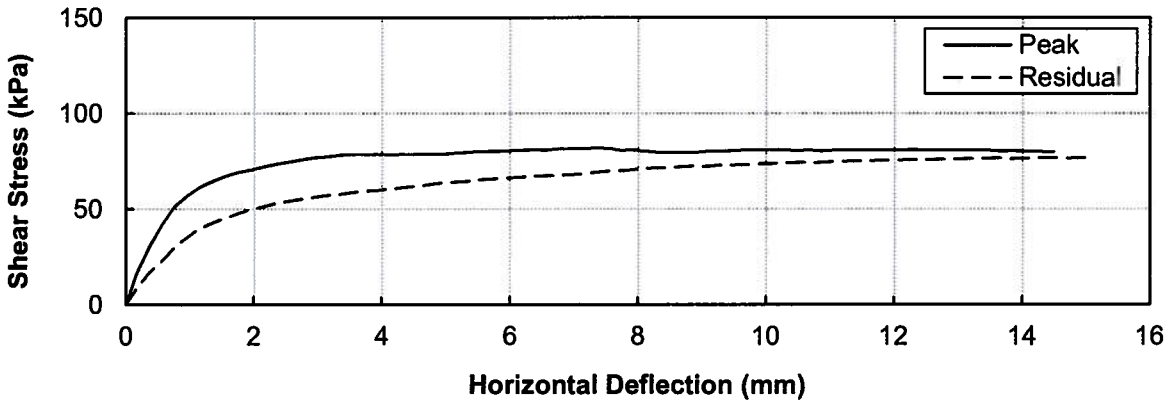
eba
A TETRA TECH COMPANY

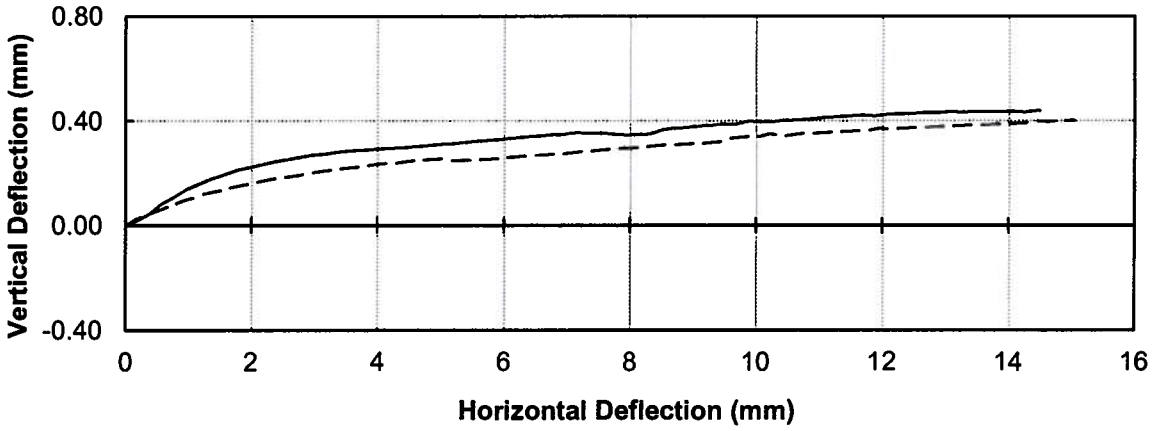
DIRECT SHEAR TEST

ASTM D3080

Project:	City of Medicine Hat Slope Setback	Test Hole No.:	BH 26
Project No.:	C12101372	Depth:	13.7-14.1 m
Client:	City of Medicine Hat	Test No.:	DS-7
Date Tested:	11-12-17	Machine:	1
Descrition:	CLAY TILL	Preparation:	Undisturbed

Normal Stress (kPa) =	135	Moisture Content (%) =	19.8
Peak Stress (kPa) =	82	Wet Density (Mg/m^3) =	2.074
Residual Stress (kPa) =	76	Dry Density (Mg/m^3) =	1.731





Remarks:

Reviewed By: _____ P.Eng.

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability.

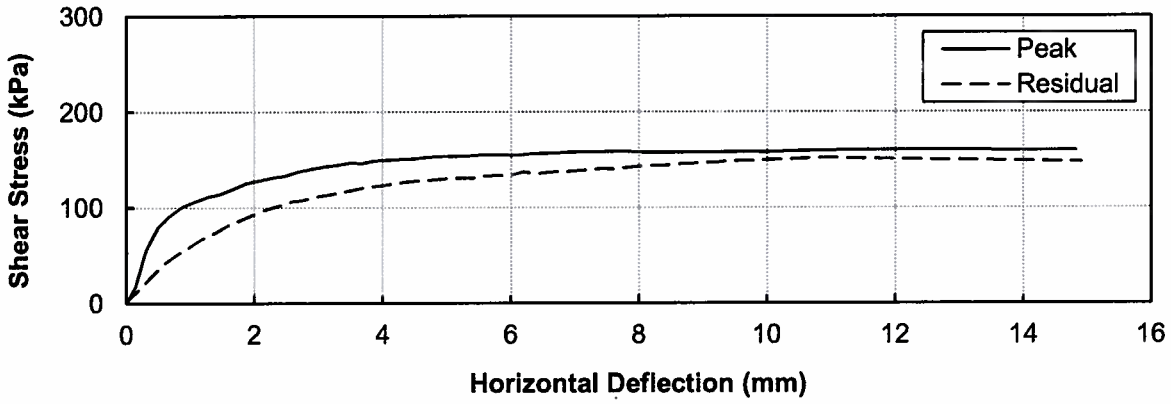
eba
A TETRA TECH COMPANY

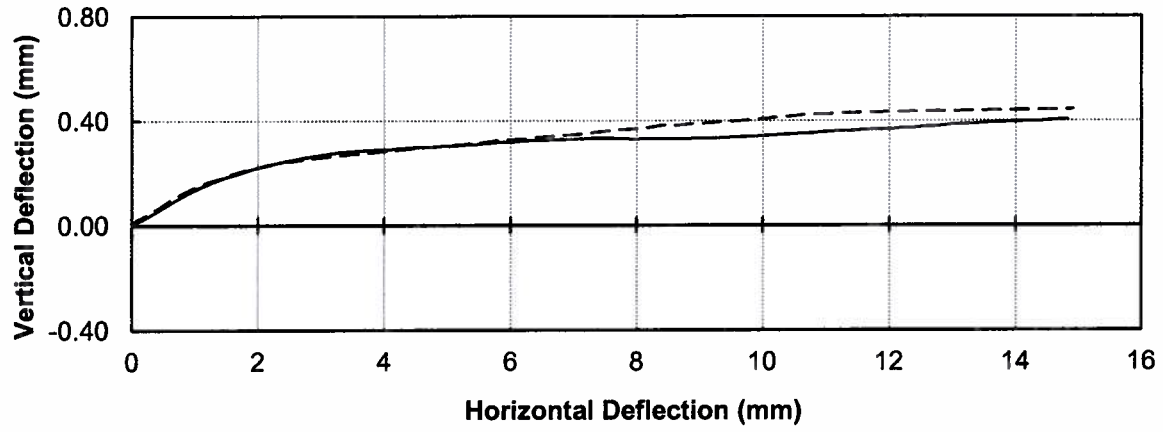
DIRECT SHEAR TEST

ASTM D3080

Project:	City of Medicine Hat Slope Setback	Test Hole No.:	BH 26
Project No.:	C12101372	Depth:	13.7-14.1 m
Client:	City of Medicine Hat	Test No.:	DS-8
Date Tested:	12-01-02	Machine:	2
Descrition:	CLAY TILL	Preparation:	Undisturbed

Normal Stress (kPa) =	270	Moisture Content (%) =	18.9
Peak Stress (kPa) =	160	Wet Density (Mg/m^3) =	2.100
Residual Stress (kPa) =	147	Dry Density (Mg/m^3) =	1.766





Remarks:

Reviewed By: _____ P.Eng.

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability.

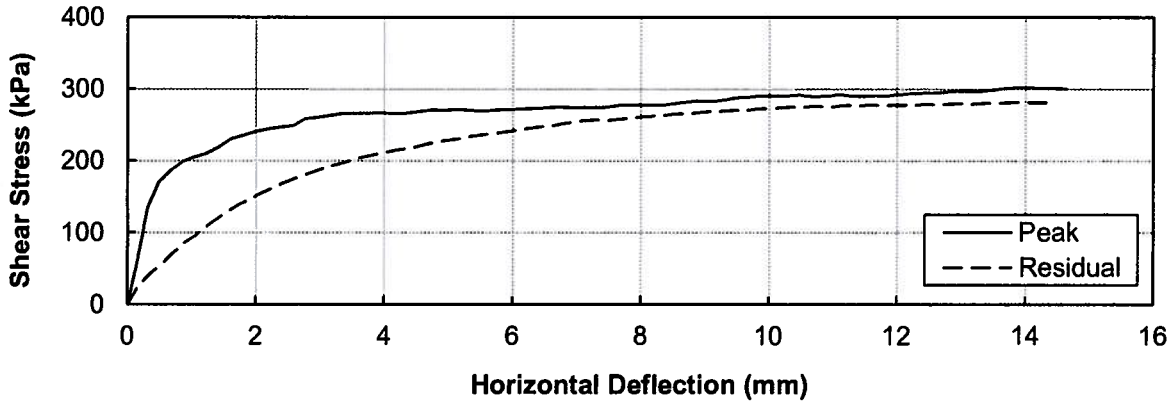
eba
A TETRA TECH COMPANY

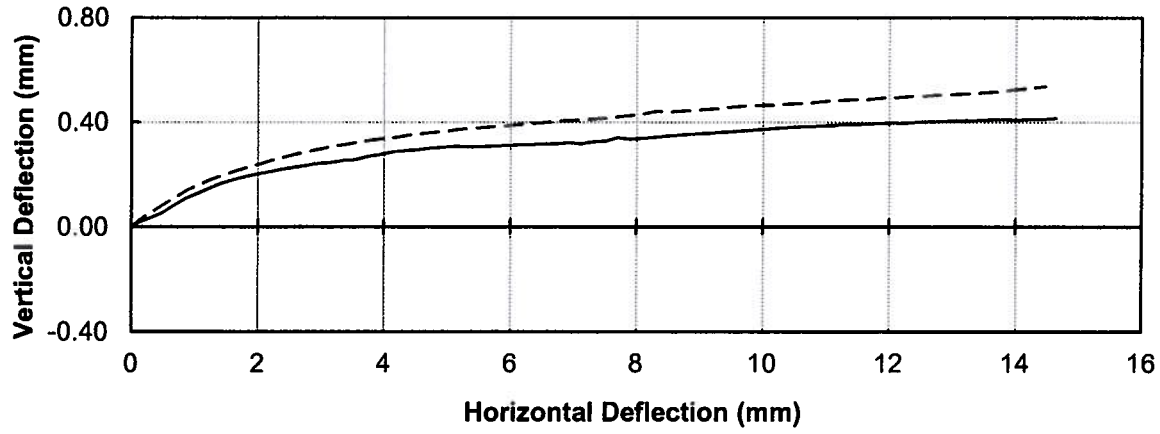
DIRECT SHEAR TEST

ASTM D3080

Project:	City of Medicine Hat Slope Setback	Test Hole No.:	BH 26
Project No.:	C12101372	Depth:	13.7-14.1 m
Client:	City of Medicine Hat	Test No.:	DS-9
Date Tested:	12-01-02	Machine:	3
Descrition:	CLAY TILL	Preparation:	Undisturbed

Normal Stress (kPa) =	540	Moisture Content (%) =	19.5
Peak Stress (kPa) =	302	Wet Density (Mg/m^3) =	2.093
Residual Stress (kPa) =	282	Dry Density (Mg/m^3) =	1.751





Remarks:

Reviewed By: _____ P.Eng.

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability.

eba
A TETRA TECH COMPANY

APPENDIX F

APPENDIX F DEFINITIONS AND CLASSIFICATION TABLES

General Terms and Classifications Used in the Terrain and Landslide Databases

Attribute	Definition
Polygon #	Alpha-numeric character string, starting with a "P" to identify the shape as a Polygon feature followed by an unique number assigned to an area having similar terrain attributes. Polygons have been defined on sloped areas having a slope gradient >15% and a slope height greater than 5 m.
Landslide #	Alpha-numeric character string, starting with a "L" to identify the shape as a Landslide feature followed by an unique number. Landslides may be a point, line or polygon feature.
Air Photo Ref	The air photo year, flight line, and number on which the linework and interpretation were completed
Land Use	Land use in the area at the time of the air photo on which the interpretation is based as per the City of Medicine Hat's Land use District designations (i.e. R1 - Single Family Residential District, R2 - Low Density Residential District, R3 - Medium Density Residential District, R4 - High Density Residential District, R5P - Manufactured Home Community Residential District, R5S - Manufactured home Subdivision Residential District, CR - Country Residential District, C1 - Restricted Home based Commercial Area District, C2 - Neighbourhood Commercial District, C3 - General Commercial District, C4 - Downtown Commercial District, M1 - General Light Industrial District, M2 - Agro-Industrial District, M3 - General Heavy Industrial District, DC - Direct Control District, H - Horticultural District, P1 - Park and Recreation District, PS - Public Service District, TU - Transportation and Utilities District, UR - Urban Reserve District, W - Water)
Coordinates	UTM coordinates of the centroid of the polygon/landslide feature as determined by GIS
Slope Height	Overall slope height from the toe of the slope to the crest of the slope through the centroid of the polygon, expressed in metres; determined by GIS by intersecting the contour layer.
Slope Gradient	Overall slope angle from the toe of the slope to the crest of the slope through the centroid of the polygon, expressed in % and degrees; determined by GIS
Slope Length	Overall slope distance from the toe of the slope to the crest of the slope through the centroid of the polygon, expressed in metres; = (slope ht)/sin(slope grad, in degrees))
Landslide Age	Applies to Landslides but can apply to general Polygons if they exhibit evidence of slope movement. Defined as Ancient, Historic, or Recent: - Ancient - assumed to pre-date the earliest air photos of record - Historic - assumed to have occurred within the period of record represented by the earliest available air photos (typically within the last 100 yrs) - Recent - movement has occurred within the last 5 years
Landslide Type	As per "Landslide Types and Classification" tab
Landslide Depth	Defined as Shallow (<5 m deep); Intermediate (5 m to <10 m deep); and Deep (>10 m deep)
Landslide Size	Area of the landslide, expressed in ha; determined by GIS
Landslide Size Class	As per "Landslide Size Class" tab
Degree of Landslide Activity	Applies to Landslides but can apply to general Polygons if they exhibit evidence of slope movement. State of landslide activity follows the definitions outlined by the UNESCO Working Party for the WLI (1993)*: - Active - landslide is currently moving - Suspended - landslide has moved within the last 12 months but is not active at present - Reactivated - landslide is an active landslide that has been inactive - Inactive - landslide has not moved within the last 12 months, of which there are 4 sub-states: Dormant - a landslide that can be reactived by its original causes or by other causes Abandoned - landslide that is no longer affected by its original causes Stabilized - landslide that has been protected from its original causes by artificial remedial measures Relict - landslide that developed under climatic or geomorphological conditions considerably different from those at present
Potential for Landslide Occurrence/Recurrence	Defined as "Low", "Moderate", "High", and "V.High" as determined from the Degree of Activity of the Landslide, the "Susceptibility" tab, and the "Hazard" tab
Contains a Watercourse	Yes or No field to identify those polygons whose terrain attributes may be modified by hydrologic processes
Slope Section	Identifies the location of the slope relative to the "Slope Database" tab that contains a list of the main, representative cross-sections of various slopes throughout the City of Medicine Hat
Estimated Potential Run-out	Probable location of potential run-out from a landslide
Consequence	As per definitions on the "Consequence" tab; determined by setback analysis and GIS
Partial Risk	As per definitions outlined in Section 13 of the report
Field Checked	Polygon was checked or not checked in the field: - NC - not checked - V - visual inspection from air craft or from a distance (e.g. from a viewpoint) - TR - reconnaissance level review during a truck traverse - FR - reconnaissance level review during a foot traverse - D - detailed review where the section was measured and detailed soil descriptions noted
Comment	Provide polygon specific observations from air photo interpretation, including comments concerning Slope Class (as defined under the "Slope Class" tab).

* UNESCO Working Party World Landslide Inventory. 1993. Multilingual landslide glossary. The Canadian Geotechnical Society, No. 47, 53-57, 32 p.

Slope Class Definition Terms

Term	Definition
Level or plain	Slopes between 0 and 5 percent (0 and 3 degrees)
Gentle	Slopes between 6 and 26 percent (4 and 15 degrees)
Moderate slope	Slopes between 27 and 49 percent (16 and 26 degrees)
Moderately steep	Slopes between 50 and 70 percent (27 and 35 degrees)
Steep	Slopes steeper than 70 percent (35 degrees)

Howes D.E. and Kenk E. 1997 - Terrain Classification System for British Columbia (Version 2), Resource Inventory Branch, Ministry of Enviornment, Lands and Parks, 100 p.

Landslide Types and Classification

Schematic landslide classification adopting the classification of Varnes 1978 and taking into account the modifications made by Cruden and Varnes, in 1996. Some integration has been made by using the definitions of Hutchinson (1988) and Hungr et al. (2001).

Type of Movement			Type of Material		
			Bedrock	Engineering Soils	
				Predominantly fine	Predominantly coarse
Falls			Rockfall	Earth fall	Debris fall
Topples			Rock topple	Earth topple	Debris topple
Slides	Rotational		Rock slump	Earth slump	Debris slump
	Translational	Few units	Rock block slide	Earth block slide	Debris block slide
		Many units	Rock slide	Earth slide	Debris slide
Lateral spreads			Rock spread	Earth spread	Debris spread
Flows			Rock flow	Earth flow	Debris flow
			Rock avalanche		Debris avalanche
			(Deep creep)	(Soil creep)	
Complex and compound			Combination in time and/or space of two or more principal types of movement.		

Notes:

Sliding mechanism is described as rotational, translational, or compound.

Cruden D.M., Varnes D. J. (1996) - Landslide types and processes. In: Turner A.K.; Shuster R.L. (eds) Landslides: Investigation and Mitigation. Transp Res Board, Spec Rep 247, pp 36–75.

Hungr O, Evans SG, Bovis M, and Hutchinson JN (2001) Review of the classification of landslides of the flow type. Environmental and Engineering Geoscience, VII, 221-238.

Hutchinson J. N.: Mass Movement. In: The Encyclopedia of Geomorphology (Fairbridge, R.W., ed.), Reinhold Book Corp., New York, pp. 688–696, 1968.

Landslide Size Classification

Size Class	Size Range	Description
1	≤ 500 m^2	Very Small
2	> 500 to 1000 m^2	Small
3	>1000 to 2500 m^2	Moderately Small
4	>2500 to 5000 m^2	Moderate
5	>5000 to 10,000 m^2 (1 ha)	Moderately Large
6	>10,000 to 100,000 m^2 (10 ha)	Large
7	>100,000 to 1,000,000 m^2 (100 ha)	Very Large
8	>1,000,000 m^2 (100 ha)	Extremely Large

APPENDIX G

APPENDIX G LANDSLIDE DATABASE

EBA, A Tetra Tech Company
Oceanic Plaza, 9th Floor, 1066 West Hastings Street
Vancouver, BC V6E 3X2 CANADA
p. 604.685.0275 f. 604.684.6241

TECHNICAL MEMO

TO:	The City of Medicine Hat	**DATE:**	April 2, 2014
C:		**MEMO NO.:**	1
FROM:	EBA GIS Group	**EBA FILE:**	C12101372
SUBJECT:	GIS Data Dictionary		

1.0 INTRODUCTION

This Technical Memo contains a list and brief description of the feature datasets within the Medicine Hat Slope Setbacks project, which were supplied in ESRI File Geodatabase (version 9.3) format. It also includes a detailed Data Dictionary for the Terrain Polygon dataset.

2.0 GIS DATASETS

Medicine_Hat_GIS.gdb

Dataset Name	Feature Class	Description
Base_Data_ from_City		Contains all datasets provided by the City.
Contours		Contains all hypsographic contours provided by the City.
Terrain_Features	Creek_Edge_1955	Creek edge as defined from 1955 aerial photography.
	Creek_Edge_2010	Creek edge as defined from 2010 aerial photography.
	Escarpment_Top_and_Toe_120228	Contains the top of escarpment (15% slope break) and two toe of escarpment lines (15% and 33% slope break).
	Properties_at_Risk_120229	Contains a copy of the City's lot lines layer, with two new fields added: Risk_Top and Risk_Toe. These fields were populated with the risk rating for each lot based on the qualitative spatial probability for upslope and downslope elements, as defined in the report.
	Setback_Toe_120228	The setback distance determined from the 15% toe of escarpment line.
	Setback_Toe_Moderate_120305	The moderate setback distance determined from the 15% toe of escarpment line.
	Setback_Top_120228	The setback distance determined from the 15% top of escarpment line.
	Setback_Top_Moderate_120308	The moderate setback distance determined from the 15% top of escarpment line.
	Terrain_Polygons_2012	The boundaries of the terrain polygons; see Section 3.0 for a detailed data dictionary.
	Terrain_Polygons_2012_Centre_ Lines	Lines drawn through the terrain polygon centroid and perpendicular to the contour lines.
	Terrain_Polygons_2012_Centroids	Centroids for each of the terrain polygons, as determined using GIS.
	Terrain_Polygons_2012_CliptoCity	The terrain polygons clipped to the City's limits.

Dataset Name	Feature Class	Description
N/A	Annotation_Features	Features associated with the annotation used in all the GIS figures.
	Annotation_Figure02	Annotation used in all the GIS figures.
	Aug2011_Tracks	Field traverse routes shown in Appendix I, Figure I-1.
	Aug2011_Waypoints	Field observation points shown in Appendix I, Figure I-2.
	Case_Study_Locations	Case study locations shown in Figure 17.
	Cross_Sections	Cross-section lines shown in Figure 19.
	Geo_Sectors	Geological sectors shown in Figure 21 (created by running a Dissolve on Geo_Subsectors).
	Geo_Subsectors	Geotechnical setback sectors shown in Figures 22-25.
	Mapbook_GRID	Grid used to divide the City into six map sheets.
	Medicine_Hat_BH	Previous borehole locations, as shown in Figure 8.
	Medicine_Hat_EBA_Boreholes_NOV2011	EBA 2011 borehole locations, as shown in Figure 9.
	Stream_Reaches	Stream reach breaks shown in Figure 20.

3.0 DATA DICTIONARY

Terrain_Polygons_2012

Field Name	Field Alias	Description
Polygon_ID	Polygon ID	Alpha-numeric character string, starting with a "P" to identify the shape as a polygon feature followed by an unique number assigned to an area having similar terrain attributes. Polygons have been defined on sloped areas having a slope gradient >15% and a slope height greater than 5 m.
Edited	Edited	Indicates who last edited the polygon feature.
TM_X; TM_Y	3TM_X; 3TM_Y	3TM coordinates of the centroid of the polygon/landslide feature.
UTM12_X; UTM12_Y	UTM12_X; UTM12_Y	UTM coordinates of the centroid of the polygon/landslide feature.
Elev_1; Elev_2	Elevation_1; Elevation_2	Elevation at start and end of the slope line drawn through the centroid of the polygon, expressed in metres.
Run	Run	Total length of the slope line drawn through the centroid of the polygon, expressed in metres.
Slp_Hght	Slope Height	Overall slope height from the toe of the slope to the crest of the slope through the centroid of the polygon, expressed in metres.
Slp_Prcnt	Slope Percent	Overall slope angle from the toe of the slope to the crest of the slope through the centroid of the polygon, expressed in %.
Slp_Dgrs	Slope Degrees	Overall slope angle from the toe of the slope to the crest of the slope through the centroid of the polygon, expressed in degrees.
Slp_Lngth	Slope Length	Overall slope distance from the toe of the slope to the crest of the slope through the centroid of the polygon, expressed in metres.
Lndsld_ID	Landslide ID	Alpha-numeric character string, starting with a "L" to identify the shape as a Landslide feature followed by an unique number.

Field Name	Field Alias	Description
AP_Ref	AirPhoto_Ref	The air photo year, flight line, and number on which the linework and interpretation were completed.
Lndsld_Age	Landslide Age	Applies to landslides but can apply to general polygons if they exhibit evidence of slope movement. A – Ancient – assumed to pre-date the earliest air photos of record. H – Historic – assumed to have occurred within the period of record represented by the earliest available air photos (typically within the last 100 years). R – Recent – movement has occurred within the last 5 years. A-H – Ancient/Historic – both ages are present within the polygon. A-R – Ancient/Recent – both ages are present within the polygon. H-R – Historic/Recent – both ages are present within the polygon.
Lndsld_Type	Landslide Type	R – earth/rock slump. T – earth/rock slide. R-T – compound. B – earth block slide (translational).
Lndsld_Dpth	Landslide Depth	Shallow (< 5 m deep) Intermediate (5 m to < 10 m deep) Deep (> 10 m deep)
Lndsl_Size	Landslide Size	Area of the landslide, expressed in metres.
Lndsld_Class	Landslide Size Class	1 (≤ 500 m^2) – very small. 2 (> 500 to 1,000 m^2) – small. 3 (> 1,000 to 2,500 m^2) – moderately small. 4 (> 2,500 to 5,000 m^2) – moderate. 5 (> 5,000 to 10,000 m^2) – moderately large. 6 (> 10,000 to 100,000 m^2) – large. 7 (>100,000 to 1,000,000 m^2) – very large. 8 (> 1,000,000 m^2) – extremely large.
Lndsld_Actvty	Landslide Activity	Applies to Landslides but can apply to general polygons if they exhibit evidence of slope movement. State of landslide activity follows the definitions outlined by the UNESCO Working Party for the WLI (1993)*: A – Active – landslide is currently moving. S – Suspended – landslide has moved within the last 12 months but is not active at present. R – Reactivated – landslide is an active landslide that has been inactive. I – Inactive – landslide has not moved within the last 12 months, of which there are 4 sub-states: D – Dormant - a landslide that can be reactivated by its original causes or by other causes. A – Abandoned – landslide that is no longer affected by its original causes. S – Stabilized – landslide that has been protected from its original causes by artificial remedial measures. R – Relict – landslide that developed under climatic or geomorphological conditions considerably different from those at present.

Field Name	Field Alias	Description
Lndsld_Ptntl	Landslide Potential	Potential for landslide occurrence/recurrence. L – Low M – Moderate H – High VH – Very High
Wtrcrs	Watercourse	Identifies those polygons whose terrain attributes may be modified by hydrologic processes. N – No Y – Yes
Slp_Sctn	Slope Section	Identifies the location of the slope relative to the main, representative cross-sections of various slopes throughout the City of Medicine Hat. SSR – South Saskatchewan River IS – Interior Slopes RC – Ross Creek SPC – Seven Persons Creek
Ptntl_Runout	Est Potential Runout	Probable location of potential run-out from a landslide.
Fld_Chckd	Field Checked	Polygon was checked or not checked in the field. NC – not checked. V – visual inspection from air craft or from a distance (e.g., from a viewpoint). TR – reconnaissance level review during a truck traverse. FR – reconnaissance level review during a foot traverse. D – detailed review where the section was measured and detailed soil descriptions noted.

* UNESCO Working Party World Landslide Inventory. 1993. Multilingual landslide glossary. The Canadian Geotechnical Society, No. 47, 53-57, 32 p.

Medicine Hat Landslide Database

Lndsld_Nm	PolygonNum	UTM12_X	UTM12_Y	Lndsl_Sz	Slp_Hght	Slp_Prcnt	Slp_Dgrs	Slp_Lngth	AP_Ref	Landuse	Lndsld_Age	Lndsld_Typ	Lndsld_Dpt	Lndsld_Cls	Lndsld_Size_ Descrption	Dgr_Lndsld	Pot_Lndsld	Wtrcrs	Slp_Sctn	EstPot_Run	Fld_Chckd	Comments
L01	P001	517937.3	5542583.4	24947.0	71.9	28.8	16.5	252.7	2006 L-7 96	Parks and Recreation	A	R	Deep	6	Large	R	VH	Y	S.Sask. West Section SSR-8	River	FR	Part of Surprise Bluffs. Large failure, reactivated by several small r-t failures, particularly on W side; more recent headwall regressing upslope from River; existing road network above crest and within the landslide
L02	P002	517944.0	5542704.3	6497.1	47.7	43.9	25.2	112.2	2006 L-7 96	Parks and Recreation	A	R	Deep	5	Moderately Large	I-D	H	N	S.Sask. West Section SSR-8	River	V	Part of Surprise Bluffs. Medium-sized r-t failure; existing road network above crest and within landslide.
L03	P003	518015.9	5542575.9	15331.0	72.4	39.1	22.4	190.2	2006 L-7 96	Parks and Recreation	A	T	Deep	6	Large	I-D	M	N	S.Sask. West Section SSR-8	River	V	Part of Surprise Bluffs. Large failure, partially treed, existing road network above crest and within landslide.
L04	P004	518133.4	5542486.8	28245.6	66.9	29.4	16.8	230.8	2006 L-7 96	Parks and Recreation	A	R	Deep	6	Large	R	M	Y	S.Sask. West Section SSR-8	River	V	Part of Surprise Bluffs. Large failure, reactivated on E side, gullied at base, partially treed, existing road network above crest and within landslide.
L05	P005	518302.0	5542519.9	54880.2	78.5	39.2	22.5	205.4	2006 L-7 96	Parks and Recreation	A	R-T	Deep	6	Large	I-D	M	N	S.Sask. West Section SSR-8	Mid-Slope Bench or River	FR	Very large failure, reactivated in isolated areas within the failure, notably near the crest, vegetated, existing road network above crest and within landslide. Double scarps and small drainages.
L06	P006	517669.1	5542799.9	94844.7	62.6	32.4	18.6	196.6	2006 L-7 96	Parks and Recreation	A	R-T	Deep	6	Large	I-D	M	N	S.Sask. West Section SSR-8	Mid-Slope Bench or River	FR	Part of Surprise Bluffs. V. large failure; has been reactivated in the probable historic past with numerous small circular failures within the headscarp; partially treed; occasional areas of erosion; small drainages; existing road network above and within landslide.
L07	P007	517164.7	5543123.1	2792.4	25.0	33.4	19.2	76.2	2006 L-8 117	Parks and Recreation	H	T	Shallow	4	Moderate	I-D	H	Y	S.Sask. West Section SSR-8	Park	V	Part of a system of dendritic coulees. Seepage/stream flow related erosion noted on at the base of the slopes. Polygon characterized by very steep coulee slopes; base of coulees are gentle. Active erosion noted within the landslide track of shallow historic landslide.
L08	P009	518564.1	5542379.7	50303.0	92.0	20.0	11.5	463.0	2006 L-7 98	Parks and Recreation	A	R-T	Deep	6	Large	R	M	Y	S.Sask. West Section SSR-8	Creek	D	Observed at W258. Severe erosion due to motorized vehicles; eastern slope has experienced recent movement; partially treed; road system above crest.
L09	P010	518860.8	5542584.9	206664.6	74.9	18.8	10.8	400.9	2006 L-7 98	Parks and Recreation	A	R-T	Deep	7	Very Large	R	VH	N	S.Sask. West Section SSR-8	Mid-Slope Bench or River	FR	Relict landslide where 70% reactivated at one time but now appears inactive - easily reactivated with slope modification, some small areas on west side are active, occasional trees, existing road system within the landslide, standing water within reactived portion. Underground reservoirs located a short distance upslope. Polygon includes an area of moderately steep slopes that could be separated into a separate polygon feature; however, it is felt that the existing slide may regress into this area.
L10	P012	519418.3	5543083.9	19409.8	42.7	49.6	28.4	89.8	2006 L-8 121	Parks and Recreation	H	R-T	Deep	6	Large	I-D	VH	N	S.Sask. West Section SSR-7	River	D	Powerhouse Slide; has seen movement post 1955. Observed at W259.
L11	P018	521725.8	5540906.2	4876.7	7.8	33.3	19.1	23.9	2006 L-6 81	Parks and Recreation	R	R-T	Shallow	4	Moderate	A	VH	Y	Seven Persons Creek Section SPC-5	Creek	D	Man-made bench (about 20 m+ wide) above this point that will help protect above business from adverse landslide affects; landslide is regressing.
L12	P093	526256.9	5541580.6	324.7	7.8	45.1	25.9	17.9	2006-L6 87	Light Industrial	Recent	T	Shallow	1	Very Small	A	VH	Y	Ross Creek Section RC-2	Creek	NC	Actively failing.
L13	P120	526037.5	5543052.6	61296.5	82.6	36.8	21.1	229.9	2006 L-8 129	Heavy Industrial	Ancient	R-T	Deep	6	Large	I-D	VH	Y	South Saskatchewan River SSR-3	River	V	Large, ancient failure referred to as the Police Point Slide. Headscarp is near vertical. Slide deposit constricts the SSR.
L14	P150	521567.1	5539484.8	4323.2	18.0	55.4	31.7	34.2	2006 L-5 62	Parks and Recreation	Ancient	R-T	Shallow	4	Moderate	I-D	VH	Y	Seven Persons Creek Section SPC-6	Creek	D	Observed at W362. Very steep slopes 80->100%. Ancient landslide.
L15	P186	520666.9	5539665.7	15509.9	31.4	53.2	30.5	61.8	2006 L-5 60	Parks and Recreation	Recent	R-T	Deep	6	Large	Active	VH	Y	Seven Persons Creek Section SPC-7A/B	Creek	D	Eagleview slide. Observed at W245, W353 and W354. Area on outside bend of SPC; actively failing; more movement apparent on east side of polygon than west side; seepage apparent. Upslope properties impacted.
L16	P189	520288.3	5539475.7	15110.7	30.2	51.8	29.7	60.9	2006 L-5 60	Parks and Recreation	R	R-T	Deep	6	Large	Active	VH	Y	Seven Persons Creek Section SPC-7A/B	Creek	D	Observed at W355 and W356. Area on outside bend of SPC, actively failing, more movement apparent on west side (characterized by large tension fractures) of polygon than east side; seepage apparent. Upslope properties impacted.
L17	P030	521963.8	5540302.6	13055.1	24.5	46.0	26.4	55.3	2006 L-6 81	Parks and Recreation	A	T	Intermediate	6	Large	I-R	H	N	Seven Persons Creek Section SPC-6	Golf Course	FR	Steep slopes, historic failures, and active erosion.
L18	P032	521917.1	5540530.5	17285.1	26.9	28.6	16.4	95.4	2006 L-6 81	Parks and Recreation	A	T	Intermediate	6	Large	I-R	H	N	Seven Persons Creek Section SPC-6	Park	FR	Steep slopes, historic failures, and active erosion.
L19	P083	525714.8	5541531.3	15492.3	40.8	32.7	18.7	127.0	2006-L6 87	Parks and Recreation	R	R	Shallow	6	Large	A	VH	N	Ross Creek Section RC-1	Park/Railway/ Gas Line	D	Observed at W300/W301 (Scholten slide), active landslides, polygon is bounded to E by City's gas line, monitoring wells present at crest.
L20	P149	521767.3	5539434.4	17815.1	36.2	52.9	30.3	71.9	2006 L-5 62	Parks and Recreation	Ancient	R-T	Intermediate	6	Large	I-R	VH	N	Seven Persons Creek Section SPC-6	Golf Course	D	Observed at W292, W360/61. Very steep slopes with sections >100% with numerous seepage zones. Numerous ancient translational slides. SPC floodplain below on which golf course is located.

Medicine Hat Landslide Database

Lndsld_Nm	PolygonNum	UTM12_X	UTM12_Y	Lndsl_Sz	Slp_Hght	Slp_Prcnt	Slp_Dgrs	Slp_Lngth	AP_Ref	Landuse	Lndsld_Age	Lndsld_Typ	Lndsld_Dpt	Lndsld_Cls	Lndsld_Size_ Descrption	Dgr_Lndsld	Pot_Lndsld	Wtrcrs	Slp_Sctn	EstPot_Run	Fld_Chckd	Comments
L21	P157	521444.0	5539938.8	10208.6	35.5	53.7	30.8	69.4	2006 L-5 61	Parks and Recreation	Recent	R-T	Shallow	6	Large	A	VH	Y	Seven Persons Creek Section SPC-6	Creek	V	On outside bend of SPC; portion of slope being undercut by SPC; actively sloughing and eroding. Most sections >100%. Pedestrian bridge at toe of slope.
L22	P181	520916.7	5539064.4	6036.5	25.9	82.5	47.3	35.3	2006 L-5 61	Urban Reserve	A	R-T	Intermediate	5	Moderately Large	I-R	VH	N	Seven Persons Creek Section SPC-6	Golf Course	NC	Ancient failure with potentially, smaller historic failures noted, actively eroding and creeping with small sloughs noted, large areas of very steep slopes >80% with sections >100%, numerous seepage zones.
L23	P205	520709.6	5539347.0	2320.0	6.9	24.6	14.1	28.5	2006 L-5 60	Urban Reserve	Ancient	R-T	Intermediate	3	Moderately Small	I-D	VH	N	Seven Persons Creek Section SPC-7A/B	Urban Reserve	V	Located on outside bend of SPC, no recent movement within this polygon but SPC has just about eroded through to the golf course.
L24	P198	520154.9	5538615.0	7192.3	20.4	64.4	36.9	34.0	2006 L-5 60	Urban Reserve	Ancient	R-T	Intermediate	5	Moderately Large	R	VH	Y	Seven Persons Creek Section SPC-7A/B	Urban Reserve/Creek	V	Very steep slope Section RC-10->100%, north end of polygon is being undercut by SPC.
L25	P208	519760.7	5538627.8	3148.6	16.6	58.5	33.5	30.1	2006 L-4 43	Urban Reserve	Recent	R-T	Intermediate	4	Moderate	A	VH	Y	Seven Persons Creek Section SPC-7A/B	Creek	NC	Very steep (>100%) actively eroding and sloughing slope, located on outside bend of SPC (and frequently flooded area), actively being undercut.
L26	P211	519481.9	5538339.4	10068.0	24.2	52.0	29.8	48.7	2006 L-4 43	Urban Reserve	Recent	R-T	Intermediate	6	Large	A	VH	Y	Seven Persons Creek Section SPC-7A/B	Creek	D	Observed at W352 at Cactus Coulee. Actively failing and regressing into upslope properties, located on outer bend of SPC. Creek undergoes a very tight bend at this point.
L27	P215	519288.6	5537731.4	14331.1	24.9	55.8	31.9	47.1	2006 L-4 43	Urban Reserve	Historic	T	Shallow	6	Large	A	VH	Y	Seven Persons Creek Section SPC-7A/B	Creek	TR	Very steep slopes on outer bend of SPC, tension cracks apparent upslope of the headscarp. Polygon includes upslope gentle sloping terrain since it is showing a moderate rate of soil creep associated with movement of the steeper slopes below.
L28	P240	519088.2	5537928.8	2675.5	10.8	57.8	33.1	19.7	2006 L-4 42	Parks and Recreation	R	T	Shallow	4	Moderate	A	VH	Y	Seven Persons Creek Section SPC-7A/B	Creek	D	Canyon Creek Slide. Observed from W246. Recent translational landslide in July 2011, slope on outer bend of SPC and actively being undercut. New subdivision (Canyon Creek upslope from this polygon).
L29	P243	518978.3	5537663.3	8300.3	22.0	52.3	29.9	44.1	2006 L-4 42	Parks and Recreation	Ancient	R-T	Intermediate	5	Moderately Large	R	H	Y	Seven Persons Creek Section SPC-7A/B	Creek	V	Steep to very steep area. Feature is an ancient failure with reactivated areas that are actively sloughing and eroding. Located on outer bend of SPC. Seepage zones are characteristic.
L30	P472	513718.7	5544207.0	3937.4	32.0	42.8	24.5	77.2	2006 L-9 135	Cypress County	A	R	Intermediate	4	Moderate	I-D	VH	Y	S. Sask. River West Section SSR-10	River	D	Observed at W349. Steep slope with active seepage. Oversteepened at toe. Located on outside bend of SSR.
L31	P253	513804.2	5544253.5	27996.2	88.7	33.4	19.1	270.4	2006 L-9 135	Cypress County	R	T	Deep	6	Large	A	VH	Y	S. Sask. River West Section SSR-11	River	D	Observed at W266 and W348.Cypress County TWP Rd 130 Slide. Progressive failure. Substantial movement first noted by owner (and observed on GoogleEarth) in 2005, large movement in Nov 2006 according to owner. Currently measures about 12 m deep to bedrock and 125 m wide. Large tension cracks located upslope of headscarp, substantial seepage. Headscarp within 10 m of the upslope property boundary. Failure involved earth only-not bedrock.
L32	P254	513909.7	5544233.5	14023.1	82.7	59.1	33.8	148.4	2006 L-9 135	Cypress County	A	R-T	Intermediate	6	Large	I-D	VH	Y	S. Sask. River West Section SSR-10	River	FR	Very steep slopes on outer bend of SSR. Active seepage. Properties above on septic fields and have large ponds.
L33	P255	514051.4	5544223.9	29003.8	78.0	47.3	27.1	171.3	2006 L-9 135	Cypress County	A	R-T	Intermediate	6	Large	I-D	VH	Y	S. Sask. River West Section SSR-10	River	D	Observed at W265. Overall slope angle about 50% but the 135 m long slope contains steep pitches up to 80% - 99% and >100% at the toe of the slope along the outer bend of SSR.
L34	P257	514300.0	5544261.3	54979.3	81.6	36.9	21.2	226.0	2006 L-9 135	Cypress County/Parks and Recreation	A	R-T	Deep	6	Large	I-D	VH	Y	S. Sask. River West Section SSR-10	River	D	Observed at W343. Redcliff Pumphouse Slide. Variable slope gradients over the slide track that contain some very steep sections >100%. Headscarp is near-vertical in till. Failure is primarily a rock slump/slide.
L35	P259	514602.4	5544334.7	21469.1	46.2	28.4	16.3	165.0	2006 L-9 135	Parks and Recreation	A	T	Intermediate	6	Large	I-D	VH	Y	S. Sask. River West Section SSR-10	River	V	Concave slide track with steep headscarp at 80% - 99%.
L36	P262	514827.7	5544405.1	4145.6	46.8	58.8	33.7	84.4	2006 L-9 136	Parks and Recreation	A	T	Intermediate	4	Moderate	I-D	VH	Y	S. Sask. River West Section SSR-10	River	V	Ancient rock slide, very steep headscarp region at 80% - 99%. River flows along toe.
L37	P267	517284.0	5544109.2	89709.6	55.3	14.5	8.3	381.4	2006 L-9 139	Urban Reserve	R	R-T	Deep	6	Large	A	VH	Y	S. Sask. River West Section SSR-9A/B	Creek	NC	Complex slope morphology within this coulee that drains into the SSR, indicating development of a large landslide (in the order of the Cypress County TWP Road 130 slide). Since 1999, a large tension cracks have developed near the crest of the slope. Slope gradient mapping suggests that slopes in the area of the initiation zone are <60%. It appears that a tote road to the initiation zone may have been pioneered and some erosion controls installed along this road.

Medicine Hat Landslide Database

Lndsld_Nm	PolygonNum	UTM12_X	UTM12_Y	Lndsl_Sz	Slp_Hght	Slp_Prcnt	Slp_Dgrs	Slp_Lngth	AP_Ref	Landuse	Lndsld_Age	Lndsld_Typ	Lndsld_Dpt	Lndsld_Cls	Lndsld_Size_ Descrption	Dgr_Lndsld	Pot_Lndsld	Wtrcrs	Slp_Sctn	EstPot_Run	Fld_Chckd	Comments
L38	P331	524602.4	5546609.4	289547.9	50.4	23.2	13.3	219.2	2006 L-10 172, 2006 L-11 193	Urban Reserve District	A	R-T	Deep	7	Very Large	A	VH	Y	S. Sask. River North Section SSR-1A/B/C	River	V	Known as Rattlesnake Slide, progressively failing due to undercutting by SSR (polygon is located on outside bend of SSR). Slopes at crest are >100%. Seepage characteristic of south end of slide - northern portion of the slide is drier. (Gas?) facilities located very close to headscarp.
L39	P335	522843.3	5548439.8	534860.5	63.8	30.2	17.3	214.4	2006 L-12 212, 211, 210; 2006 L-13 223	Urban Reserve District/Direct Control District	A	R-T	Deep	7	Very Large	A	VH	Y	S. Sask. River North Section SSR-1A/B/C	River	V	Known as Fertilizer Plant Slide, progressively failing due to undercutting by SSR (polygon is located on outside bend of SSR). Slopes at crest are >100%. Seepage characteristic of the entire slide area. Most recent activity has been shallow translational failures.
L40	P343	520736.4	5550808.8	48227.7	31.1	31.9	18.3	99.1	2006 L-14 234	Direct Control District	A	T	Deep	6	Large	I-D	H	Y	S. Sask. River North Section SSR-1A/B/C	Creek	NC	Appears to be an ancient, large translational failure. Slopes form a section of the southern slopes of this deep coulee. An impounded lake is directly upstream to the west. Slopes are generally <59%, but the creek is currently downcutting through the toe of the slope creating oversteepended slopes that have experienced previous failures (extending upslope to mid-polygon elevation. The initial downcutting appears to be rapid and appears to be the result of the earth dam being breached a short distance upstream. A farm (cattle) exists at the toe of the slope.
L41	P345	521162.6	5550708.9	73295.2	44.9	26.3	15.0	172.9	2006 L-14 235	Direct Control District	A	R-T	Deep	6	Large	I-D	H	Y	S. Sask. River North Section SSR-1A/B/C	Creek	NC	Ancient failure. Headscarp is typically <59% but with pitches up to 79%. Steeper slope sections show a high rate of soil creep in connection with seepage.
L42	P346	521183.2	5550893.0	83750.4	44.4	21.6	12.4	207.3	2006 L-14 235	Direct Control District	A	R-T	Deep	6	Large	I-D	H	Y	S. Sask. River North Section SSR-1A/B/C	Creek	NC	Ancient failure. Headscarp is typically <59% but with pitches up to 69%. Lower slopes just above the creek are very steep (up to 100%) and show active erosion.
L43	P158	521337.2	5539870.0	2748.2	36.1	60.9	34.9	63.1	2006 L-5 61	Parks and Recreation	Recent	R-T	Deep	4	Moderate	A	VH	Y	Seven Persons Creek Section SPC-6	Creek	V	On outside bend of SPC, slope being undercut by SPC, actively sloughing and eroding. Most sections >100%; air photos potentially show a large tension crack extending the width of the polygon at about mid-polygon elevation.
L44	P425	514777.6	5544320.9	1120.9	16.6	57.2	32.7	30.8	2006 L-9 136	Parks and Recreation	A	T	Shallow	3	Moderately Small	I-D	H	Y	S. Sask. River West Section SSR-10	River	V	Steep slopes (up to 70% - 79%), displays a high rate of soil creep. River flows along toe.
L45	P465	520916.7	5539064.4	9455.2	25.8	54.8	31.4	49.5	2006 L-5 61	Urban Reserve	A	R-T	Intermediate	5	Moderately Large	I-R	VH	N	Seven Persons Creek Section SPC-6	Golf Course	NC	Ancient failure with potentially, smaller historic failures noted, actively eroding and creeping with small sloughs noted; large areas of very steep slopes >80% with sections >100%, numerous seepage zones.
L46	P517	524231.5	5549758.0	292955.3	63.0	50.8	26.9	139.0	2006 L-12 213, 214, 215; 2006 L-13 226, 227	Outside City Limits	A	R-T	Deep	7	Very Large	A	VH	Y	S. Sask. River North Section SSR-1A/B/C	River	V	Known as Evilsmelling Bluffs Slide; progressively failing due to undercutting by SSR (polygon is located on outside bend of SSR). Occasional seepage areas noted. Actively moving on west end where large tension cracks noted at mid and upper elevations.

APPENDIX H

APPENDIX H AIR PHOTO INVENTORY

Appendix H: Aerial Photograph Inventory

Year	Flight Line	Photo Numbers	Color/B&W	Scale	Coverage of Study Area
2006	AG0602	1-237	Color	1:8,000	Full
2002	GRS2003	1-289	Color	1:8,000	Full
1995	E95-014	228-275	B&W	1:10,000	Partial
1981	YC 8125	1-59 and 61-102	B&W	1:20,000	Full, except missing Photo 60 in riverside neighbourhood.
1975	MA 923	1-98, 100-118, 120-131, and 136	B&W	1:24,000	Full, except missing Photos 99 and 119.
1962	YC 473	50-61, 66-68, 70, 72, 74, 76-79, 80-87, 89, and 91-94	B&W	1:12,000	Partial
1962	YC 475	2-17	B&W	1:12,000	Partial
1955	55-48/1	1-29	B&W	1:6,000	
1955	55-48/2	1-29	B&W	1:6,000	
1955	55-48/3	1-15 and 19-29	B&W	1:6,000	
1955	55-48/4	1-15, 19-21, 23-24, 27, and 29-30	B&W	1:6,000	
1955	55-48/5	1-15, 18-22, 24, and 27-29	B&W	1:6,000	
1955	55-48/7	9-28	B&W	1:6,000	
1955	55-48/8	9-30	B&W	1:6,000	
1955	55-48/9	9-30	B&W	1:6,000	
1955	55-48/10	10-30	B&W	1:6,000	

APPENDIX I

APPENDIX I TRAVERSE MAP AND FIELD CHECK MAP

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix001_Traverse.mxd modified 4/3/2014 by stephanie.leusink

13000 14000 15000 16000 17000 18000 19000

5553000 5552000 5551000 5550000 5549000 5548000 5547000 5546000

N W E S

Trans-Canada Hwy

Redcliff

South Saskatchewan River

Redcliff Pumphouse Slide

Echodale Regional Park

268 357 252 250 251 350 351 348 346 349 265 347 343 345 264 253 254 337 335 336

LEGEND

Observation Point

- Aug 02 2011
- Aug 03 2011
- Aug 04 2011
- Aug 05 2011
- Aug 06 2011
- Aug 07 2011
- Aug 08 2011
- Aug 09 2011
- Aug 10 2011

Traverse Route

- Aug 02 2011
- Aug 03 2011
- Aug 04 2011 (Helicopter)
- Aug 05 2011
- Aug 06 2011
- Aug 07 2011
- Aug 08 2011
- Aug 09 2011 (Helicopter)
- Aug 10 2011

- Road
- City Boundary
- River / Creek

NOTES
Base data source: City of Medicine Hat

A B C D E F

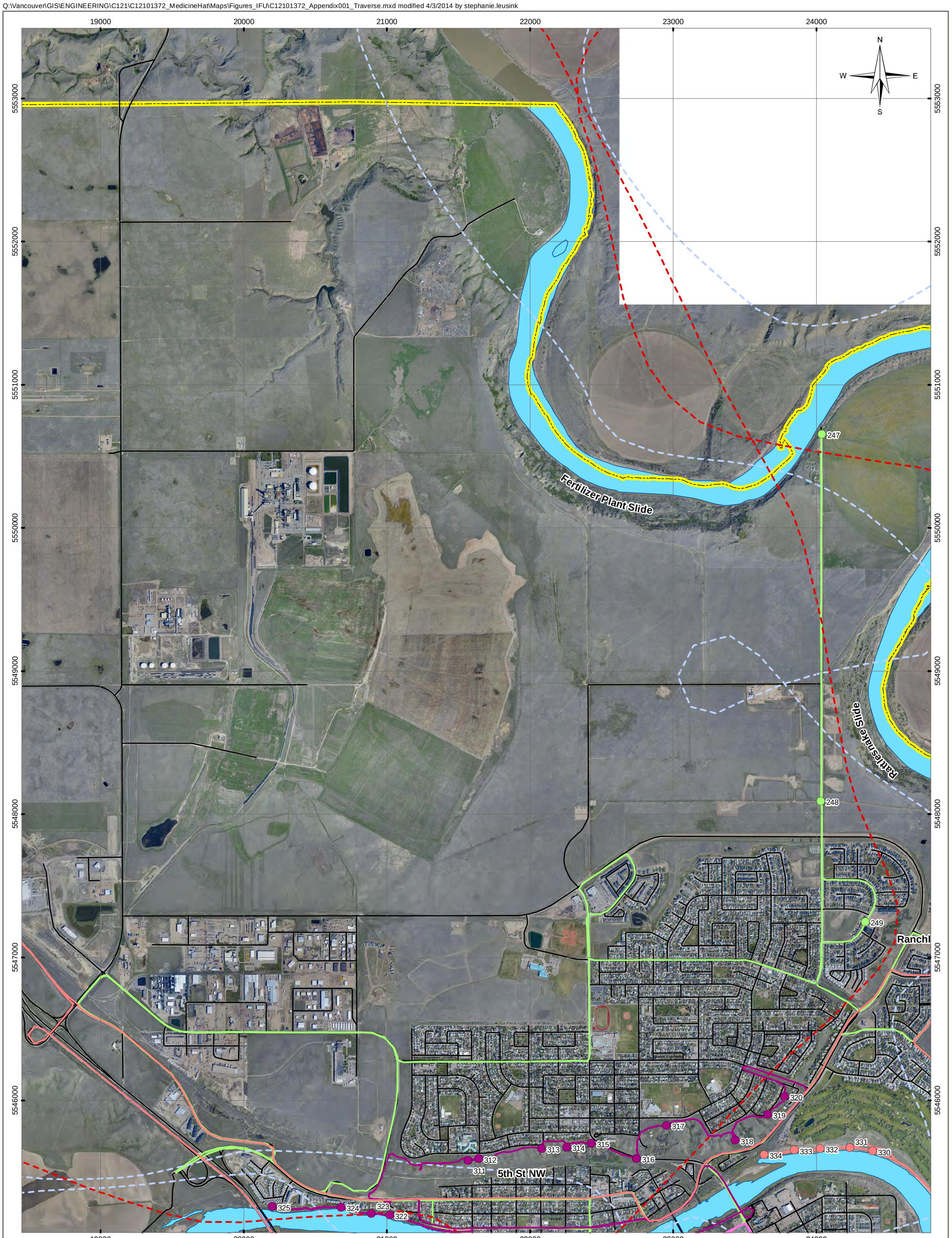
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Traverse Routes and Observation Points

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Appendix001_Traverse.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure I-1A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix001_Traverse.mxd modified 4/3/2014 by stephanie.leusink

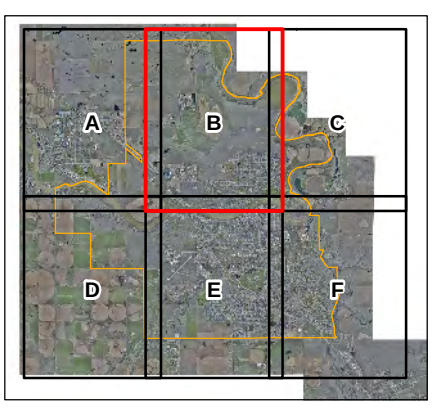


LEGEND

Observation Point	Traverse Route
Aug 02 2011	Aug 02 2011
Aug 03 2011	Aug 03 2011
Aug 04 2011	Aug 04 2011 (Helicopter)
Aug 05 2011	Aug 05 2011
Aug 06 2011	Aug 06 2011
Aug 07 2011	Aug 07 2011
Aug 08 2011	Aug 08 2011
Aug 09 2011	Aug 09 2011 (Helicopter)
Aug 10 2011	Aug 10 2011

Road
City Boundary
River / Creek

NOTES
Base data source: City of Medicine Hat



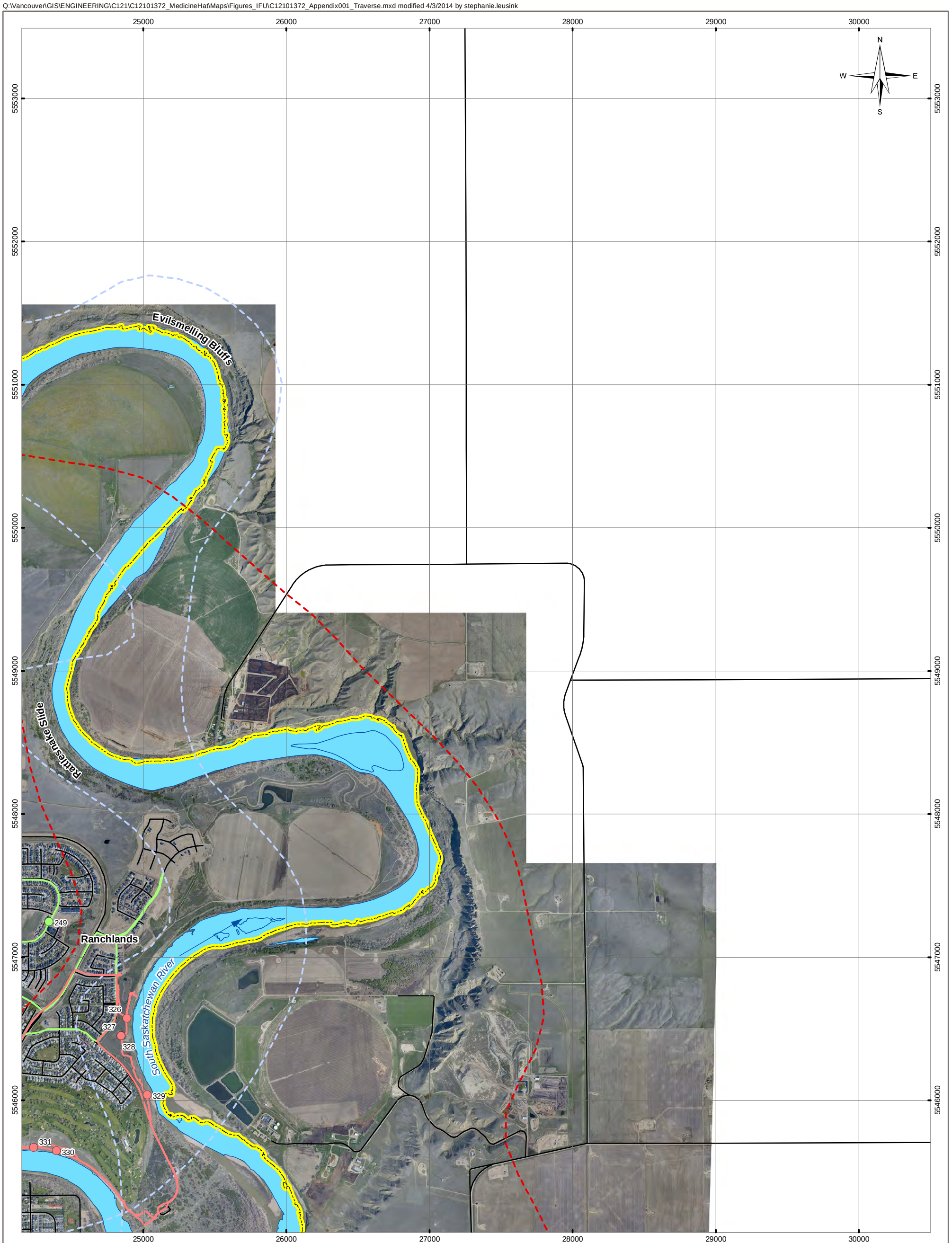
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Traverse Routes and Observation Points

PROJECTION: UTM Zone 12 (3TM)		DATUM: NAD83		CLIENT: City of Medicine Hat
Scale: 1:25,000 (500 250 0 500 Metres)				
FILE NO.: C12101372_Appendix001_Traverse.mxd				A TETRA TECH COMPANY
PROJECT NO.: C12101372	DWN: MEZ	CKD: SL	APVD: SH	REV: 0
OFFICE: EBA-VANC	DATE: April 3, 2014			Figure I-1B

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix001_Traverse.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

Observation Point

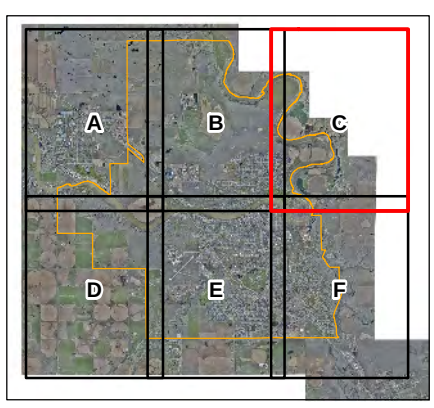
- Aug 02 2011
- Aug 03 2011
- Aug 04 2011
- Aug 05 2011
- Aug 06 2011
- Aug 07 2011
- Aug 08 2011
- Aug 09 2011
- Aug 10 2011

Traverse Route

- Aug 02 2011
- Aug 03 2011
- Aug 04 2011 (Helicopter)
- Aug 05 2011
- Aug 06 2011
- Aug 07 2011
- Aug 08 2011
- Aug 09 2011 (Helicopter)
- Aug 10 2011

- Road
- City Boundary
- River / Creek

NOTES
Base data source: City of Medicine Hat



STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Traverse Routes and Observation Points

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Appendix001_Traverse.mxd				eba A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure I-1C**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix001_Traverse.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

Observation Point

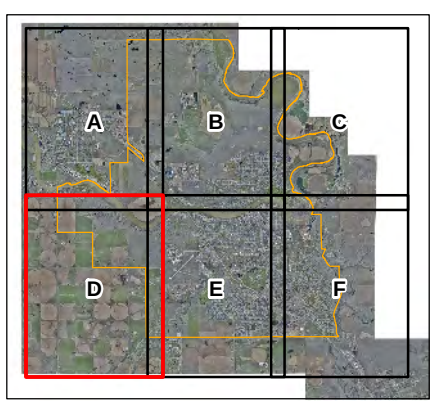
- Aug 02 2011
- Aug 03 2011
- Aug 04 2011
- Aug 05 2011
- Aug 06 2011
- Aug 07 2011
- Aug 08 2011
- Aug 09 2011
- Aug 10 2011

Traverse Route

- Aug 02 2011
- Aug 03 2011
- Aug 04 2011 (Helicopter)
- Aug 05 2011
- Aug 06 2011
- Aug 07 2011
- Aug 08 2011
- Aug 09 2011 (Helicopter)
- Aug 10 2011

- Road
- City Boundary
- River / Creek

NOTES
Base data source: City of Medicine Hat



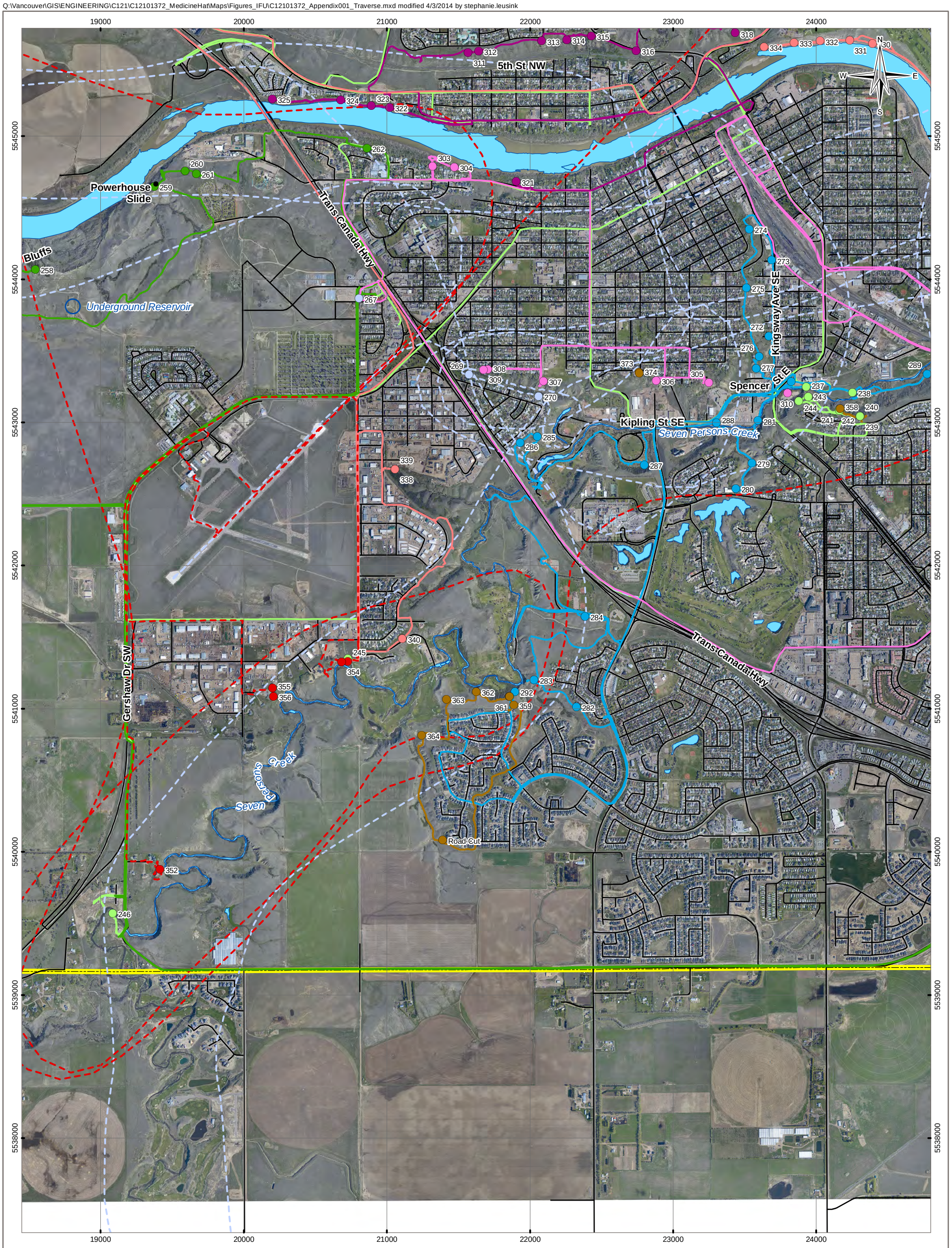
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Traverse Routes and Observation Points

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Appendix001_Traverse.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure I-1D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix001_Traverse.mxd modified 4/3/2014 by stephanie.leusink



LEGEND

Observation Point

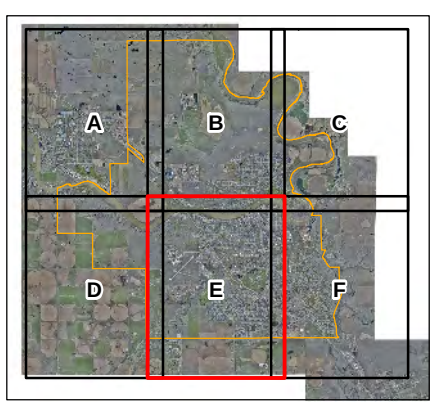
- Aug 02 2011
- Aug 03 2011
- Aug 04 2011
- Aug 05 2011
- Aug 06 2011
- Aug 07 2011
- Aug 08 2011
- Aug 09 2011
- Aug 10 2011

Traverse Route

- Aug 02 2011
- Aug 03 2011
- Aug 04 2011 (Helicopter)
- Aug 05 2011
- Aug 06 2011
- Aug 07 2011
- Aug 08 2011
- Aug 09 2011 (Helicopter)
- Aug 10 2011

- Road
- City Boundary
- River / Creek

NOTES
Base data source: City of Medicine Hat



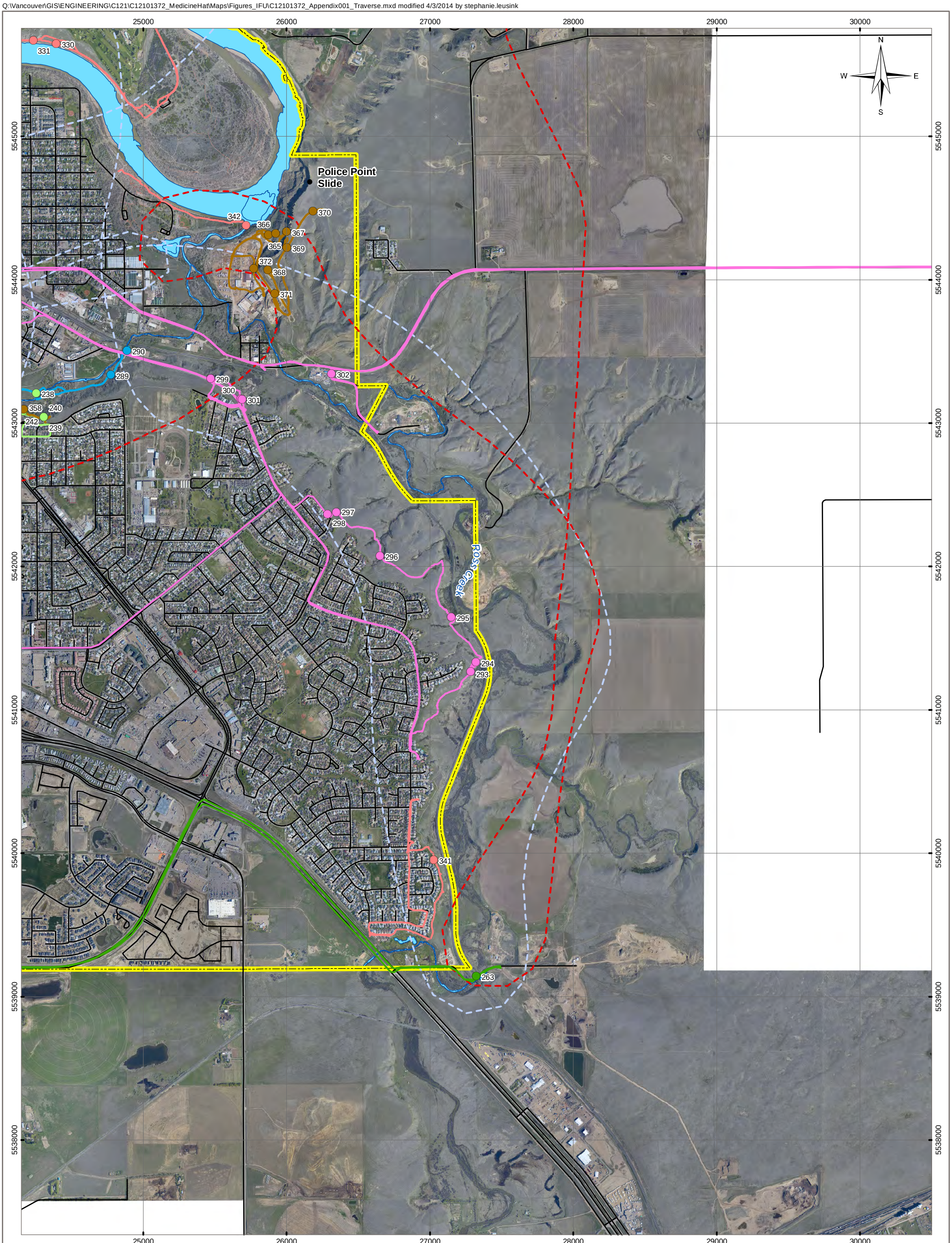
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Traverse Routes and Observation Points

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Appendix001_Traverse.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure I-1E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix001_Traverse.mxd modified 4/3/2014 by stephanie.leusink

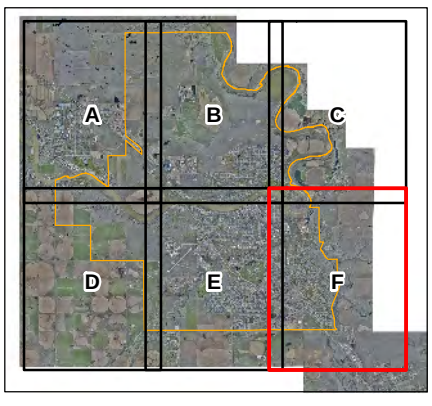


LEGEND

Observation Point	Traverse Route
Aug 02 2011	Aug 02 2011
Aug 03 2011	Aug 03 2011
Aug 04 2011	Aug 04 2011 (Helicopter)
Aug 05 2011	Aug 05 2011
Aug 06 2011	Aug 06 2011
Aug 07 2011	Aug 07 2011
Aug 08 2011	Aug 08 2011
Aug 09 2011	Aug 09 2011 (Helicopter)
Aug 10 2011	Aug 10 2011

Road
City Boundary
River / Creek

NOTES
Base data source: City of Medicine Hat



STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Traverse Routes and Observation Points

PROJECTION: UTM Zone 12 (3TM)			DATUM: NAD83	CLIENT: City of Medicine Hat	
Scale: 1:25,000 (500 250 0 500 Metres)					
FILE NO.: C12101372_Appendix001_Traverse.mxd					
PROJECT NO.: C12101372	DWN: MEZ	CKD: SL	APVD: SH	REV: 0	
OFFICE: EBA-VANC	DATE: April 3, 2014				

eba A TETRA TECH COMPANY

Figure I-1F

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix002_FieldCheck.mxd modified 4/3/2014 by stephanie.leusink

13000 14000 15000 16000 17000 18000 19000

5553000 5552000 5551000 5550000 5549000 5548000 5547000 5546000

N W E S

P358 P353 P357 P354 P352 P356 P421 P363 P355 P349 P350 P348 P351

Trans-Canada Hwy

Redcliff

P431 P265 P268 P266 P267 P429 P430

South Saskatchewan River

P455 P456 P458 P457 P454 P472 P253 P255 P257 P262 P259 P426 P261 P258 P260 P263 P432 P383 P251 P460 P254 P252 P423 P422 P428 P427 P256 P384 P385 P386 P264 P387 P388 P393 P394 P395 P396

Redcliff Pumphouse Slide

Echodale Regional Park

13000 14000 15000 16000 17000 18000 19000

LEGEND

Field Check

- Detailed Review (D)
- Foot Traverse Review (FR)
- Truck Traverse Review (TR)
- Visual Inspection (V)
- Not Checked (NC)

- Road
- City Boundary
- River / Creek

A B C D E F

NOTES
Base data source: City of Medicine Hat

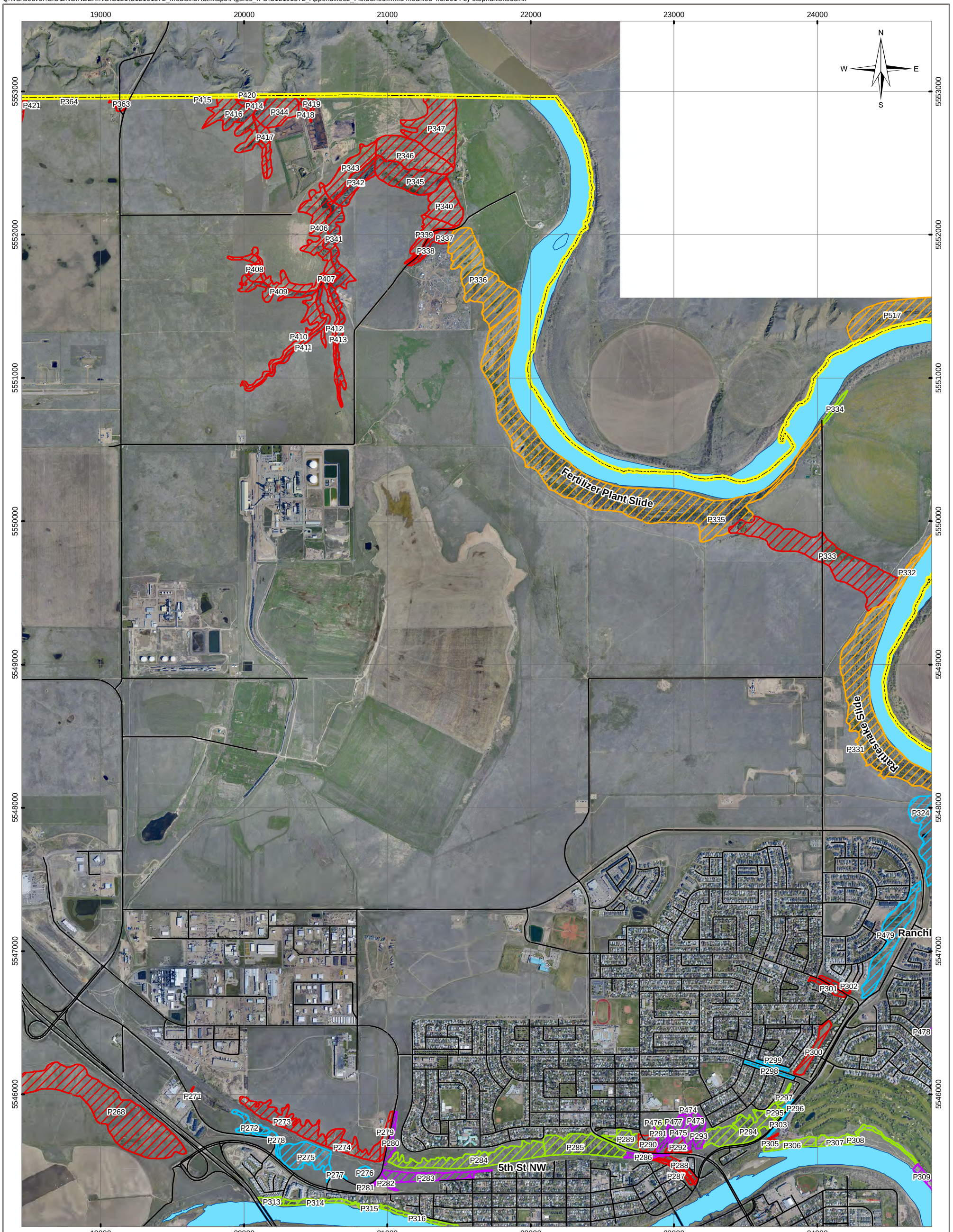
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Terrain Polygons Field Check

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				
FILE NO. C12101372_Appendix002_FieldCheck.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure I-2A**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix002_FieldCheck.mxd modified 4/3/2014 by stephanie.leusink

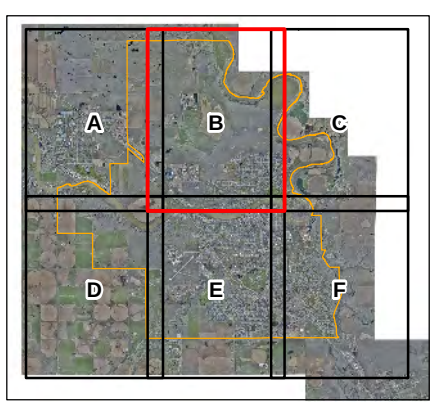


LEGEND

Field Check

- Detailed Review (D)
- Foot Traverse Review (FR)
- Truck Traverse Review (TR)
- Visual Inspection (V)
- Not Checked (NC)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

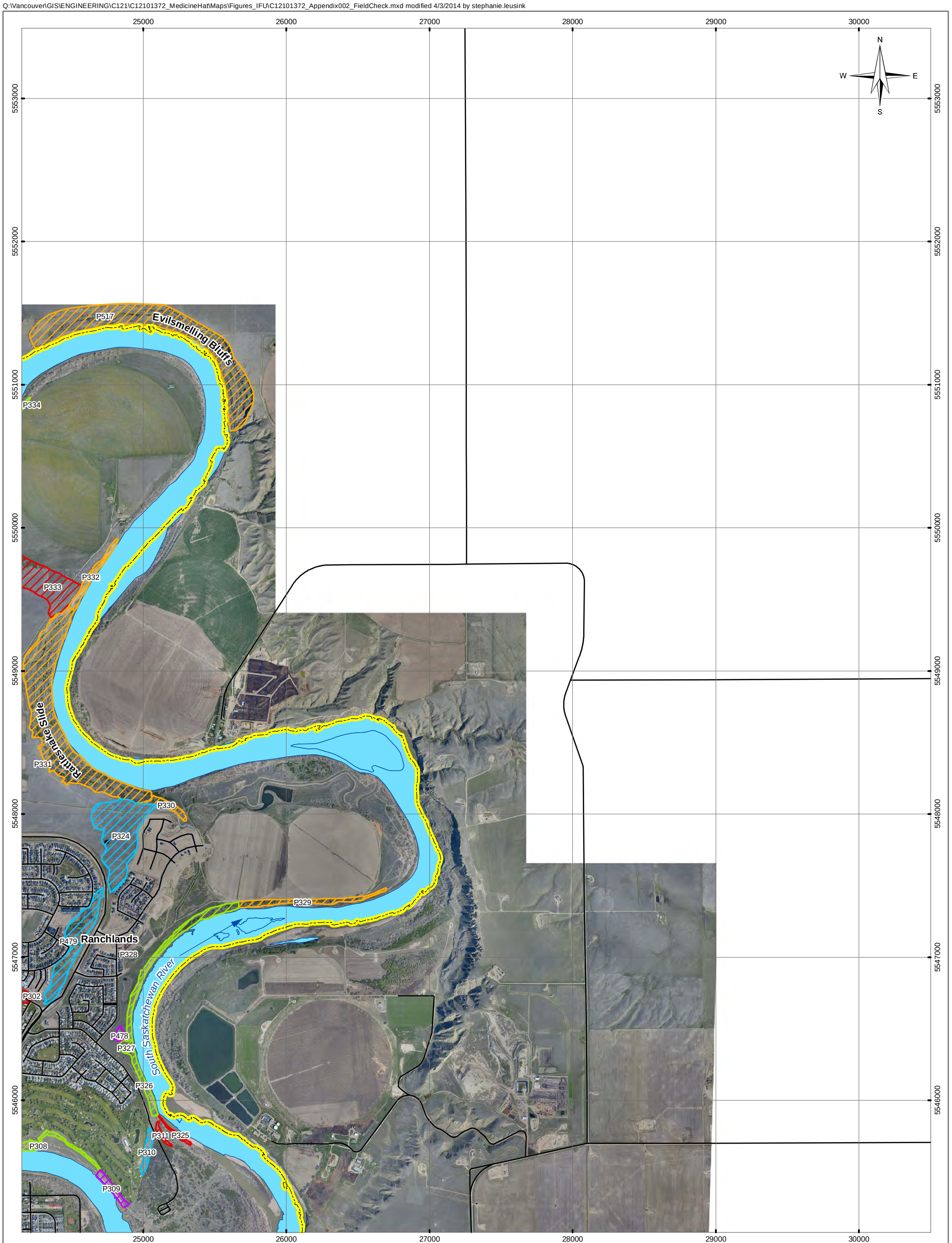
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Terrain Polygons Field Check

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				
FILE NO. C12101372_Appendix002_FieldCheck.mxd				A TETRA TECH COMPANY
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure I-2B**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix002_FieldCheck.mxd modified 4/3/2014 by stephanie.leusink

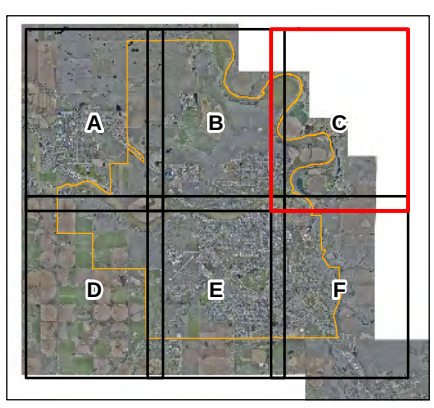


LEGEND

Field Check

- Detailed Review (D)
- Foot Traverse Review (FR)
- Truck Traverse Review (TR)
- Visual Inspection (V)
- Not Checked (NC)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Terrain Polygons
Field Check

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat	
Scale: 1:25,000 — 500 250 0 500 — Metres					
FILE NO. C12101372_Appendix002_FieldCheck.mxd				A TETRA TECH COMPANY	
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0	**Figure I-2C**
OFFICE EBA-VANC	**DATE** April 3, 2014				

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix002_FieldCheck.mxd modified 4/3/2014 by stephanie.leusink

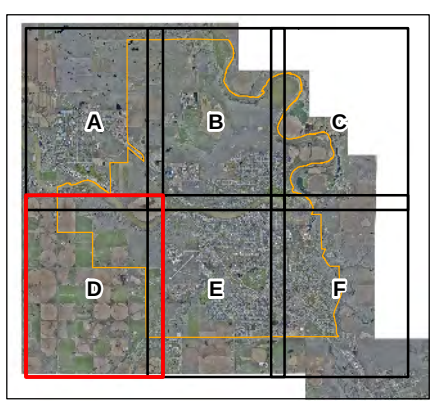


LEGEND

Field Check

- Detailed Review (D)
- Foot Traverse Review (FR)
- Truck Traverse Review (TR)
- Visual Inspection (V)
- Not Checked (NC)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

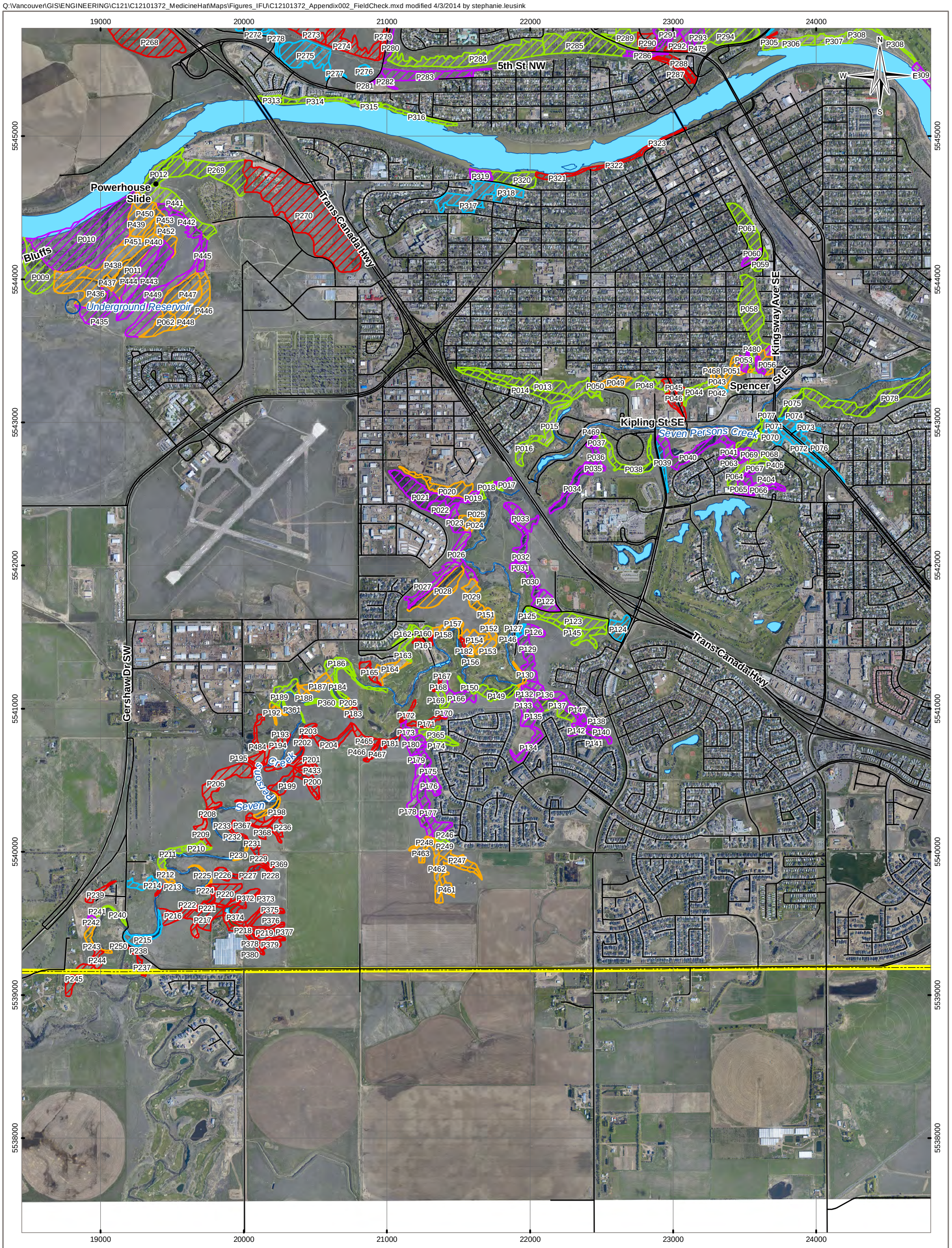
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Terrain Polygons Field Check

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Appendix002_FieldCheck.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure I-2D**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix002_FieldCheck.mxd modified 4/3/2014 by stephanie.leusink

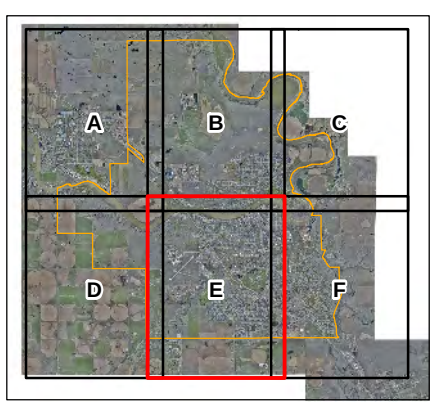


LEGEND

Field Check

- Detailed Review (D)
- Foot Traverse Review (FR)
- Truck Traverse Review (TR)
- Visual Inspection (V)
- Not Checked (NC)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

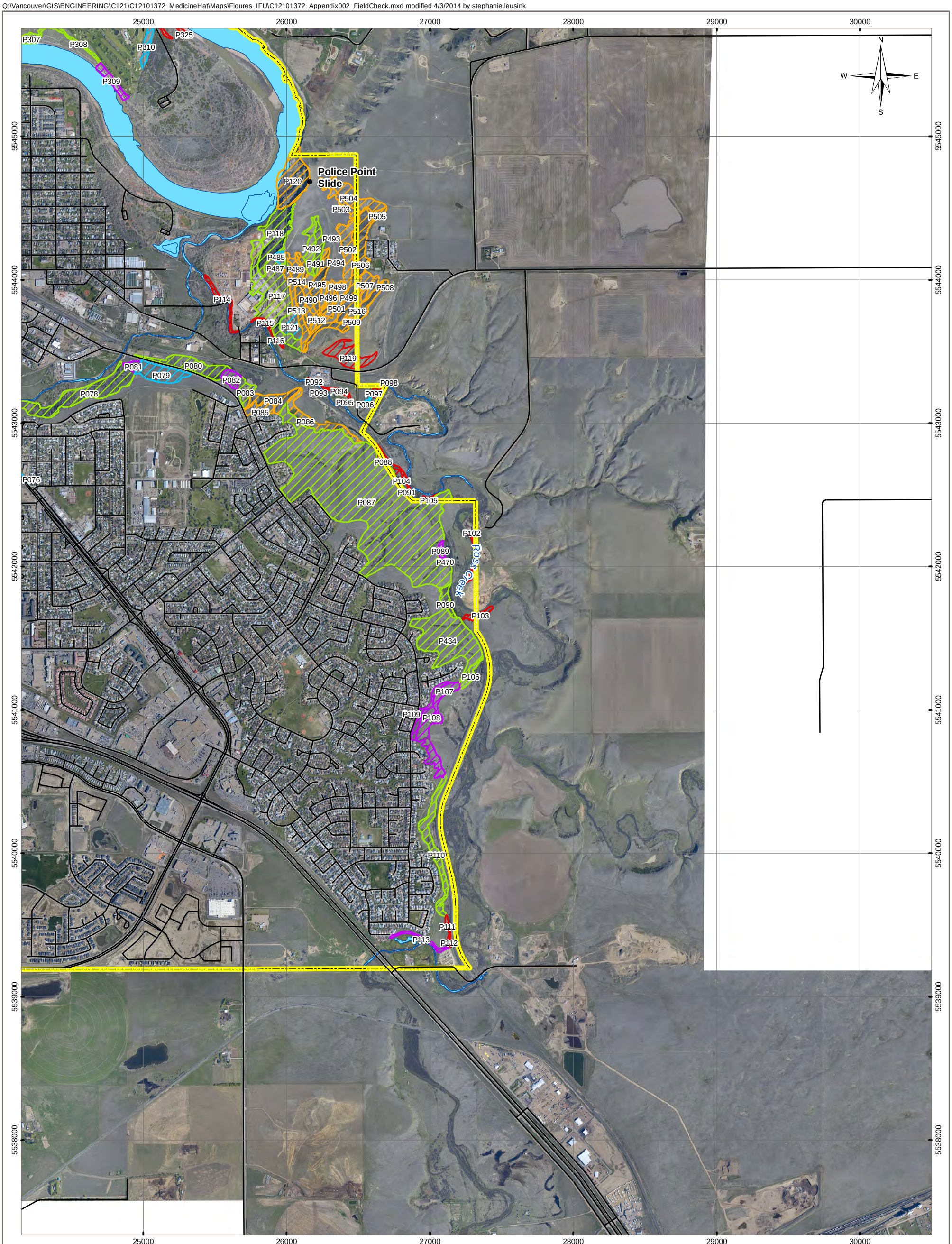
STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Terrain Polygons
Field Check

PROJECTION UTM Zone 12 (3TM)			**DATUM** NAD83	**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Appendix002_FieldCheck.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure I-2E**

Q:\Vancouver\GIS\ENGINEERING\C121\C12101372_MedicineHat\Maps\Figures_IFU\C12101372_Appendix002_FieldCheck.mxd modified 4/3/2014 by stephanie.leusink

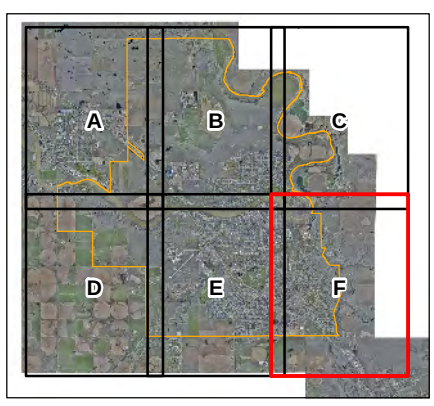


LEGEND

Field Check

- Detailed Review (D)
- Foot Traverse Review (FR)
- Truck Traverse Review (TR)
- Visual Inspection (V)
- Not Checked (NC)

- Road
- City Boundary
- River / Creek



NOTES
Base data source: City of Medicine Hat

STATUS
ISSUED FOR USE

MEDICINE HAT SLOPE SETBACKS

Terrain Polygons Field Check

PROJECTION UTM Zone 12 (3TM)		**DATUM** NAD83		**CLIENT** City of Medicine Hat
Scale: 1:25,000 — 500 250 0 500 — Metres				eba A TETRA TECH COMPANY
FILE NO. C12101372_Appendix002_FieldCheck.mxd				
PROJECT NO. C12101372	**DWN** MEZ	**CKD** SL	**APVD** SH	**REV** 0
OFFICE EBA-VANC	**DATE** April 3, 2014			**Figure I-2F**

APPENDIX J

APPENDIX J SELECTED PHOTOGRAPHS OF AREAS REPRESENTED BY CROSS-SECTIONS

INTERIOR SLOPES



Photo 1: IS-1 Clay Mine



Photo 2: IS-1 Clay Mine



Photo 3: IS-2 Above Kingsway



Photo 4: IS-2 Above Kingsway



Photo 5: IS-2 Above Kingsway



Photo 6: IS-3 Below 13 Street SE



Photo 7: IS-4 Above 5 Street NW



Photo 8: IS-4 Above 5 Street NW



Photo 9: IS-5 Above Power Plant

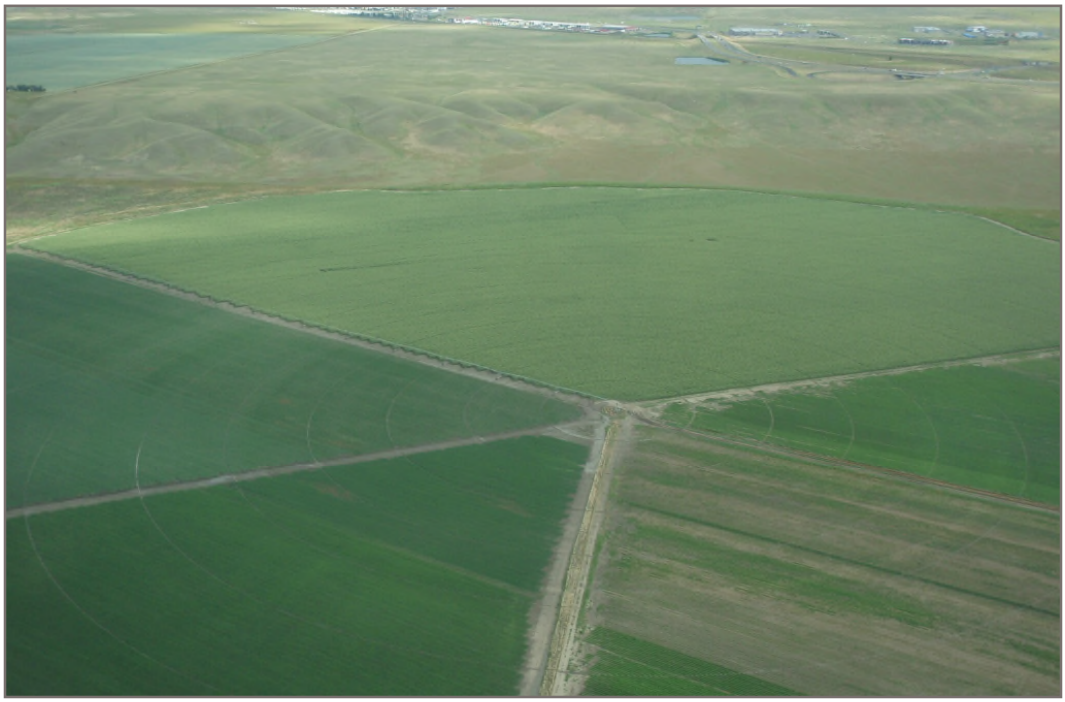


Photo 10: IS-6 Near Redcliff



Photo 11: IS-7 Echo Dale



Photo 12: IS-7 Echo Dale



Photo 13: NE Interior Slopes

ROSS CREEK



Photo 1: Ross Creek RC-1



Photo 2: Ross Creek RC-2



Photo 3: Ross Creek RC-3



Photo 4: Ross Creek RC-3



Photo 5: Ross Creek RC-3



Photo 6: Ross Creek RC-3



Photo 7: Ross Creek RC-4

SEVEN PERSONS CREEK



Photo 1: Seven Persons Creek 7A and 7B



Photo 2: Seven Persons Creek 7A and 7B



Photo 3: Seven Persons Creek 7A and 7B



Photo 4: Seven Persons Creek 7A and 7B



Photo 5: Seven Persons Creek 7A and 7B



Photo 6: Seven Persons Creek 7A and 7B



Photo 7: Near Highway 1 Crossing



Photo 8: Near Highway 1 Crossing



Photo 9: SPC-1 ADM Slide



Photo 10: SPC-1 ADM Slide



Photo 11: SPC-1 ADM Slide



Photo 12: SPC-1 ADM Slide



Photo 13: SPC-1 ADM Slide



Photo 14: SPC-1 ADM Slide



Photo 15: SPC-1 ADM Slide



Photo 16: SPC-2 Malborough



Photo 17: SPC-3 East Kin Coulee



Photo 18: SPC-4 Kin Coulee Park



Photo 19: SPC-4 Kin Coulee Park



Photo 20: SPC-4 Kin Coulee Park



Photo 21: SPC-5 Industrial Zone



Photo 22: SPC-6 Near Sunset Drive



Photo 23: SPC-6 Near Sunset Drive



Photo 24: SPC-6 Near Sunset Drive



Photo 25: SPC-6 Near Sunset Drive

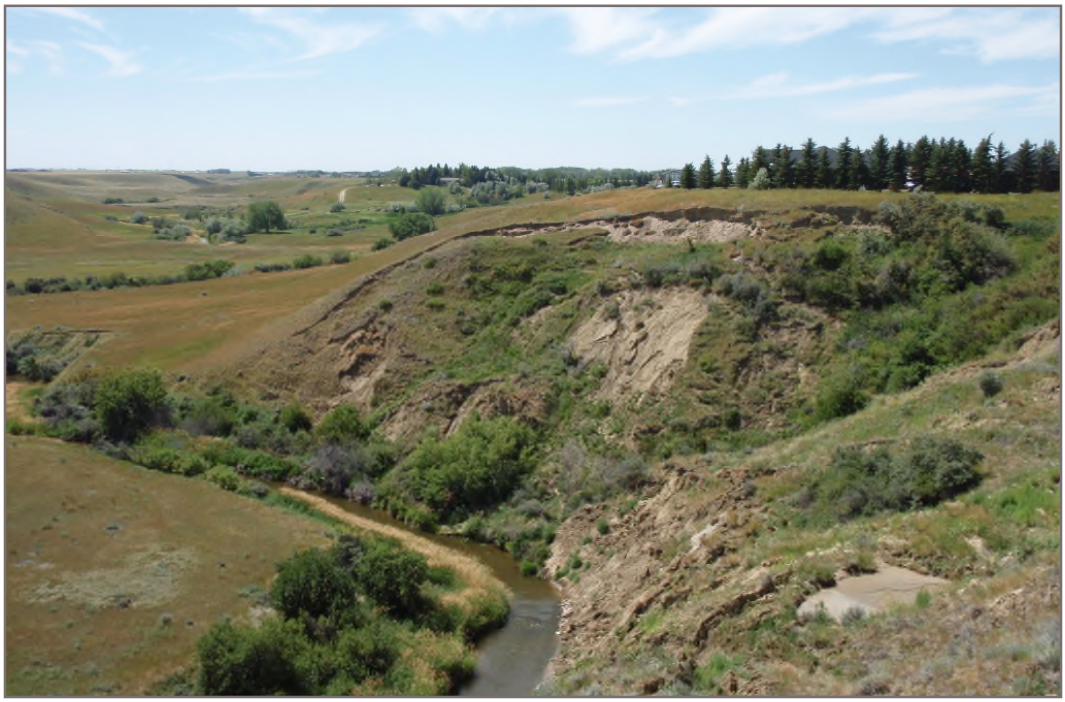


Photo 26: SPC-7A Eagleridge Slide



Photo 27: SPC-7A Eagleridge Slide



Photo 28: SPC-7A Eagleridge Slide



Photo 29: SPC-7A Eagleridge Slide



Photo 30: SPC-7A Eagleridge Slide



Photo 31: SPC-7A Eagleridge Slide



Photo 32: SPC-7A Eagleridge Slide



Photo 33: SPC-7A Eagleridge Slide



Photo 34: SPC-7A Eagleridge Slide



Photo 35: SPC-7B Canyon Creek Slide



Photo 36: SPC-7B Canyon Creek Slide



Photo 37: SPC-7B Canyon Creek Slide

SOUTH SASKATCHEWAN RIVER



Photo 1: SSR-1 at N City Limit



Photo 2: SSR-1 at Evilsmelling Bluffs



Photo 3: SSR-1 Fertilizer Plant Slide



Photo 4: SSR-1 Rattlesnake Slide Sag Pond



Photo 5: SSR-1 Rattlesnake Slide



Photo 6: SSR-1 Rattlesnake Slide



Photo 7: SSR-2



Photo 8 SSR-2



Photo 9: SSR-3 Police Point Slide



Photo 10: SSR-3 Police Point Slide



Photo 11: SSR-4 Golf and Country Club



Photo 12: SSR-5 1 Street SW



Photo 13: SSR-6 Rideau Manor



Photo 14: SSR-6 Rideau Manor



Photo 15: SSR-6 Rideau Manor



Photo 16: SSR-6 Rideau Manor



Photo 17: SSR-7 Powerhouse Slide



Photo 18: SSR-7 Powerhouse Slide



Photo 19: SSR-8 Surprise Bluffs



Photo 20: SSR-9 near Redcliff



Photo 21: SSR-9 near Redcliff



Photo 22: SSR-9 near Redcliff



Photo 23: SSR-10 Redcliff Pumphouse Slide



Photo 24: SSR-10 Redcliff Pumphouse Slide



Photo 25: SSR-10 Redcliff Pumphouse Slide—Sinkhole near Redcliff Pumphouse Slide



Photo 26: Cypress County TWP RD 130 Slide



Photo 27: Cypress County TWP RD 130 Slide



Photo 28: Cypress County TWP RD 130 Slide



Photo 29: Cypress County TWP RD 130 Slide

APPENDIX K

APPENDIX K CROSS-SECTIONS

Appendix K – Table of Contents

Appendix Reference	Cross-Section
K-1A	IS-1 Critical Slip
K-1B	IS-1 Setback Slip Surface
K-2A	IS-2 Critical Slip
K-2B	IS-2 Setback Slip Surface
K-3A	IS-3A Critical Slip
K-3B	IS-3A Setback Slip Surface
K-4	IS-3B Critical Slip
K-5A	IS-3B Setback Slip Surface
K-5B	IS-4
K-6	IS-5 Critical Slip
K-7	IS-5 Setback Slip Surface
K-8A	IS-6
K-8B	IS-7
K-9A	RC-1 Critical Slip
K-10	RC-1 Setback Slip Surface
K-11A	RC-2 Critical Slip Surface
K-11B	RC-3
K-12	RC-4A Critical Slip
K-13A	RC-4A Setback Slip Surface
K-13B	RC-4B
K-14A	SPC-1 Critical Slip
K-14B	SPC-1 Setback Slip Surface
K-15A	SPC-2 Critical Slip
K-15B	SPC-2 Setback Slip Surface
K-16A	SPC-3 Critical Slip
K-16B	SPC-3 Setback Slip Surface
K-17A	SPC-4A Critical Slip
K-17B	SPC-4A Setback Slip Surface
K-18A	SPC-4B Critical Slip
K-18B	SPC-4B Setback Slip Surface
K-19A	SPC-5 Critical Slip
K-19B	SPC-5 Setback Slip Surface
K-20	SPC-6 Critical Slip
K-21A	SPC-6 Setback Slip Surface
K-21B	SPC-7A
K-22A	SPC-7B Critical Slip
K-22B	SCP-7B Setback Slip Surface
K-23A	SSR-1A Critical Slip
K-23B	SSR-1A Setback Slip Surface

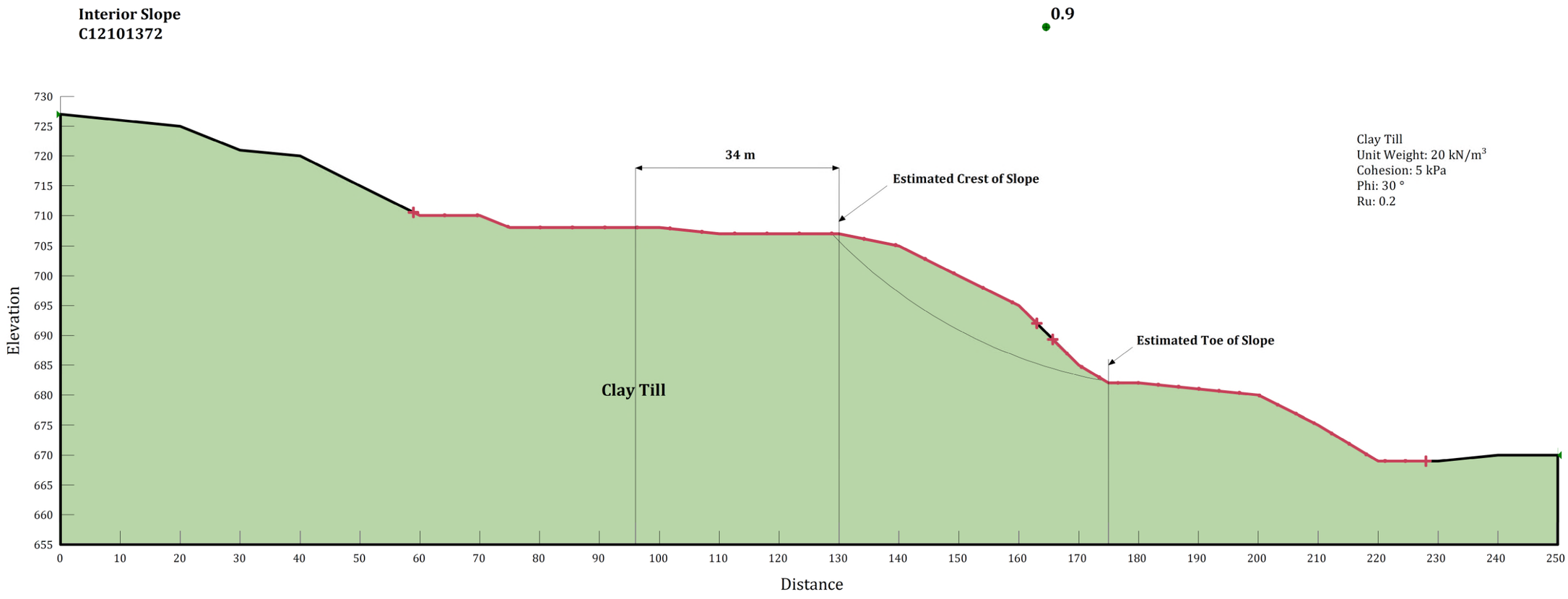
Appendix Reference	Cross-Section
K-24A	SSR-1B Critical Slip
K-24B	SSR-1B Setback Slip Surface
K-25A	SSR-1C Critical Slip
K-25B	SSR-1C Setback Slip Surface
K-26A	SSR-2 Critical Slip
K-26B	SSR-2 Setback Slip Surface
K-27A	SSR-3 Critical Slip
K-27B	SSR-3 Setback Slip Surface
K-28A	SSR-4 Critical Slip
K-28B	SSR-4 Setback Slip Surface
K-29	SSR-5A Critical Slip
K-30	SSR-5A Setback Slip Surface
K-31A	SSR-5B
K-31B	SSR-6
K-32A	SSR-7 Critical Slip
K-32B	SSR-7 Setback Slip Surface
K-33A	SSR-8 Critical Slip
K-33B	SSR-8 Setback Slip Surface
K-34A	SSR-9A Critical Slip
K-34B	SSR-9A Setback Slip Surface
K-35A	SSR-9B Critical Slip
K-35B	SSR-9B Setback Slip Surface
K-36A	SSR-10 Critical Slip
K-36B	SSR-10 Setback Slip Surface
K-37A	SSR-11 Critical Slip
K-37B	SSR-11 Setback Slip Surface

*K-##A – Reference to Critical Slip Surface

*K-##B – Reference to Setback Slip Surface

Cross Section IS-1

Interior Slope
C12101372



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat Slope Setback Report

Cross Section IS-1 Critical Slip

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

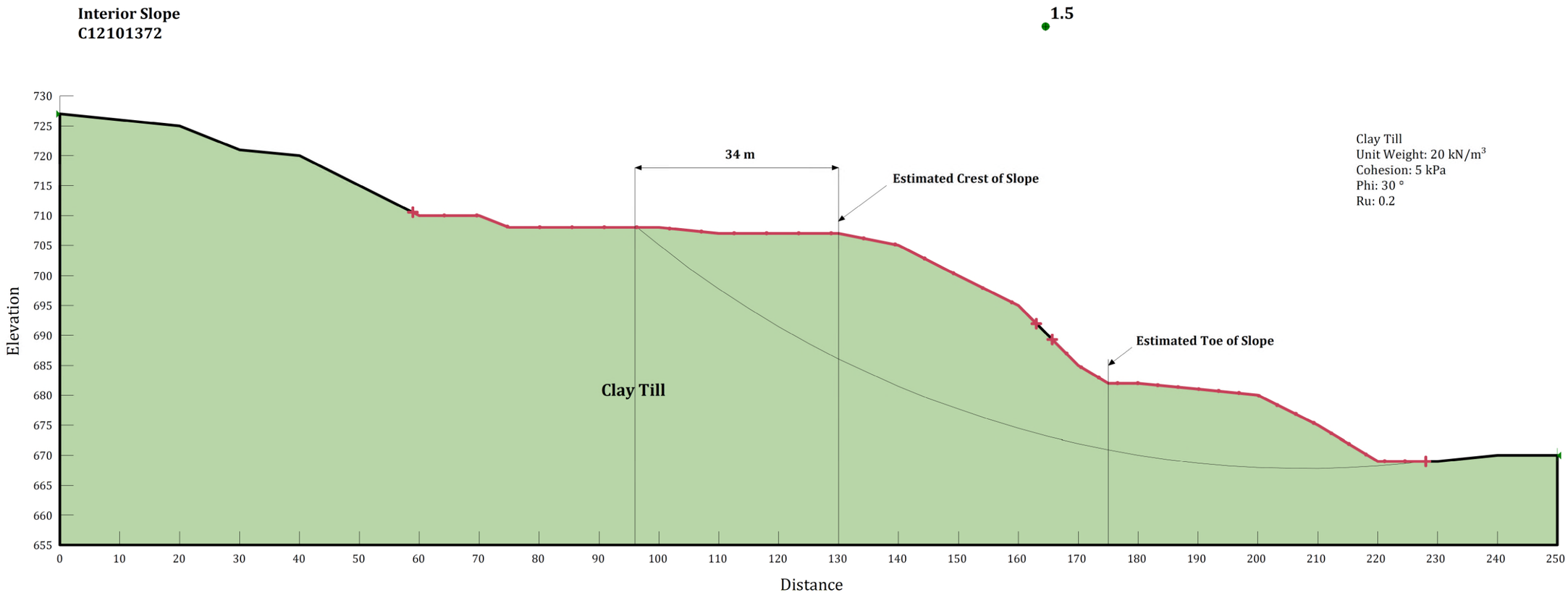
OFFICE EBA-Riverbend

DATE April 2014

Appendix K-1A

Cross Section IS-1

Interior Slope
C12101372



Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

eba
A TETRA TECH COMPANY

The City of Medicine Hat Slope Setback Report

Cross Section IS-1 Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

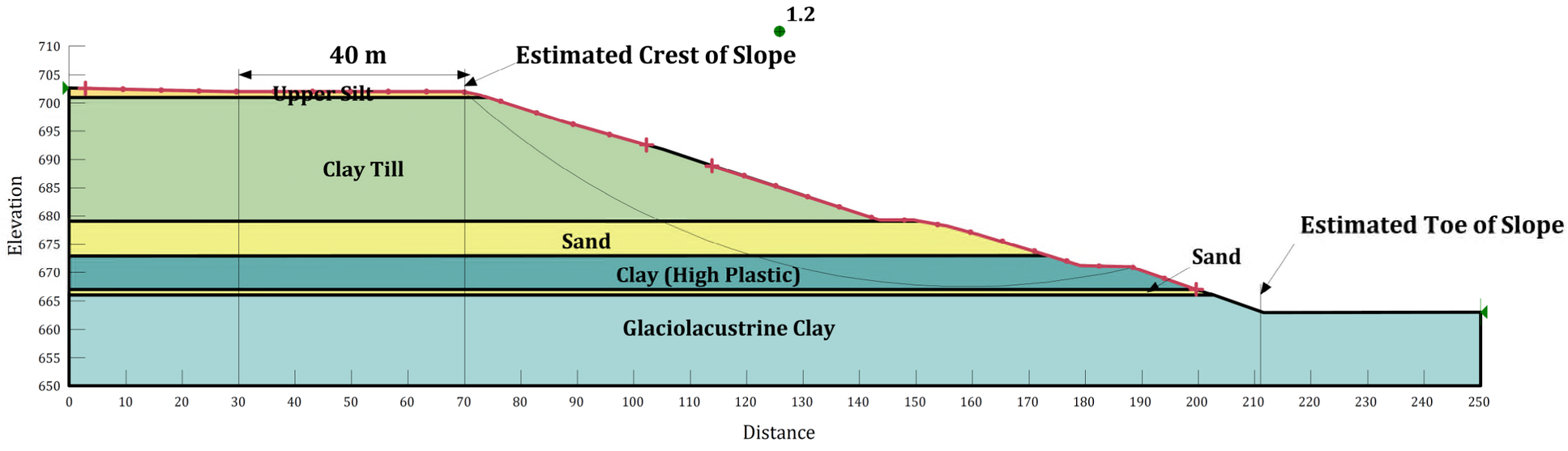
OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-1B

Cross Section IS-2

Interior Slope

C12101372



Upper Silt
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.3

Clay Till
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.3

Clay (High Plastic)
Unit Weight: 18 kN/m³
Cohesion: 1 kPa
Phi: 18 °
Ru: 0.3

Glaciolacustrine Clay
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.3

LEGEND

NOTES

STATUS
ISSUEDE FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section IS-2
Critical Slip

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

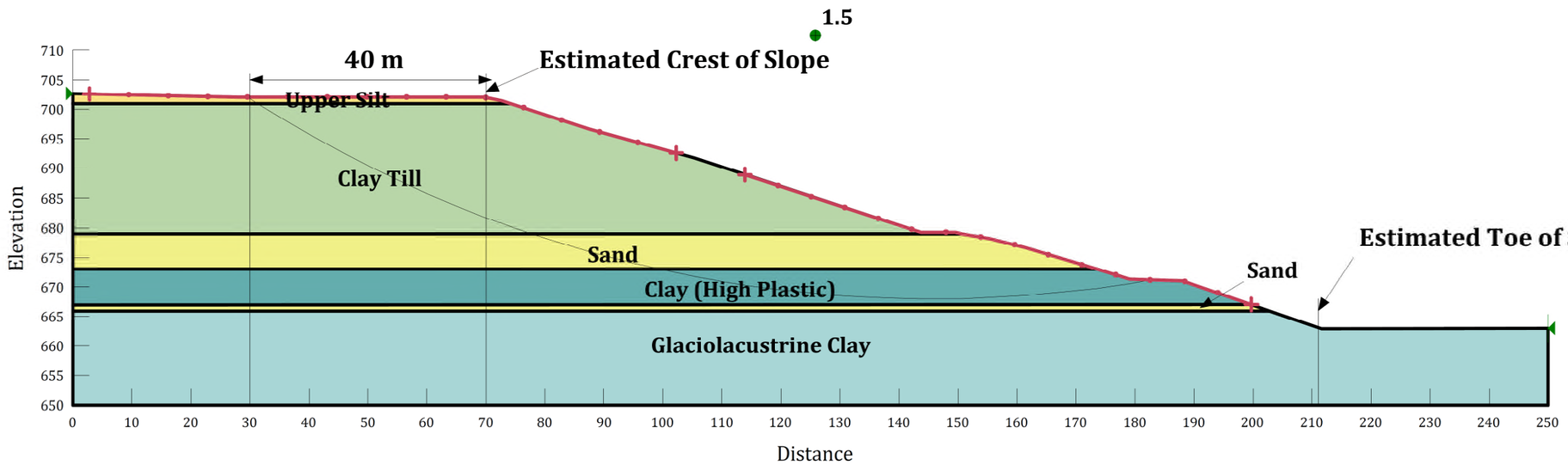
OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-2A

Cross Section IS-2

Interior Slope

C12101372



Upper Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.3

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.3

Clay (High Plastic)
Unit Weight: 18 kN/m^3
Cohesion: 1 kPa
Phi: 18 °
Ru: 0.3

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.3

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

eba
A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section IS-2
Setback Slip Surface

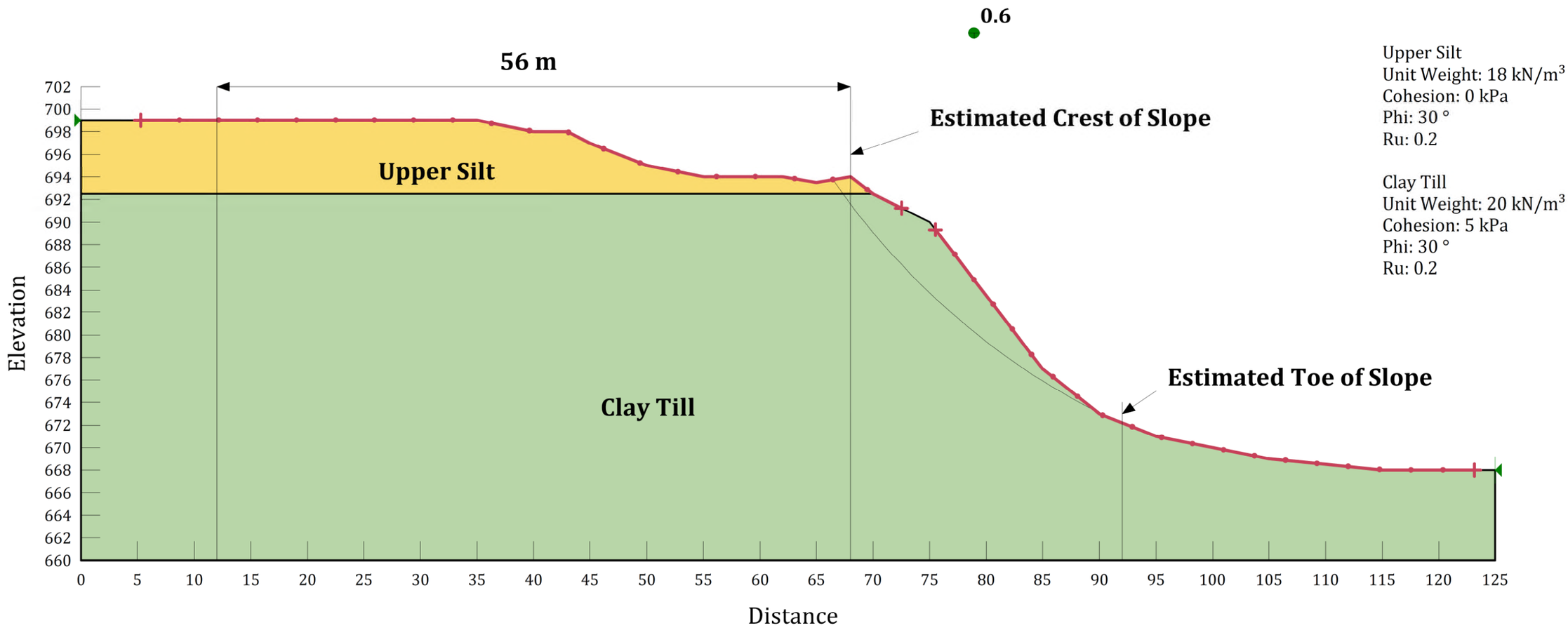
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-2B

Cross Section IS-3A

Interior Slope
C12101372



Upper Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section IS-3A
Critical Slip

A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

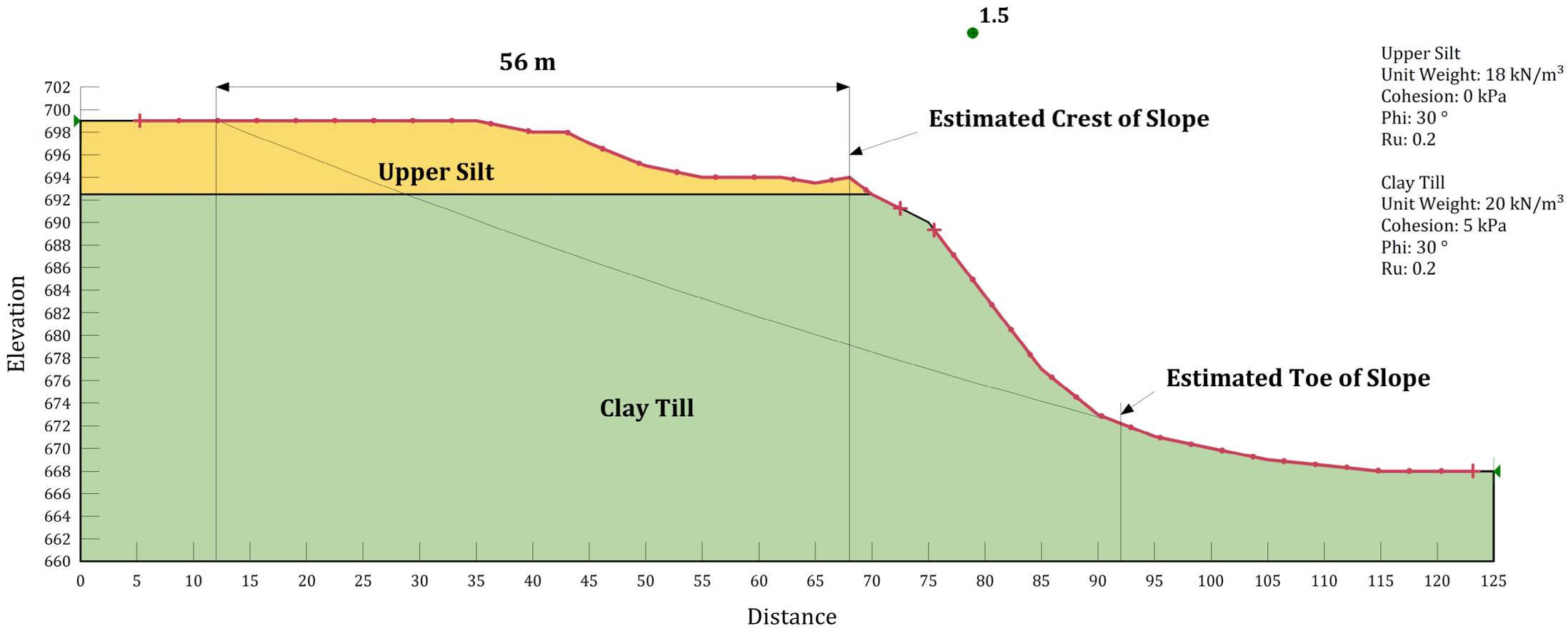
OFFICE EBA-Riverbend
DATE April 2014

Appendix K-3A

C:\Users\becky.wohlgemuth\Desktop\App K\K-3A.doc

Cross Section IS-3A

Interior Slope
C12101372



Upper Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section IS-3A
Setback Slip Surface

eba
A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

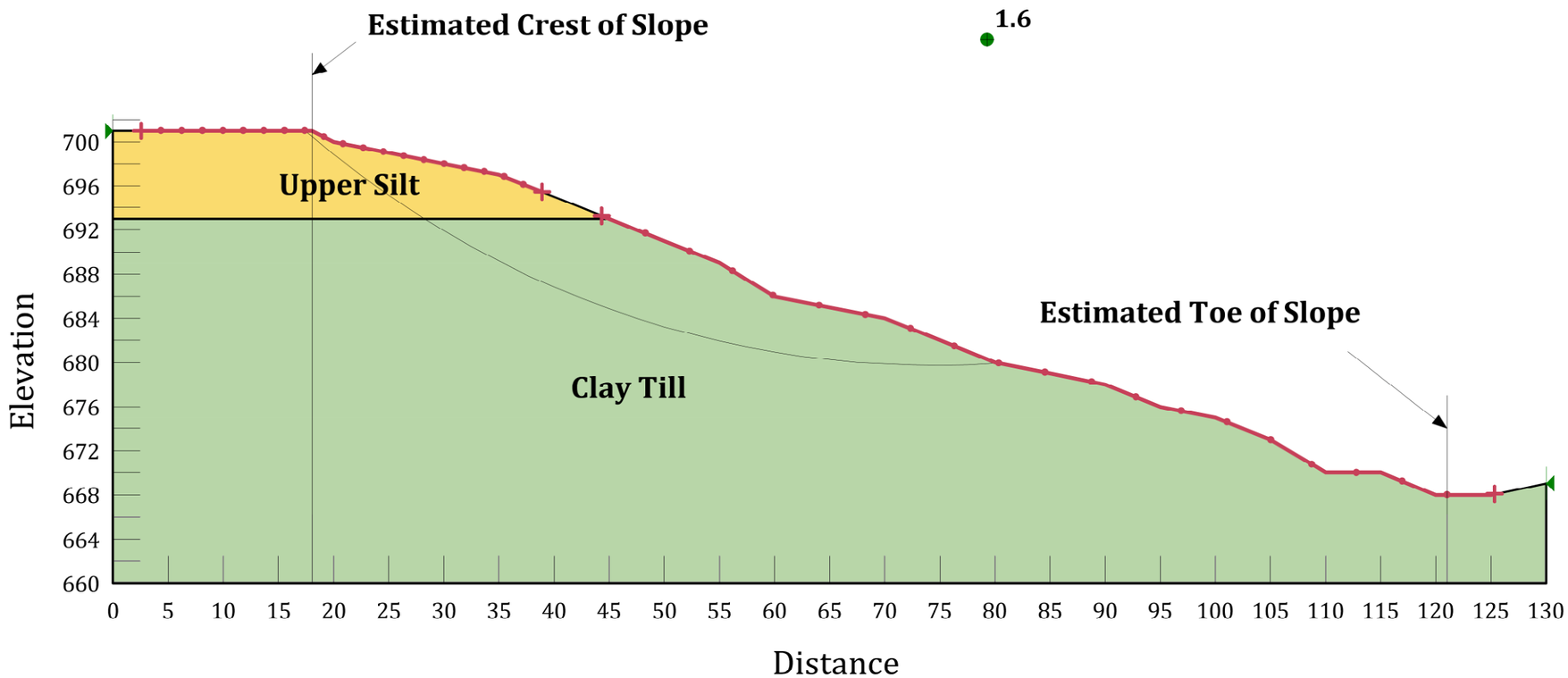
OFFICE
EBA-Riverbend

DATE
April 2014

Appendix K-3B

Cross Section IS-3B

Interior Slope
C12101372



Upper Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat Slope Setback Report

Cross Section IS-3 Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	XXX	XXX	XXX

OFFICE
EBA-Riverbend

DATE
April 2014

Appendix K-4

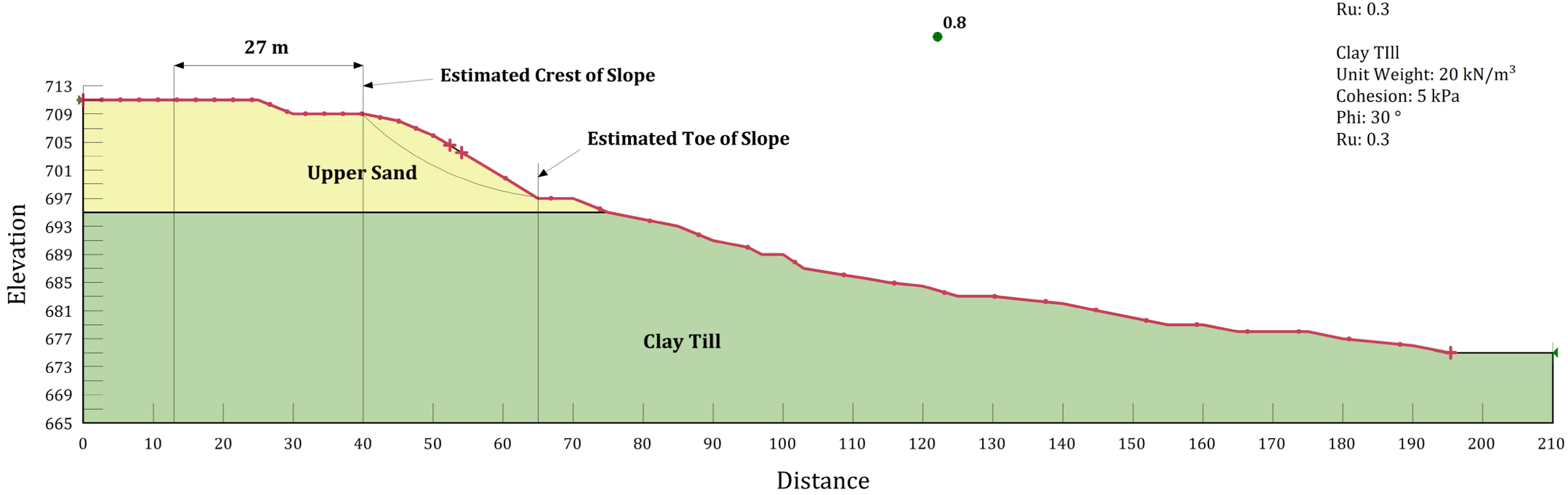
C:\Users\becky.wohlgemuth\Desktop\App K\K-4.doc

Cross Section IS-4

Interior Slope
C12101372

Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.3

Clay TIll
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

eba
A TETRA TECH COMPANY

The City of Medicine Hat Slope Setback Report

Cross Section IS-4 Critical Slip

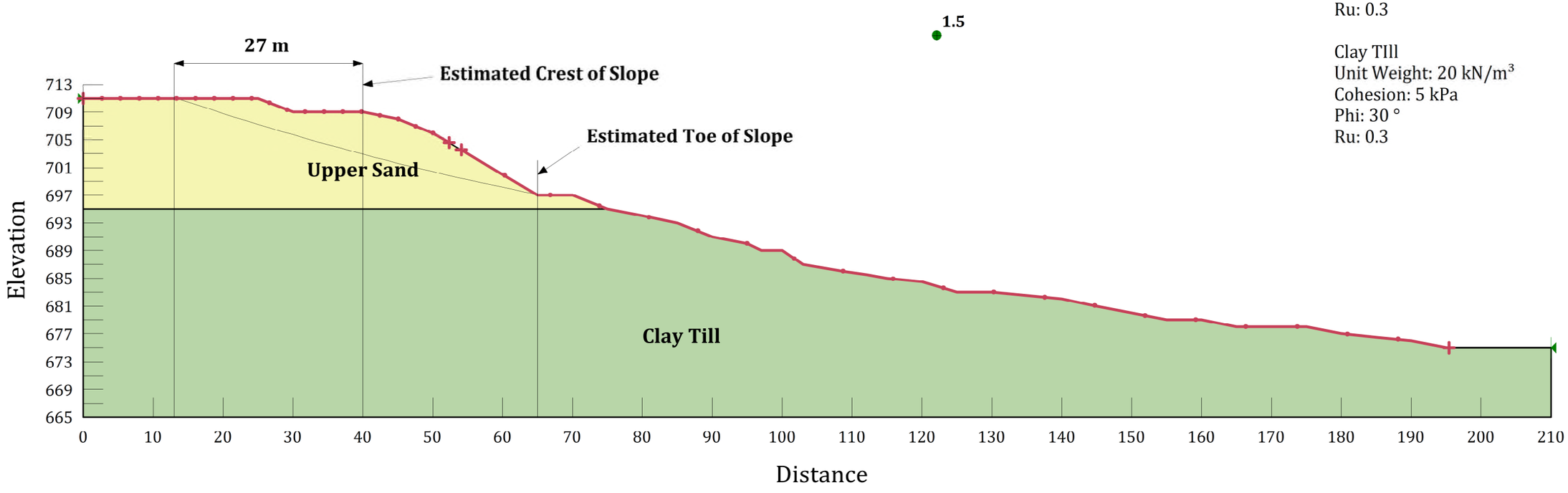
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-5A

Cross Section IS-4

Interior Slope
C12101372



Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.3

Clay TIll
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

eba
A TETRA TECH COMPANY

The City of Medicine Hat Slope Setback Report

Cross Section IS-4 Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE
EBA-Riverbend

DATE
April 2014

Appendix K-5B

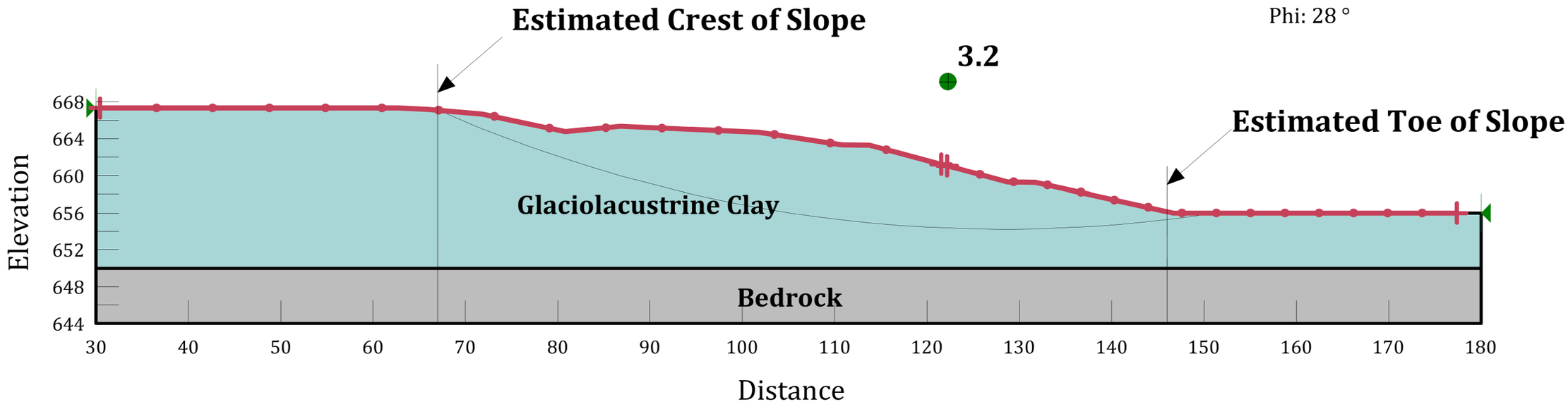
Cross Section IS-5

Interior Slope

C12101372

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Bedrock
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat Slope Setback Report

Cross Section IS-5 Setback Slip Surface

A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

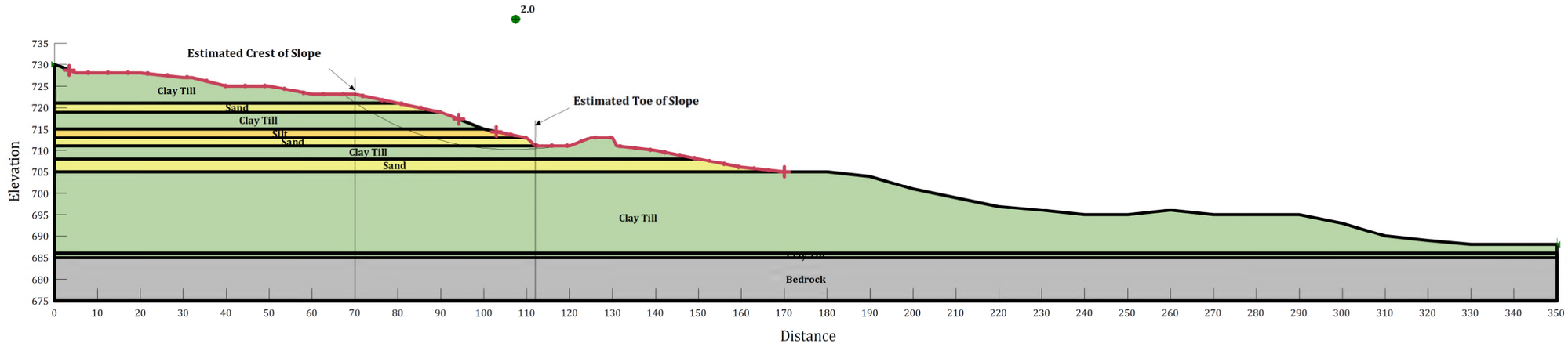
Appendix K-6

C:\Users\becky.wohlgemuth\Desktop\App K\K-6.doc

Cross Section IS-6

Interior Slope

C12101372



Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Bedrock
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section IS-6
Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

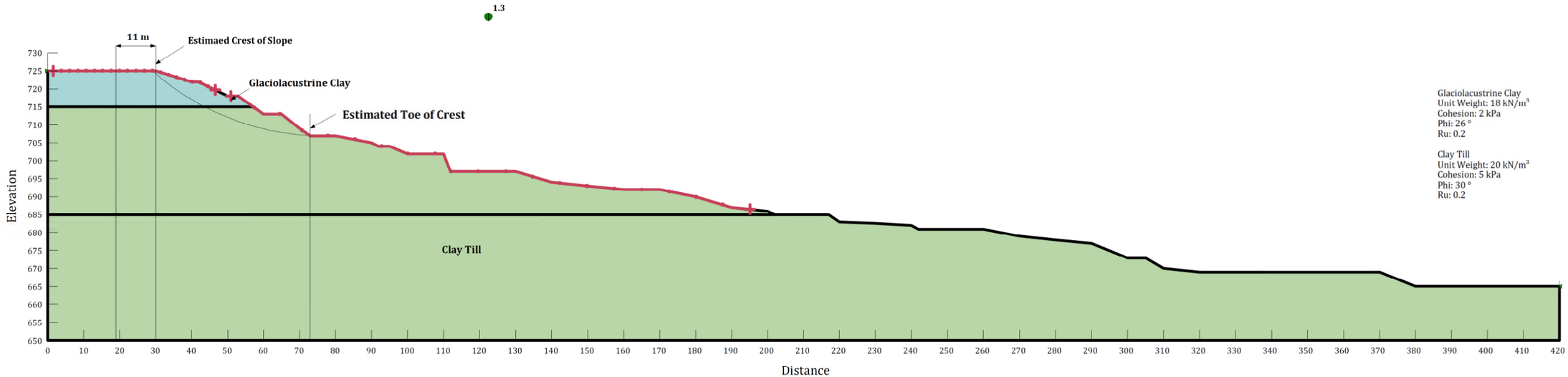
OFFICE
EBA-Riverbend

DATE
April 2014

Appendix K-7

Cross Section IS-7

Interior Slope
C12101372



Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section IS-7
Critical Slip

A TETRA TECH COMPANY

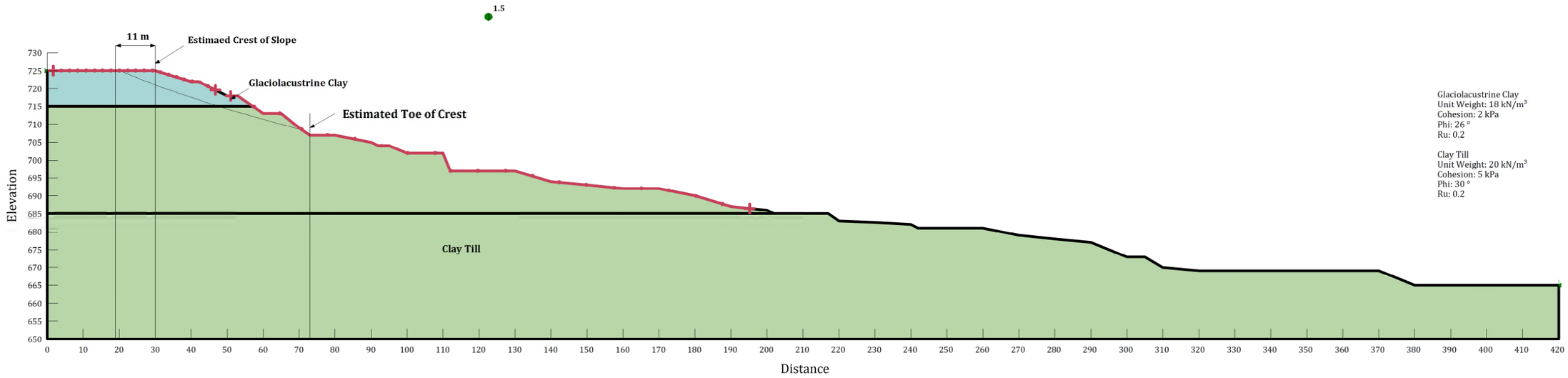
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-8A

Cross Section IS-7

Interior Slope
C12101372



Glaciolacustrine Clay
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section IS-7
Setback Slip Surface

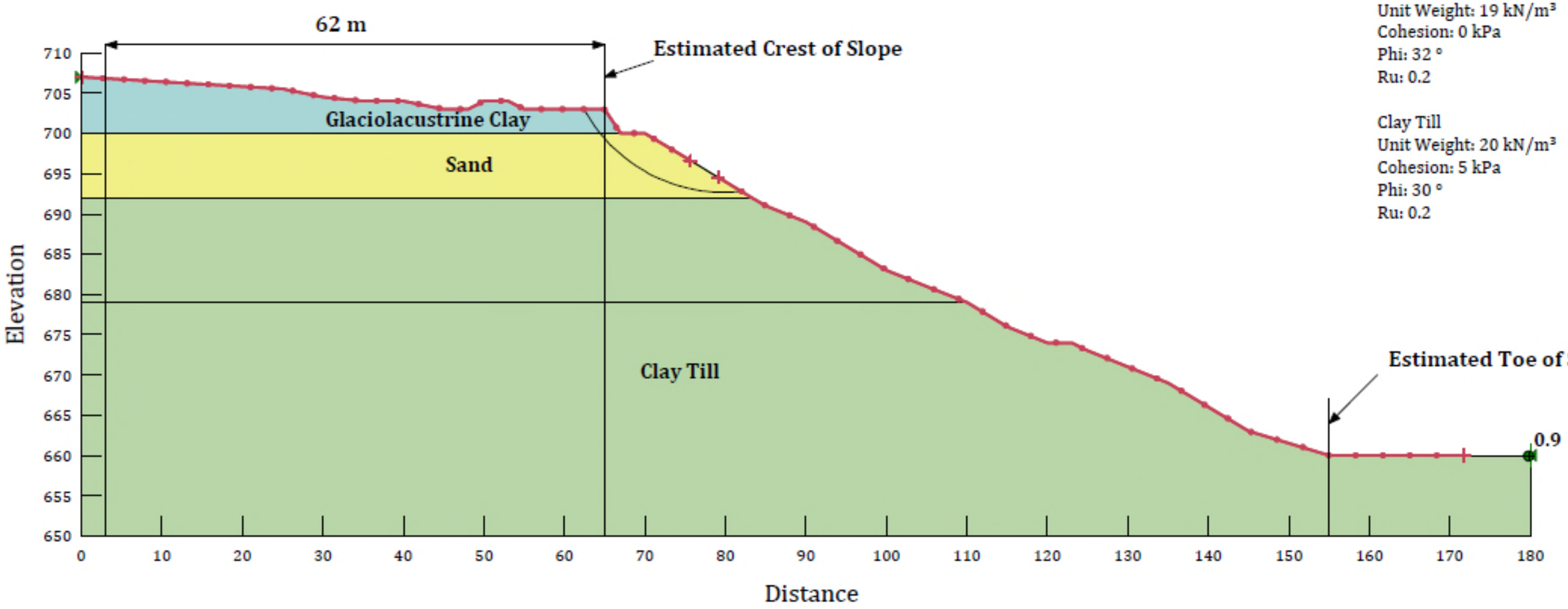
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-8B

Cross Section RC-1

Ross Creek
C12101372



Glaciolacustrine Clay
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section RC-1
Critical Slip

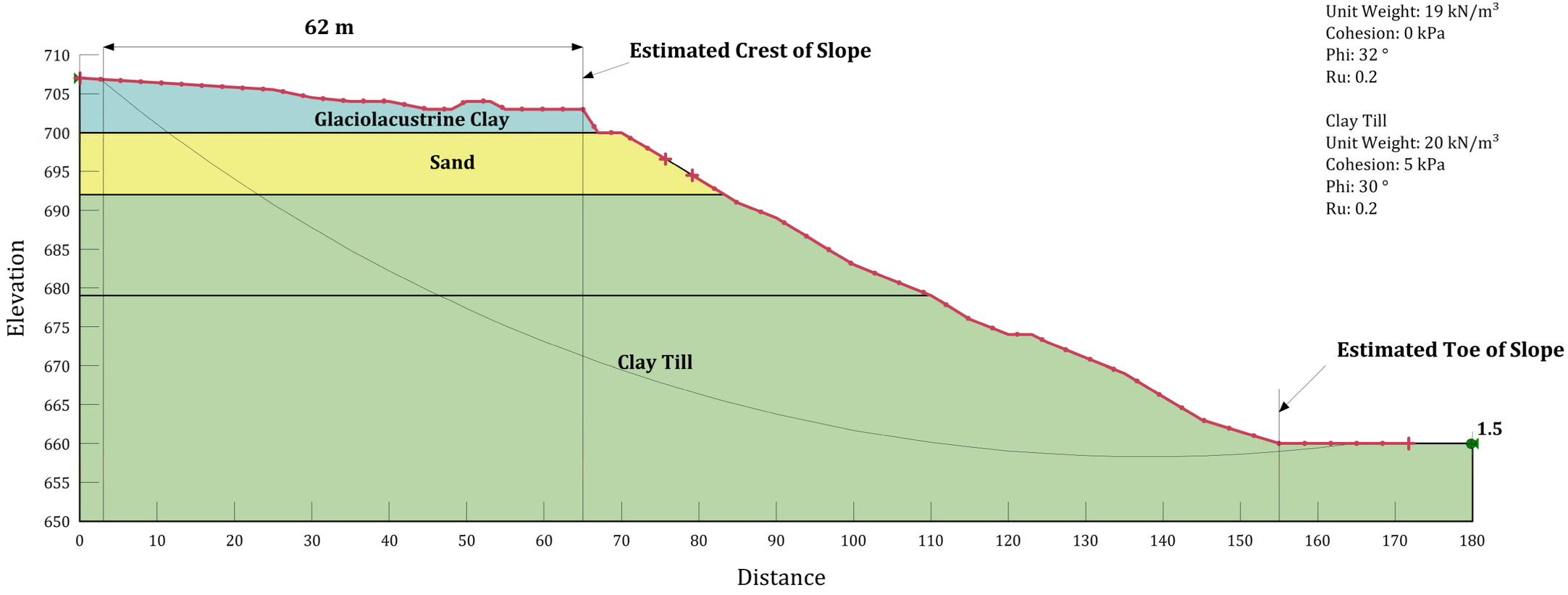
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE: EBA-Riverbend
DATE: April 2014

Appendix K-9A

Cross Section RC-1

Ross Creek
C12101372



Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section RC-1
Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	O

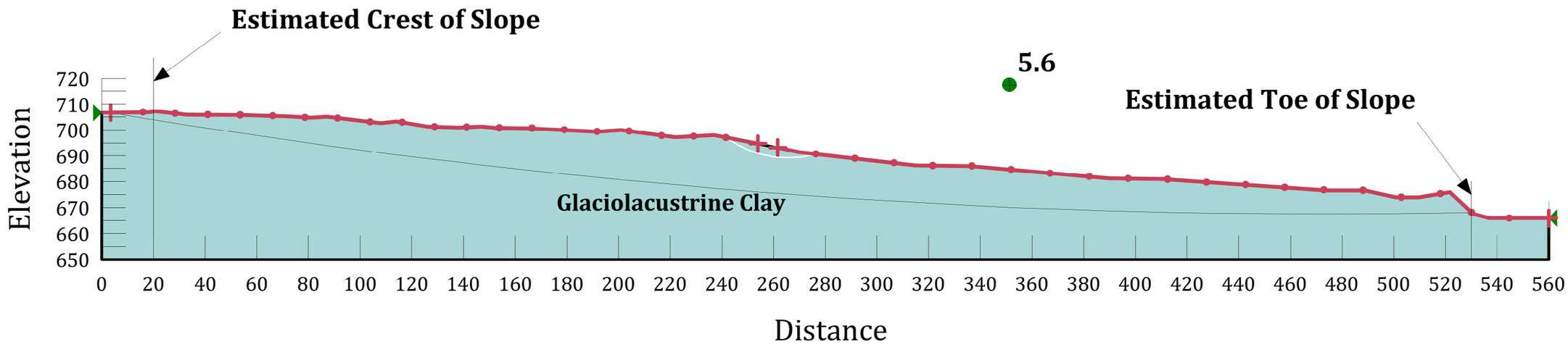
OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-9B

Cross Section RC-2

Rose Creek
C12101372

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section RC-2
Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

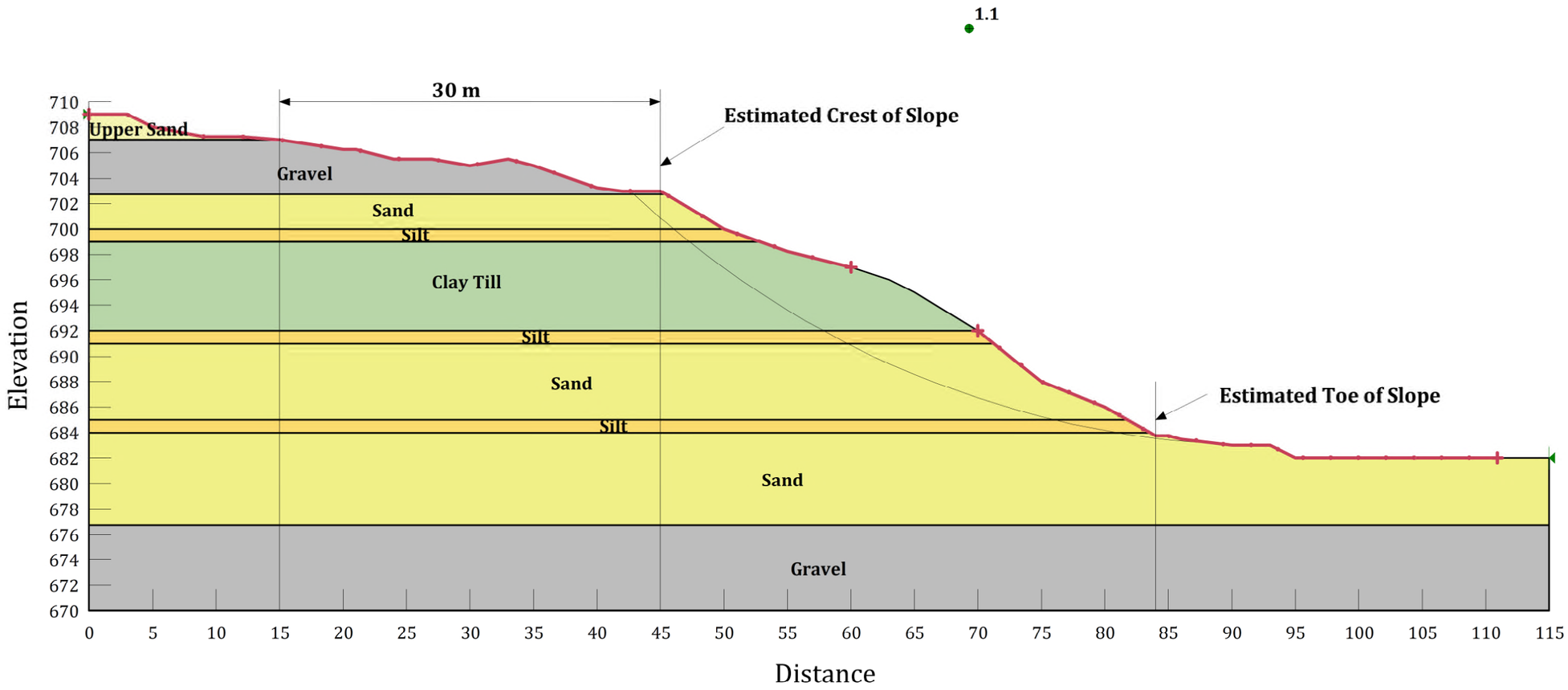
OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-10

C:\Users\becky.wohlgemuth\Desktop\App K\K-10.doc

Cross Section RC-3

Ross Creek
C12101372



Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section RC-3
Critical Slip

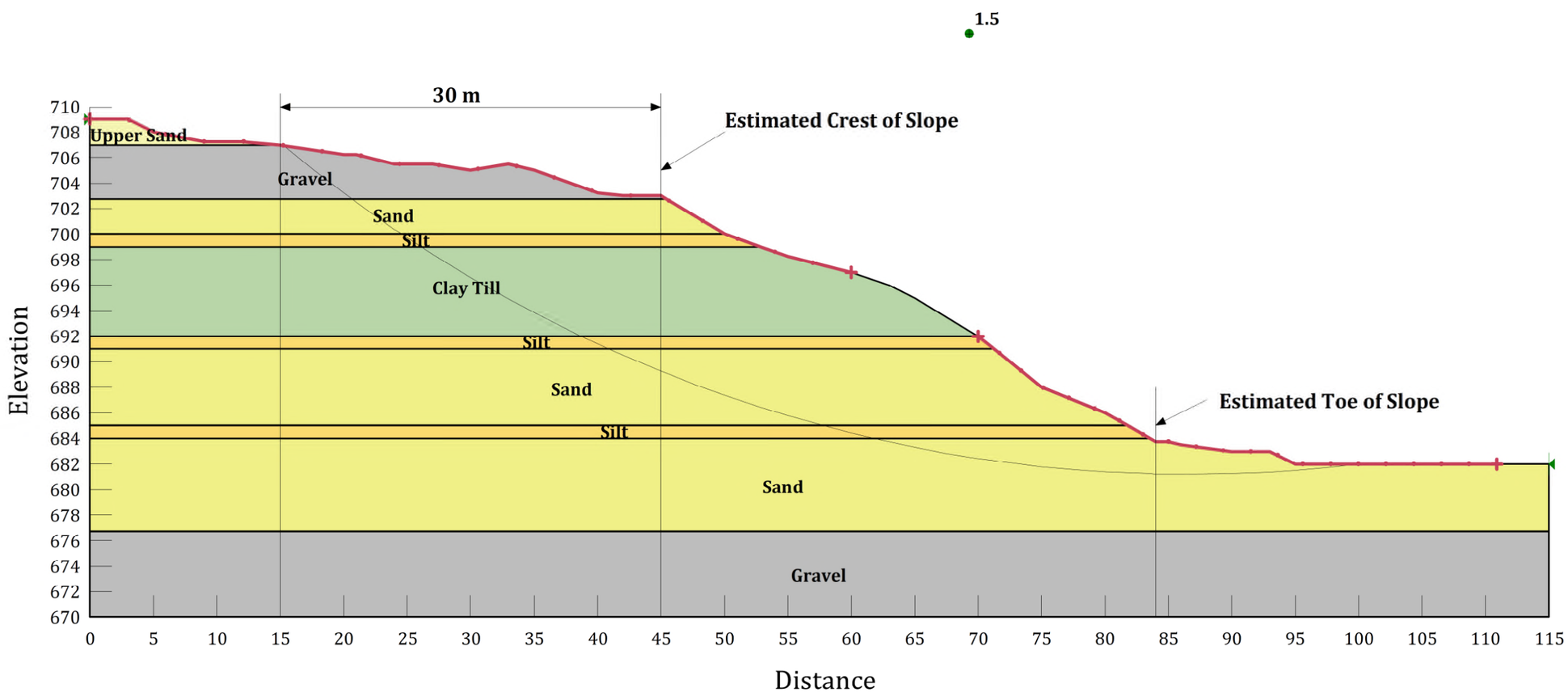
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE: EBA-Riverbend
DATE: April 2014

Appendix K-11A

Cross Section RC-3

Ross Creek
C12101372



Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section RC-3
Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

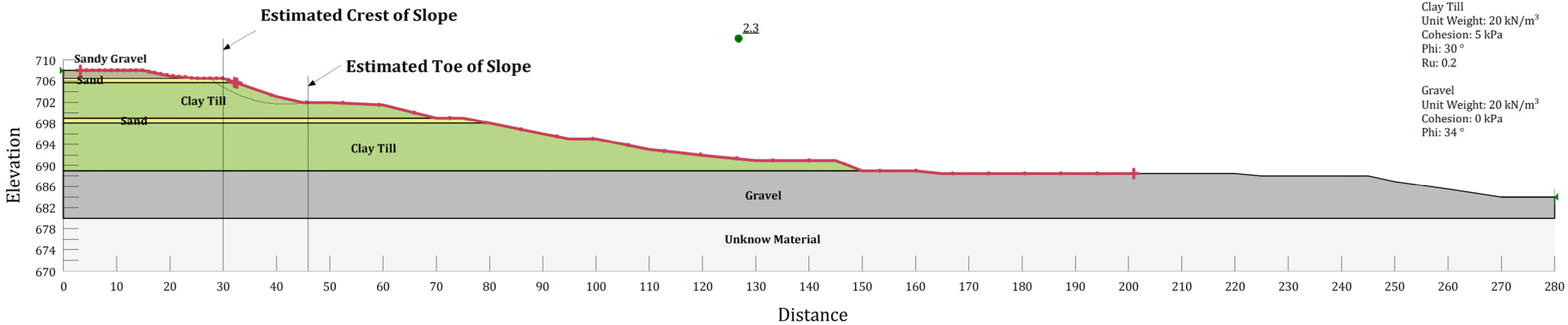
OFFICE
EBA-Riverbend

DATE
April 2014

Appendix K-11B

Cross Section RC-4A

Ross Creek
C12101372



Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

eba
A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section RC-4A
Setback Slip Surface

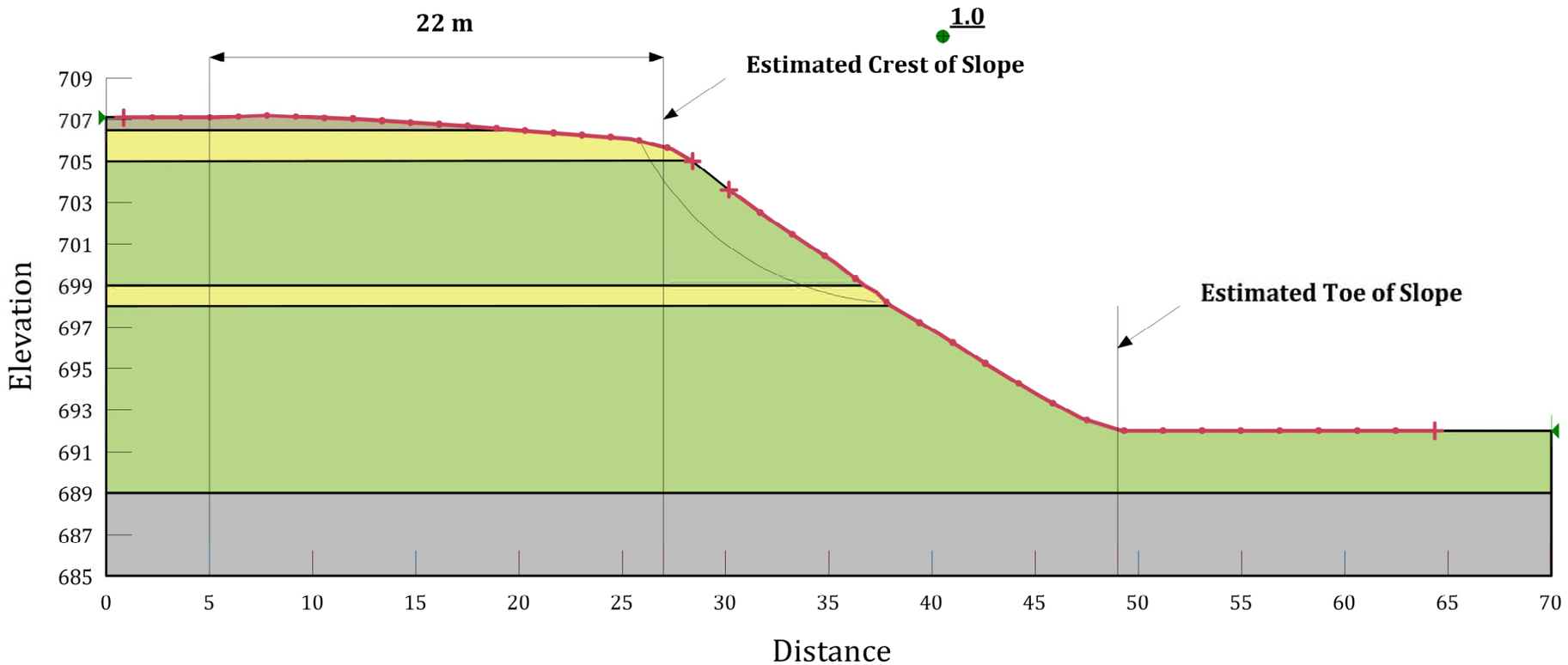
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-12

Cross Section RC-4B

Ross Creek
C12101372



Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section RC-4B
Critical Slip

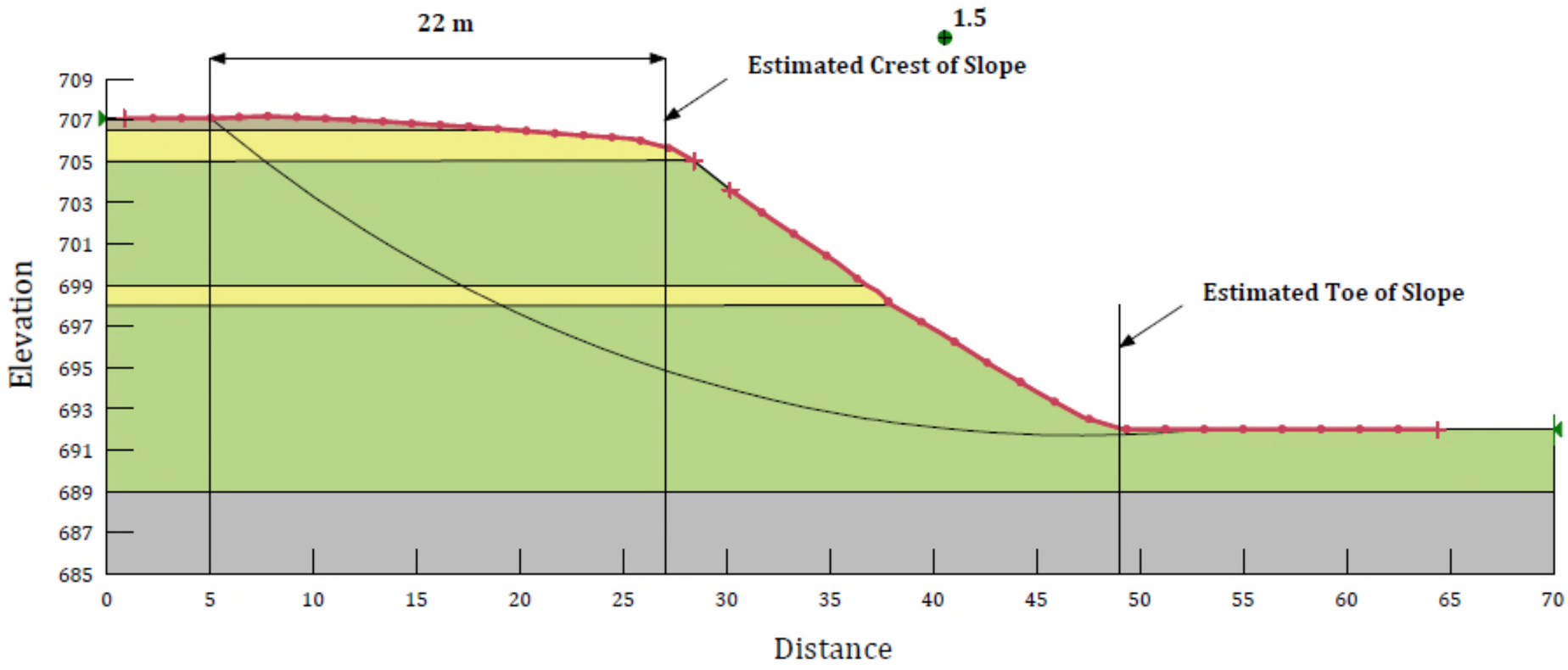
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE EBA-Riverbend
DATE April 2014

Appendix K-13A

Cross Section RC-4B

Ross Creek
C12101372



Sandy Gravel
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 33 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Gravel
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 34 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section RC-4B
Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

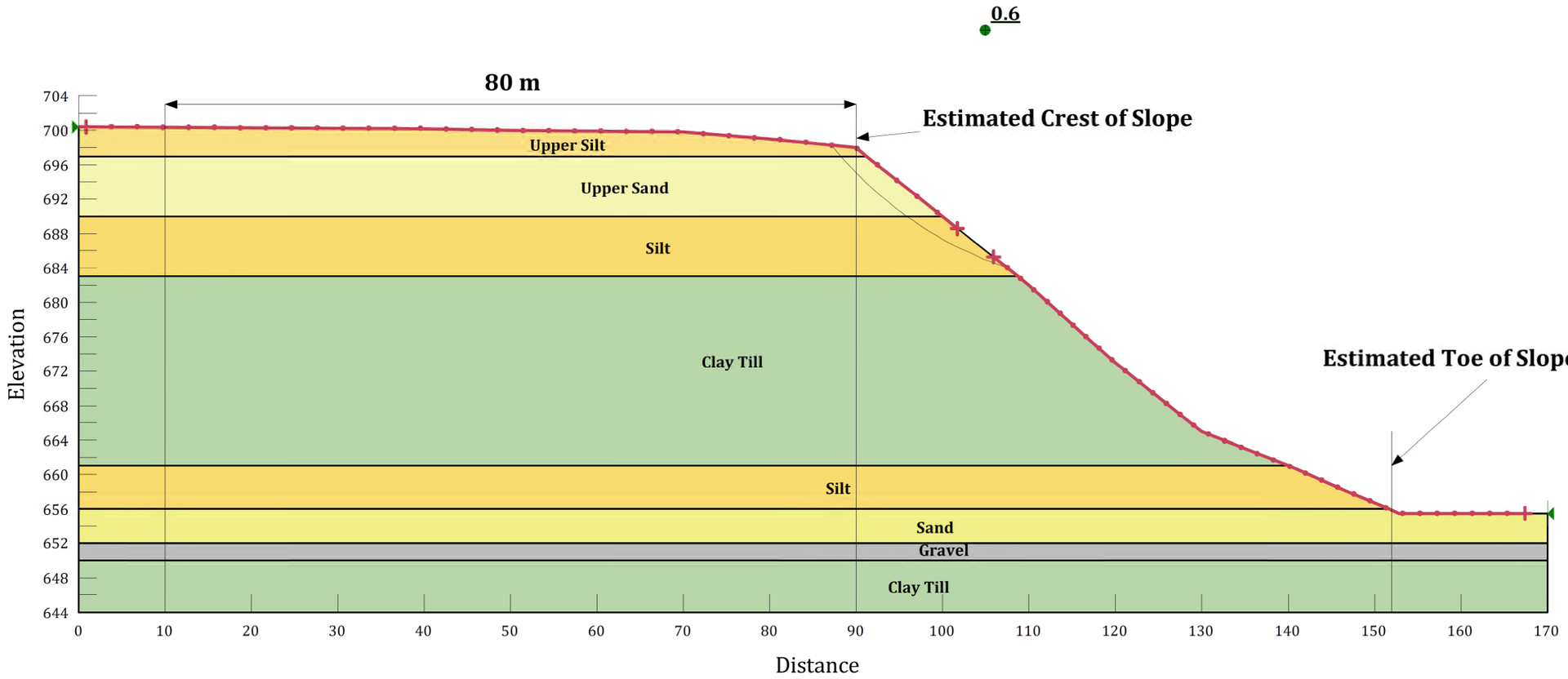
OFFICE
EBA-Riverbend

DATE
April 2014

Appendix K-13B

Cross Section SPC-1

ADM Slide
Seven Persons Creek
C12101327



Upper Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat Slope Setback Report

Cross Section SPC-1 Critical Slip

eba A TETRA TECH COMPANY

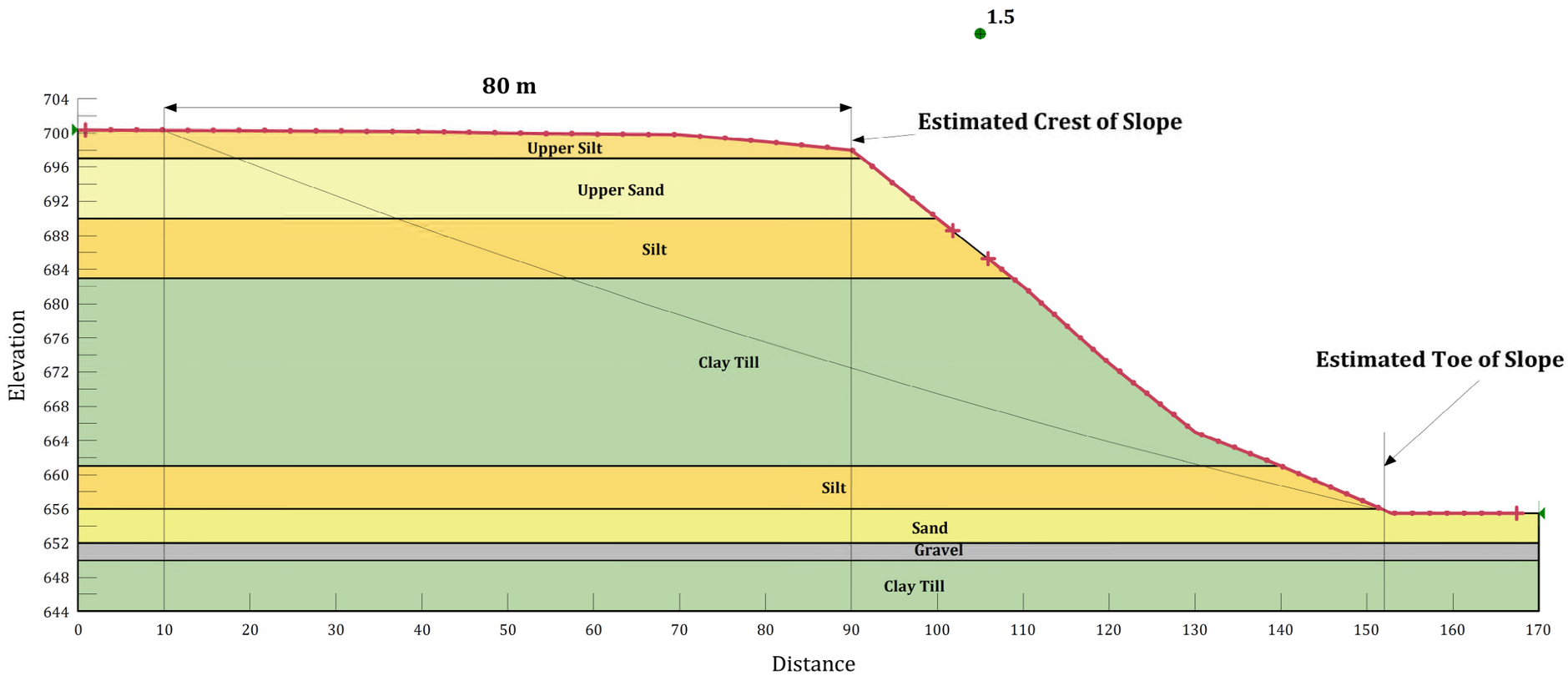
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-14A

Cross Section SPC-1

ADM Slide
Seven Persons Creek
C12101327



Upper Silt
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Upper Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Silt
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Gravel
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 34 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SPC-1
Setback Surface Slip

A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE
EBA-Riverbend

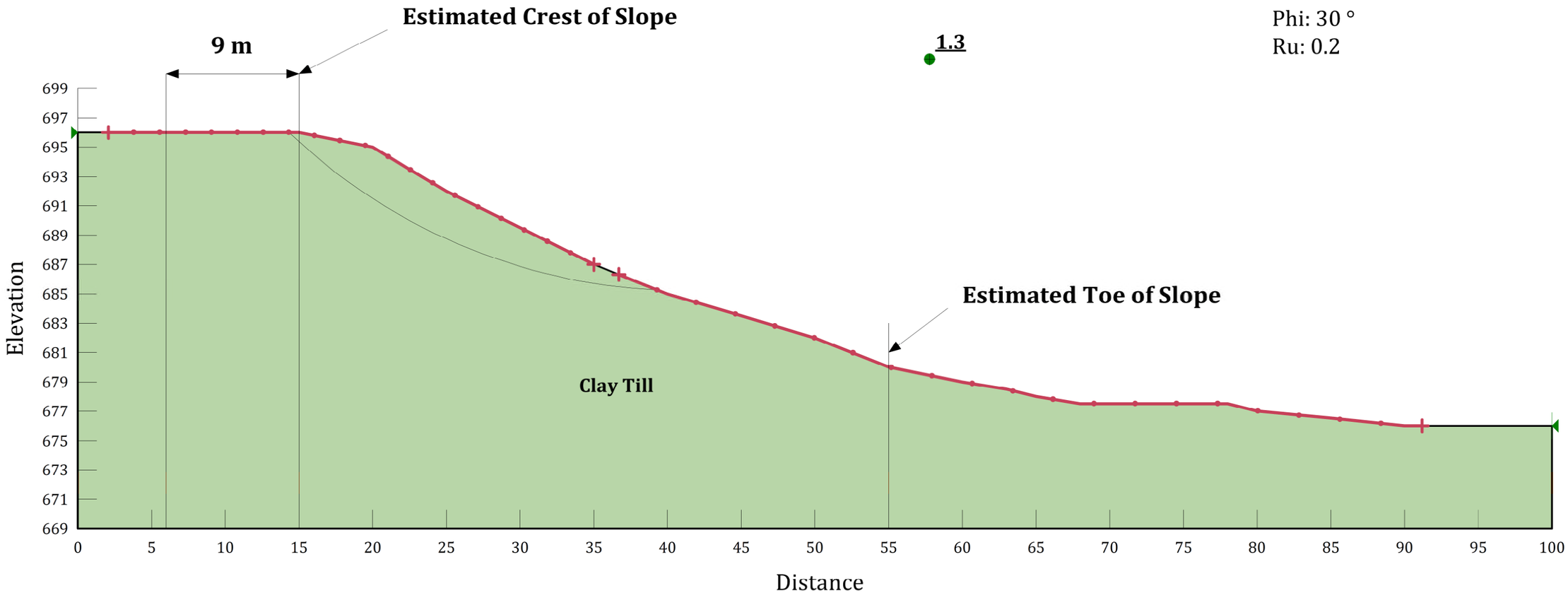
DATE
April 2014

Appendix K-14B

Cross Section SPC-2

Seven Persons Creek
C12101372

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat Slope Setback Report

Cross Section SPC-2 Critical Slip

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE EBA-Riverbend
DATE April 2014

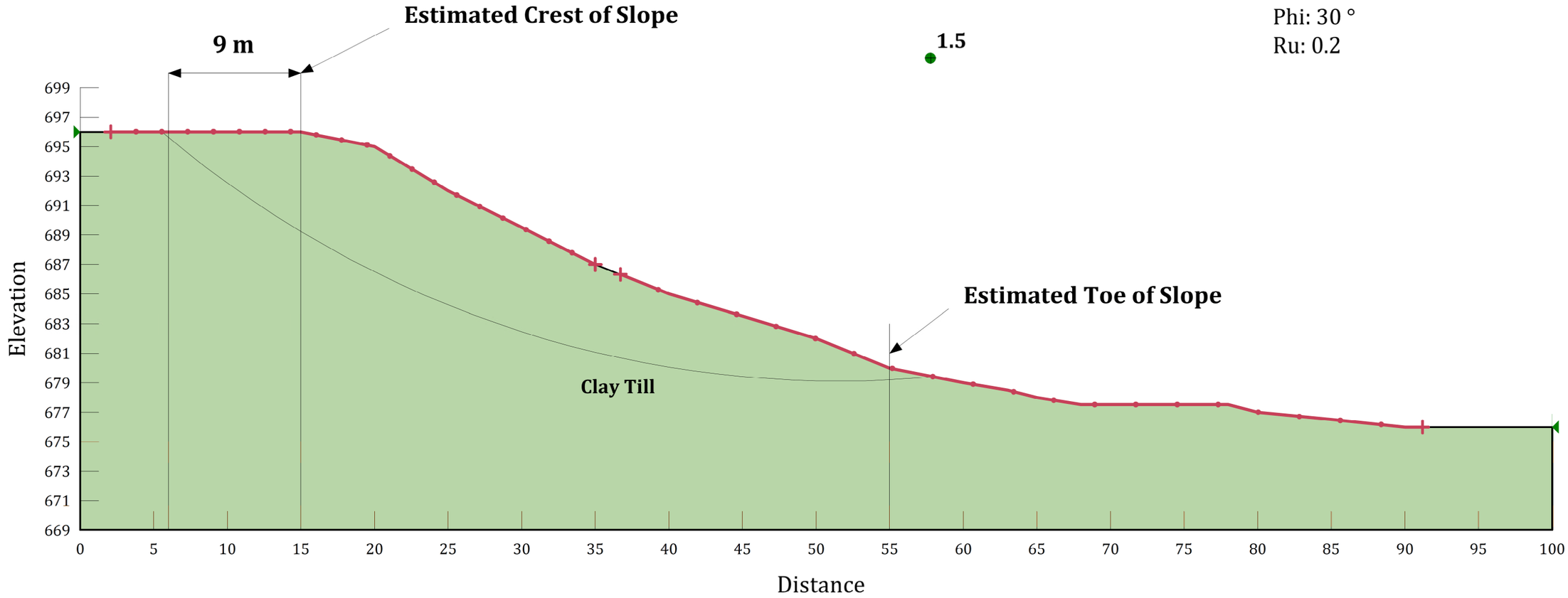
Appendix K-15A

C:\Users\becky.wohlgemuth\Desktop\App K\K-15A.doc

Cross Section SPC-2

Seven Persons Creek
C12101372

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat Slope Setback Report

Cross Section SPC-2 Setback Surface Slip

A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE EBA-Riverbend
DATE April 2014

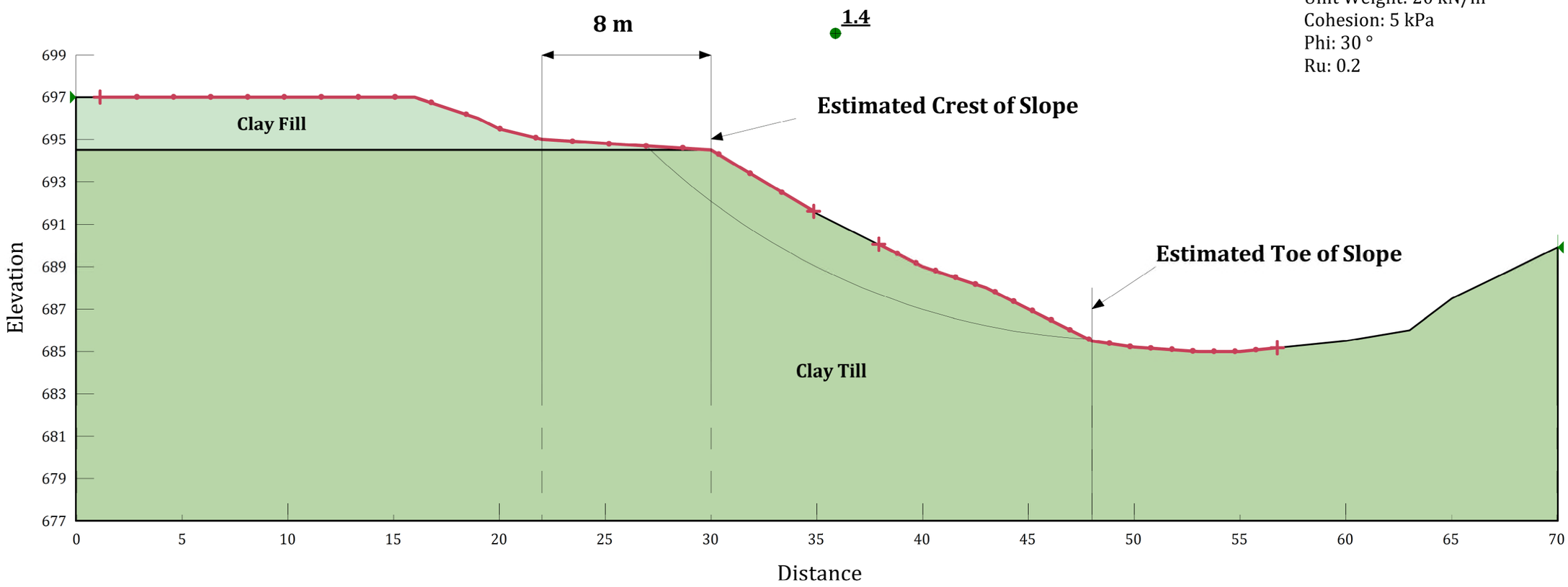
Appendix K-15B

Cross Section SPC-3

Seven Persons Creek
C12101372

Clay Fill
Unit Weight: 19 kN/m^3
Cohesion: 1 kPa
Phi: 27 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

eba
A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SPC-3
Critical Slip

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

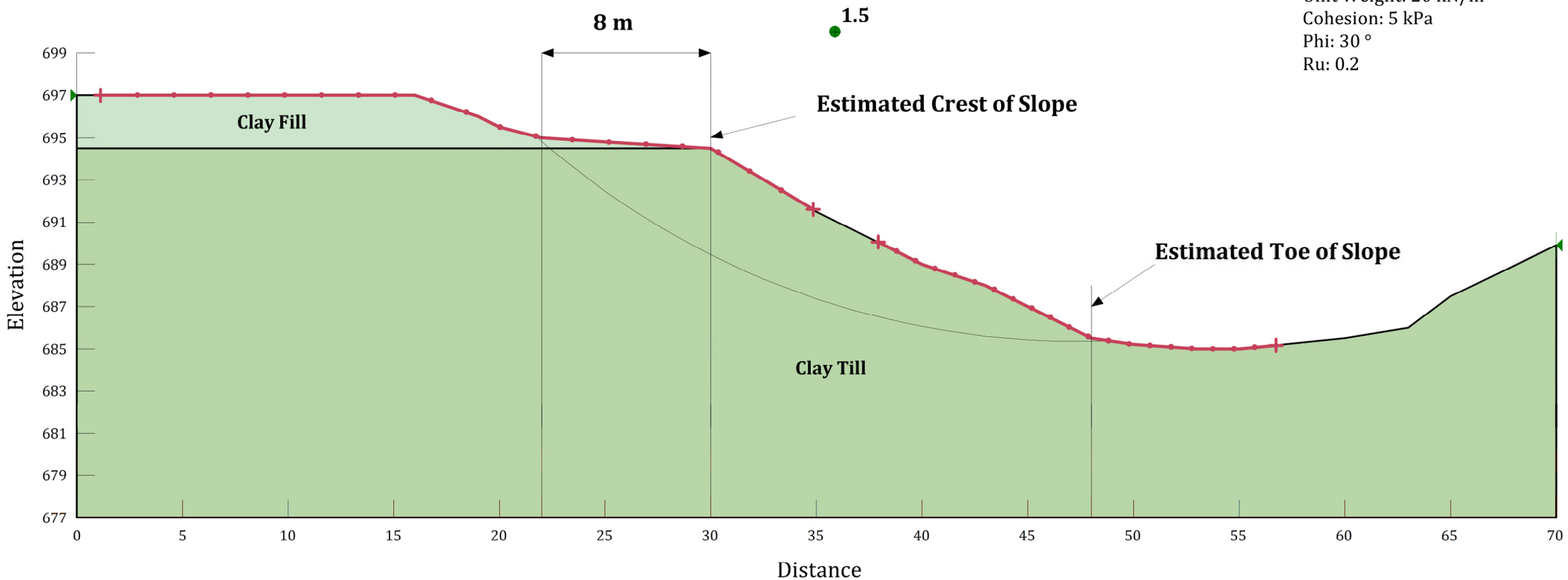
Appendix K-16A

Cross Section SPC-3

Seven Persons Creek
C12101372

Clay Fill
Unit Weight: 19 kN/m^3
Cohesion: 1 kPa
Phi: 27 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat Slope Setback Report

Cross Section SPC-3 Setback Slip Surface

A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

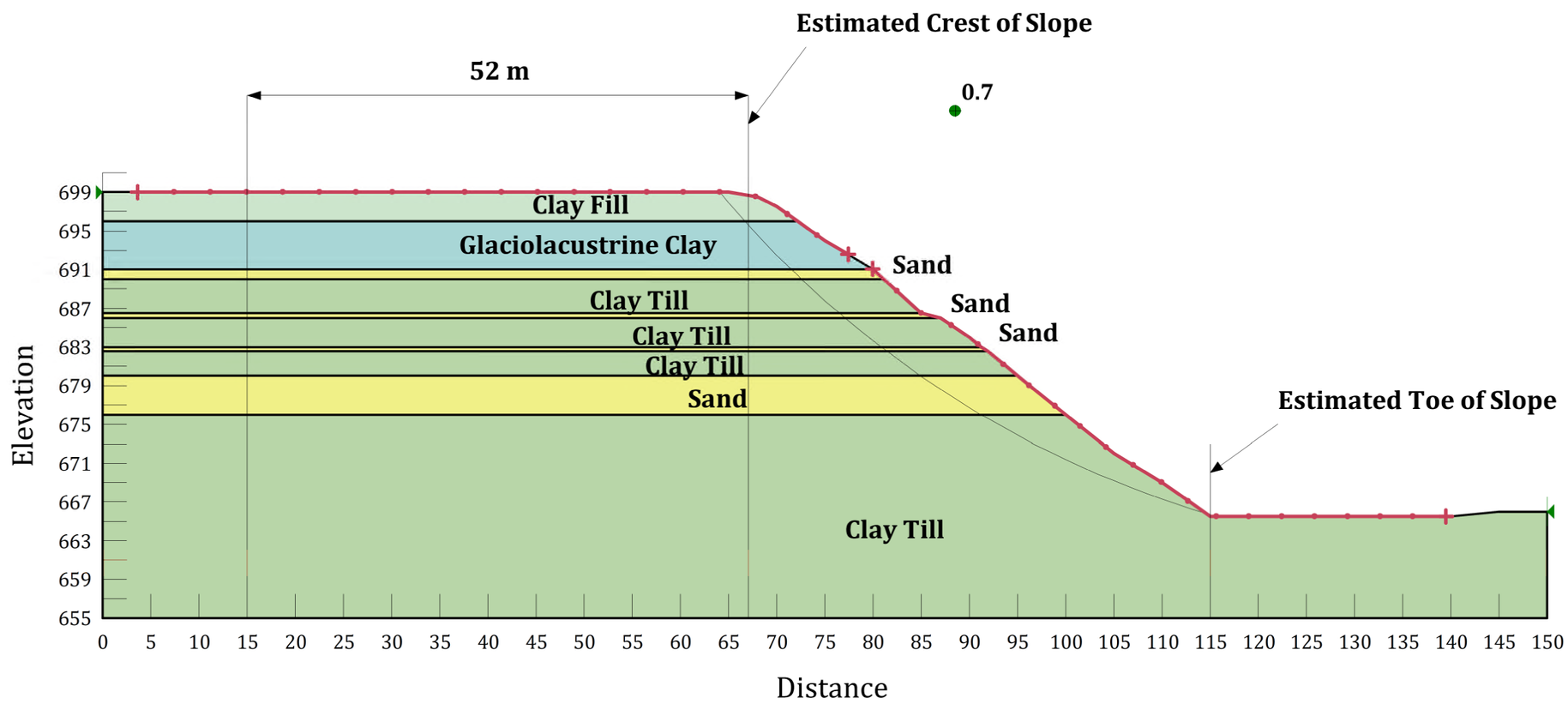
OFFICE
EBA-Riverbend

DATE
April 2014

Appendix K-16B

Cross Section SPC-4A

Seven Persons Creek
C12101372



Clay Fill
Unit Weight: 19 kN/m³
Cohesion: 1 kPa
Phi: 27 °
Ru: 0.2

Glaciolacustrine Clay
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SPC-4A
Critical Slip

A TETRA TECH COMPANY

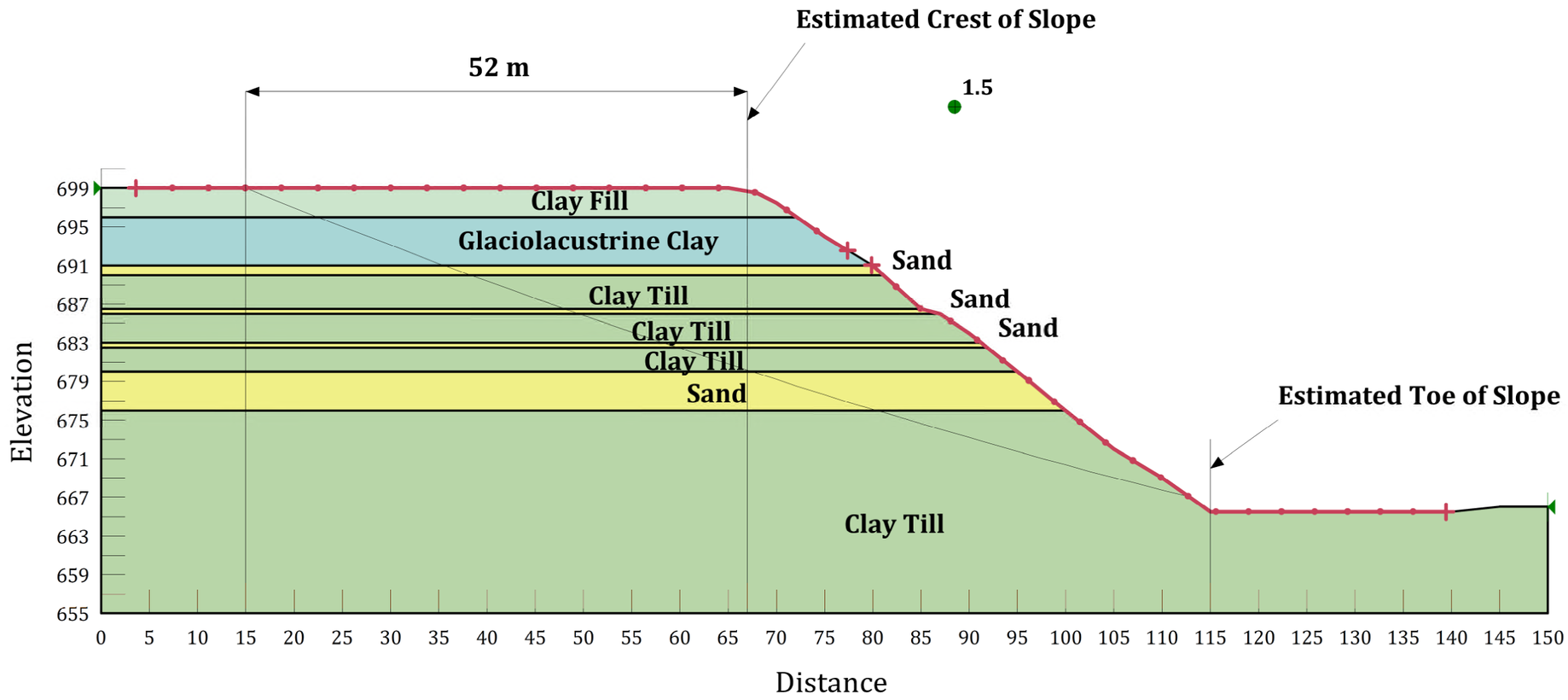
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-17A

Cross Section SPC-4A

Seven Persons Creek
C12101372



Clay Fill
Unit Weight: 19 kN/m^3
Cohesion: 1 kPa
Phi: 27 °
Ru: 0.2

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SPC-4A
Setback Slip Surface

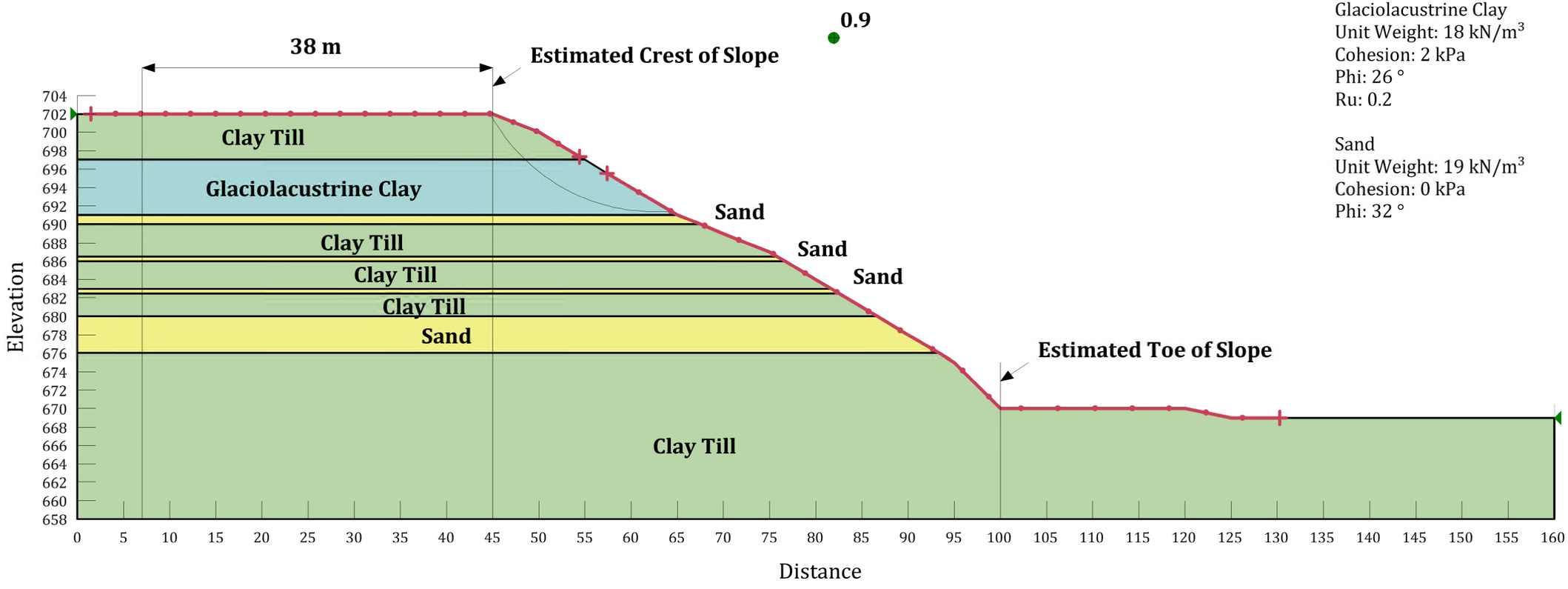
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE: EBA-Riverbend
DATE: April 2014

Appendix K-17B

Cross Section SPC-4B

Seven Persons Creek
C12101372



Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SPC-4B
Critical Slip

A TETRA TECH COMPANY

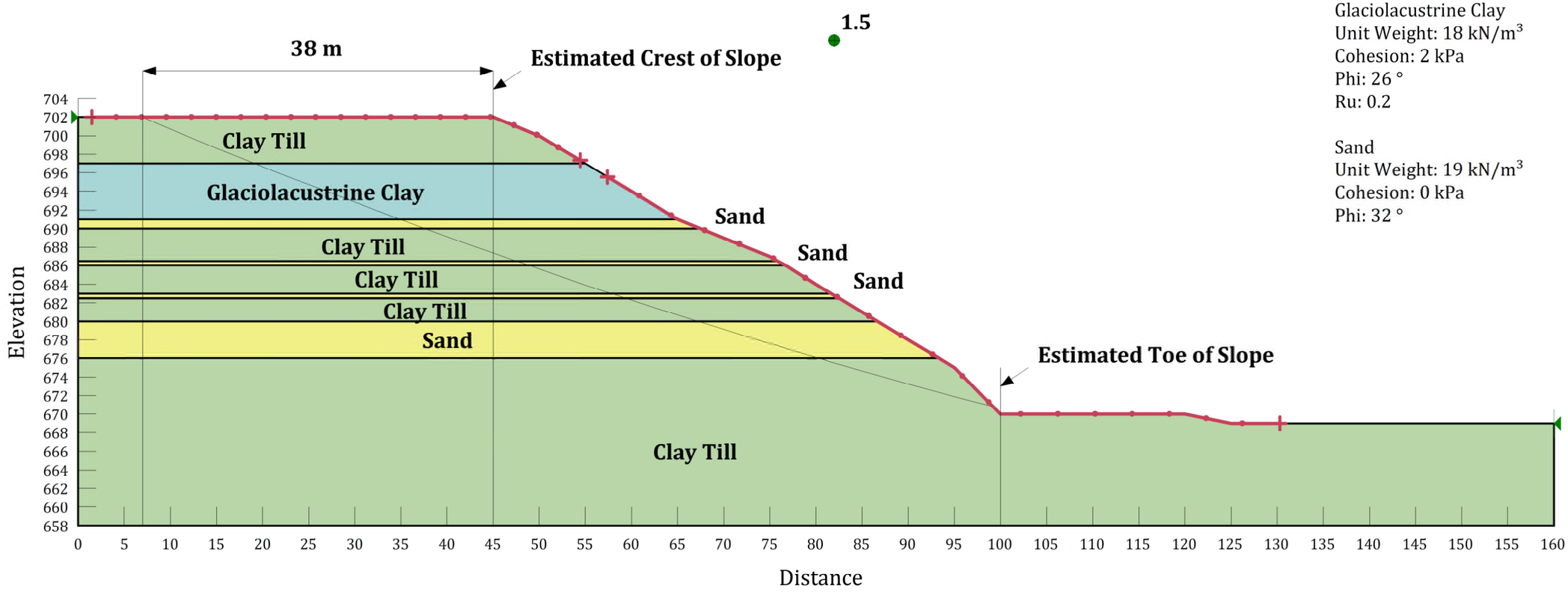
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-18A

Cross Section SPC-4B

Seven Persons Creek
C12101372



Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SPC-4B
Setback Slip Surface

A TETRA TECH COMPANY

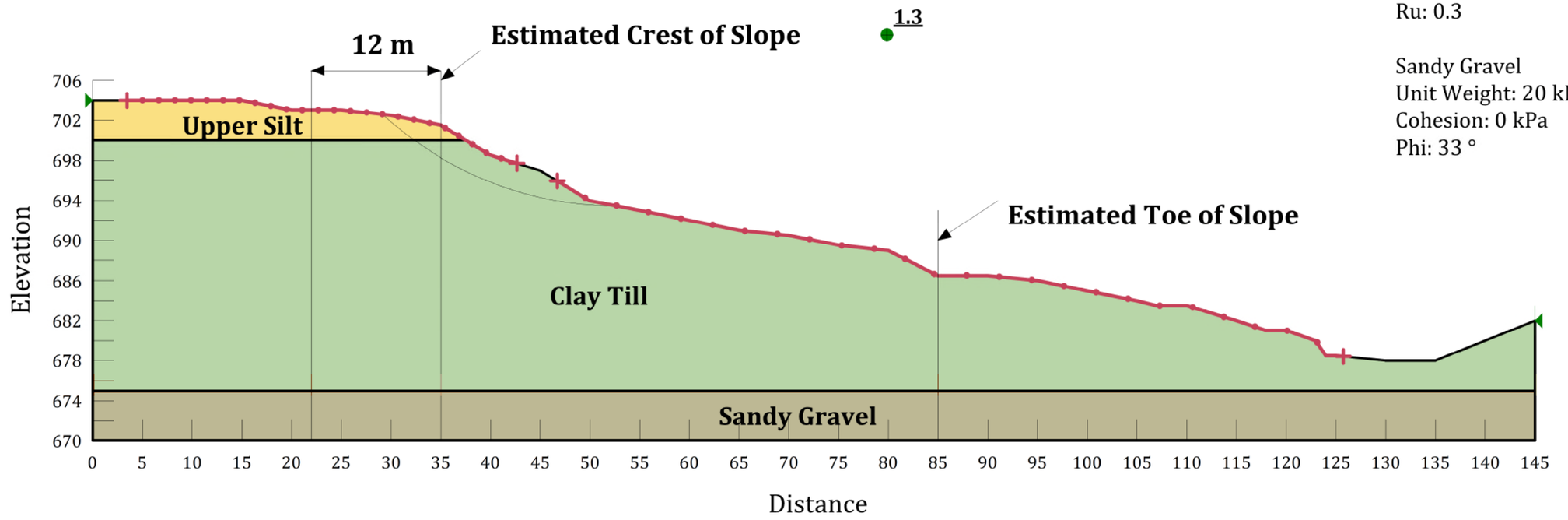
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-18B

Cross Section SPC-5

Seven Persons Creek
C12101372



Upper Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.3

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SPC-5
Critical Slip

eba
A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-19A

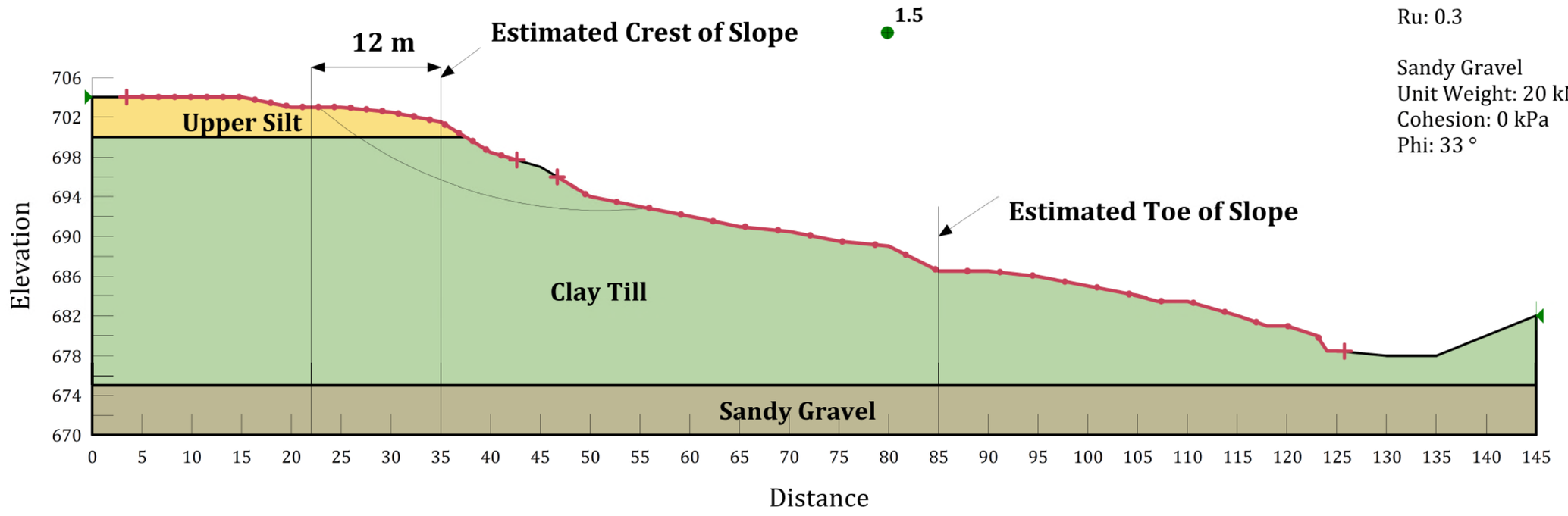
Cross Section SPC-5

Seven Persons Creek
C12101372

Upper Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.3

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °
Ru: 0.3



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat Slope Setback Report

Cross Section SPC-5 Setback Slip Surface

A TETRA TECH COMPANY

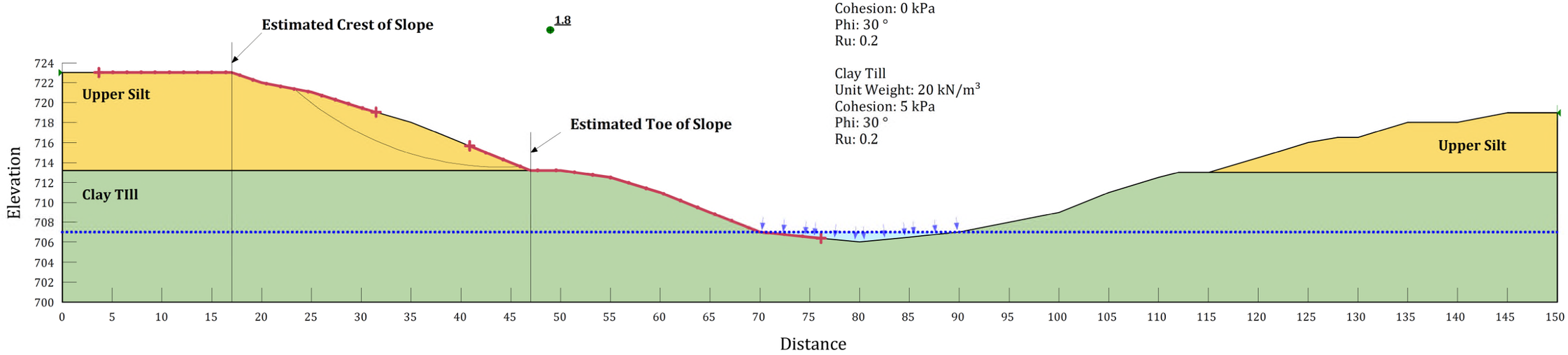
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE EBA-Riverbend
DATE April 2014

Appendix K-19B

Cross Section SPC-6

Seven Persons Creek
C12101372



Upper Silt
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SPC-6
Setback Slip Surface

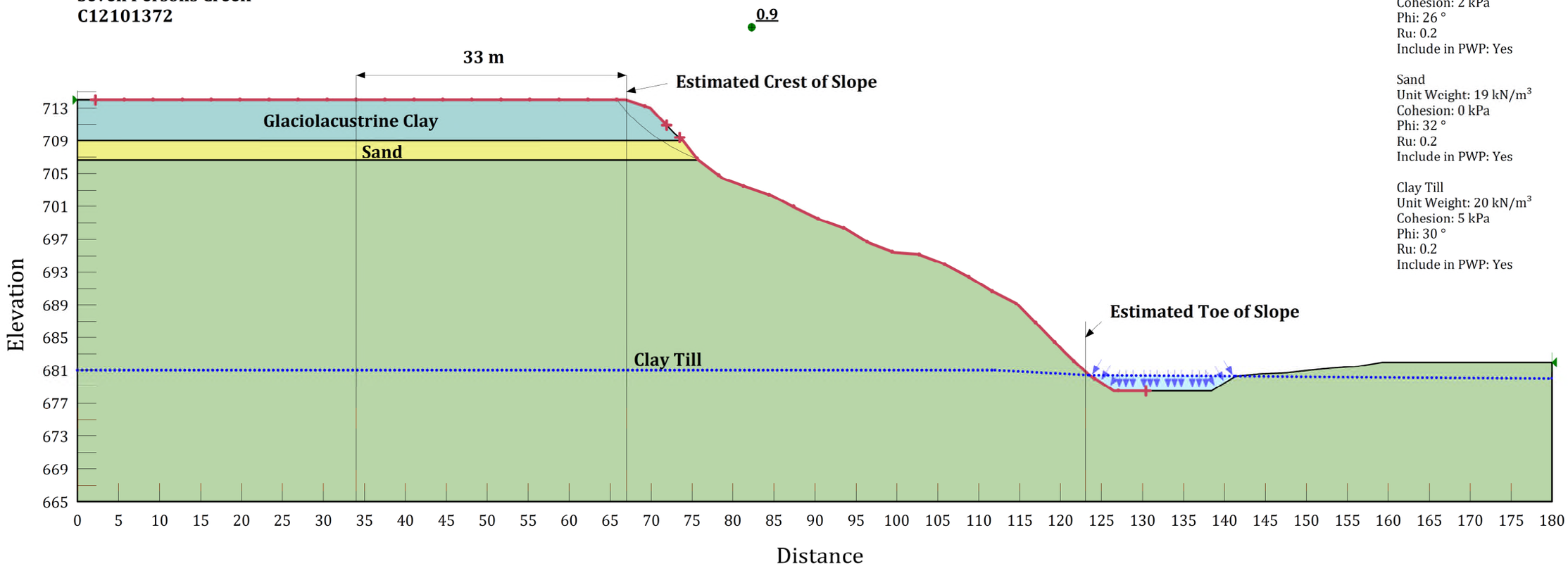
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-20

Cross Section SPC-7A

Eagle View Slide
Seven Persons Creek
C12101372



Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2
Include in PWP: Yes

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2
Include in PWP: Yes

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2
Include in PWP: Yes

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SPC-7A
Critical Slip

eba
A TETRA TECH COMPANY

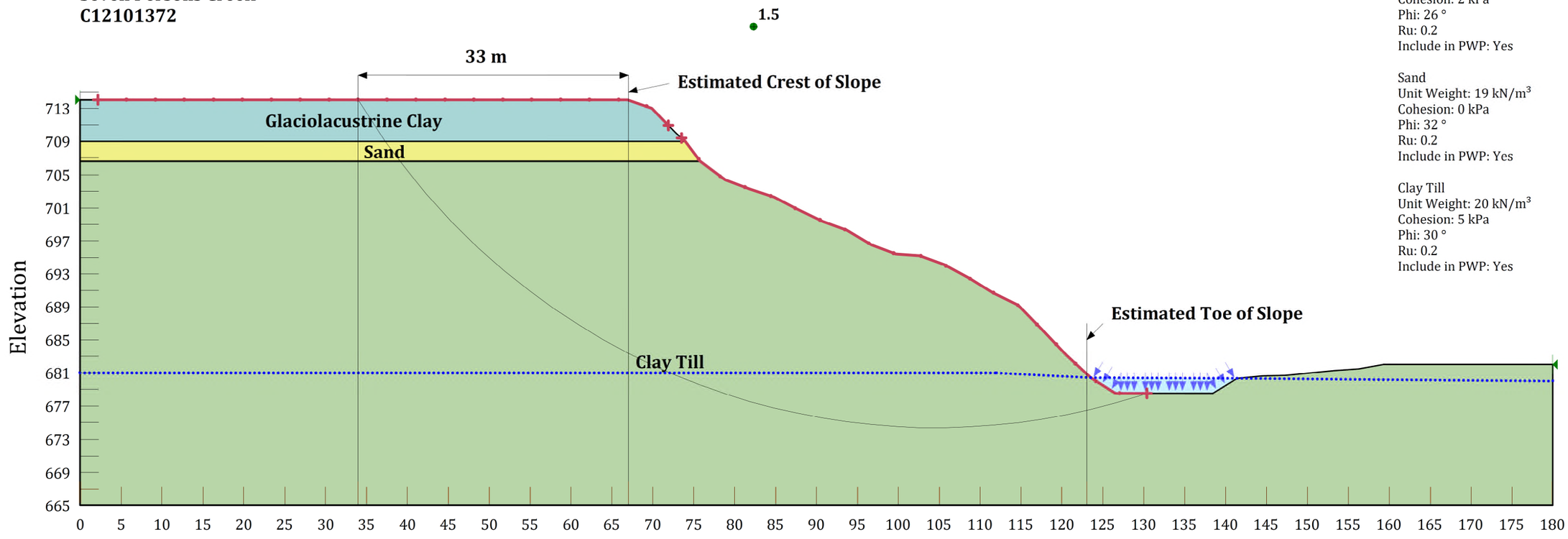
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-21A

Cross Section SPC-7A

Eagle View Slide
Seven Persons Creek
C12101372



Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2
Include in PWP: Yes

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2
Include in PWP: Yes

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2
Include in PWP: Yes

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SPC-7A
Setback Slip Surface

A TETRA TECH COMPANY

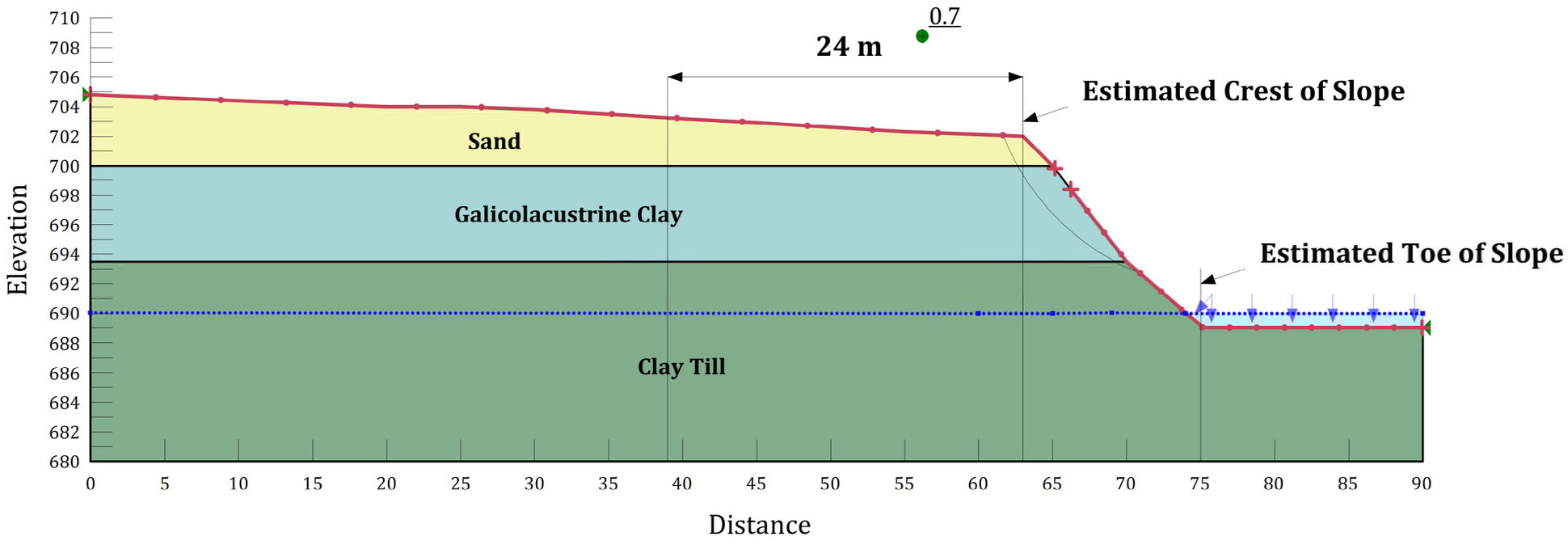
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-21B

Cross Section SPC-7B

Canyon Creek Slide
Seven Persons Creek
C12101372



Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat Slope Setback Report

Cross Section SPC-7B Critical Slip

A TETRA TECH COMPANY

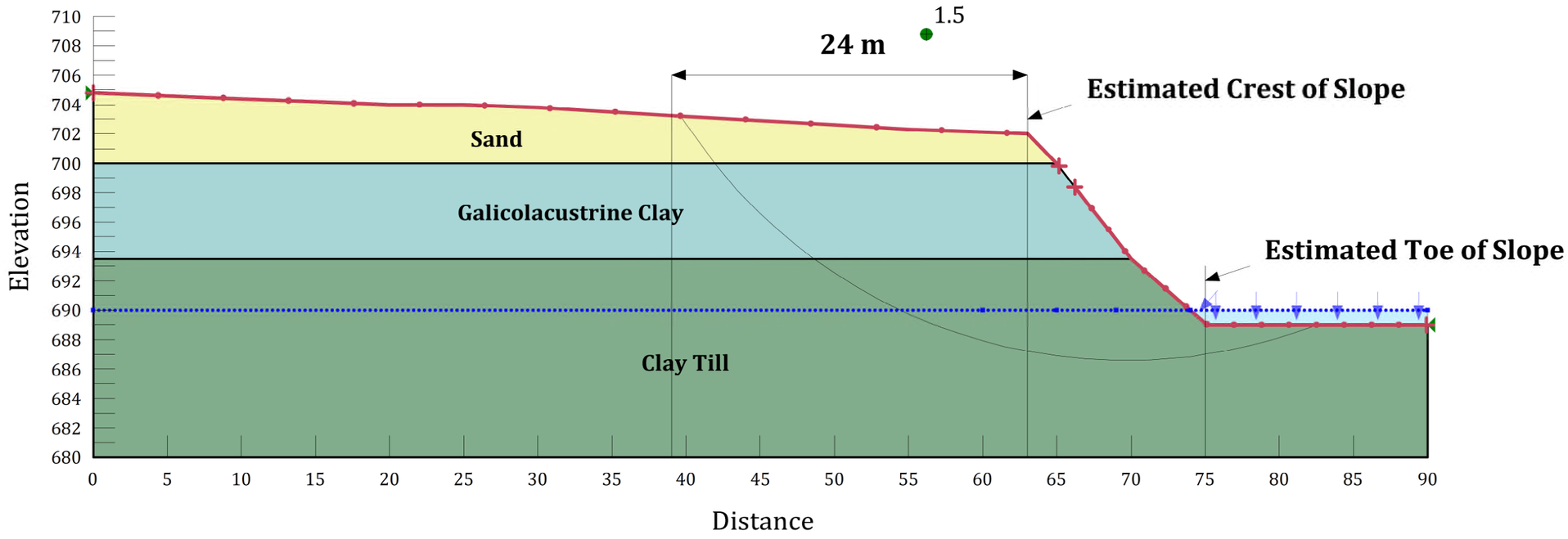
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-22A

Cross Section SPC-7B

Canyon Creek Slide
Seven Persons Creek
C12101372



Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SPC-7B
Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

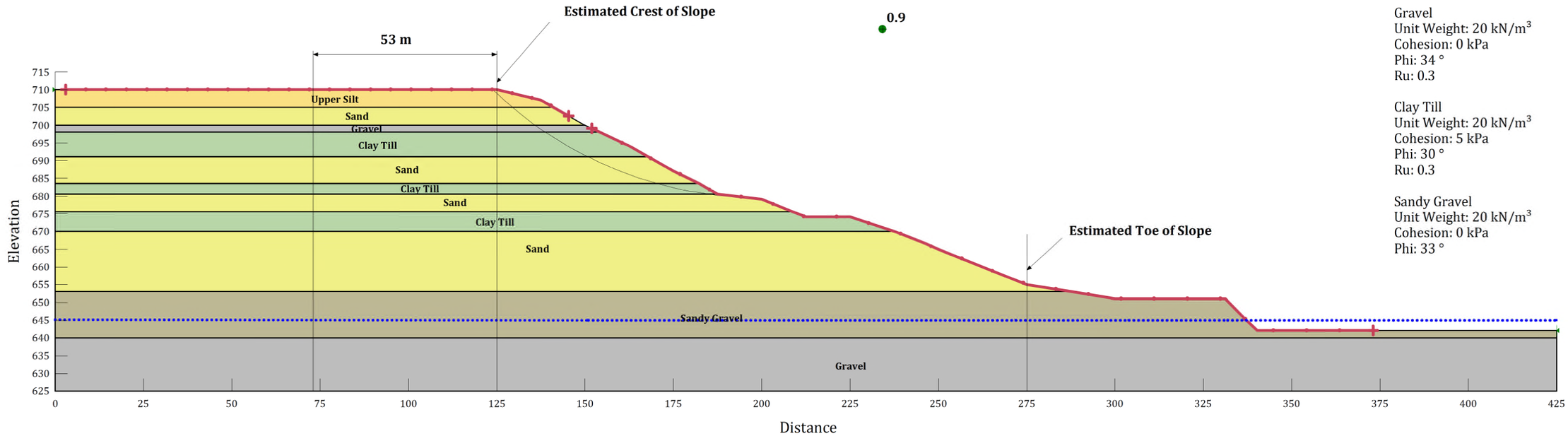
OFFICE
EBA-Riverbend

DATE
April 2014

Appendix K-22B

Cross Section SSR-1A

Fertilizer Plant Slide
South Saskatchewan River
C12101372



Upper Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.3

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.3

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °
Ru: 0.3

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-1A
Critical Slip

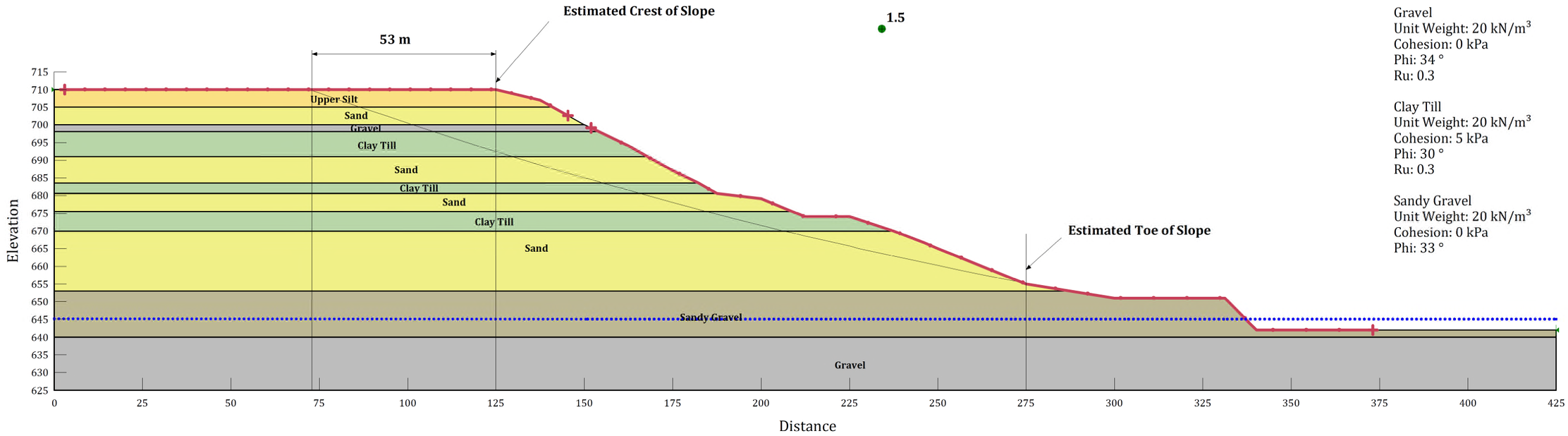
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-23A

Cross Section SSR-1A

Fertilizer Plant Slide
South Saskatchewan River
C12101372



Upper Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.3

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.3

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °
Ru: 0.3

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-1A
Setback Slip Surface

A TETRA TECH COMPANY

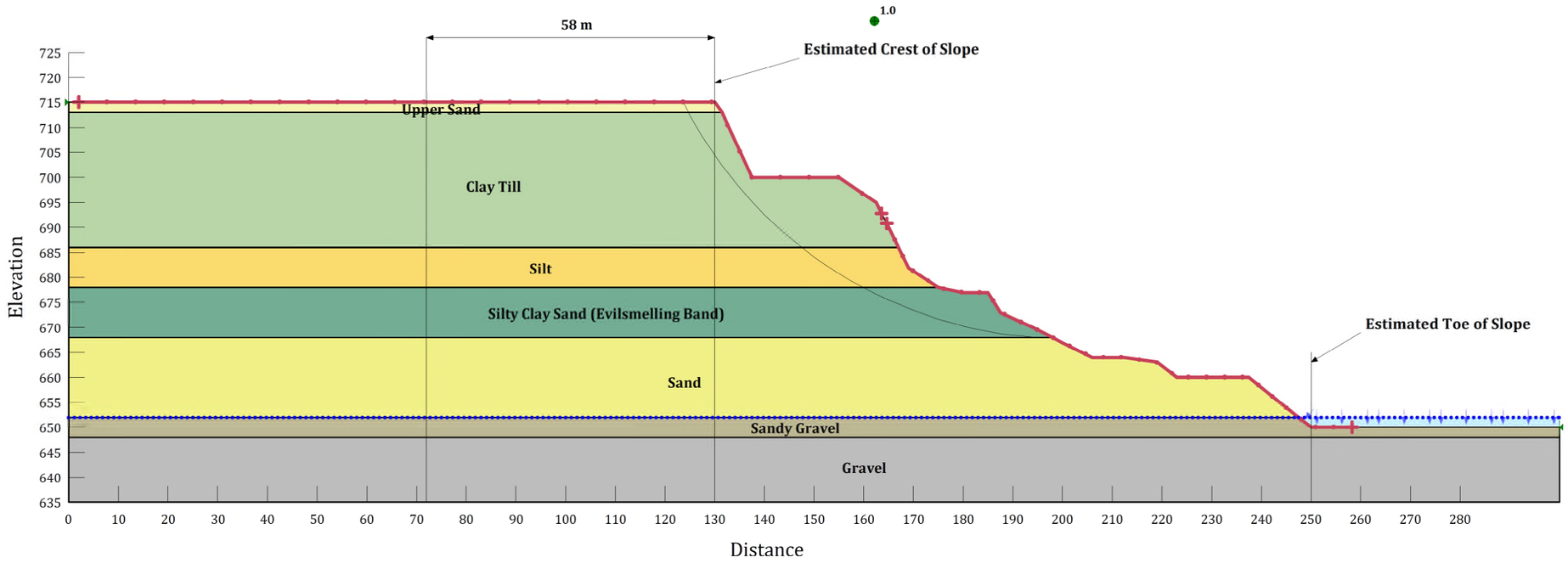
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-23B

Cross Section SSR-1B

Evilsmelling Bluff Slide
South Saskatchewan River
C1201372



Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Silty Clay Sand (Evilsmelling Band)
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-1B
Critical Slip

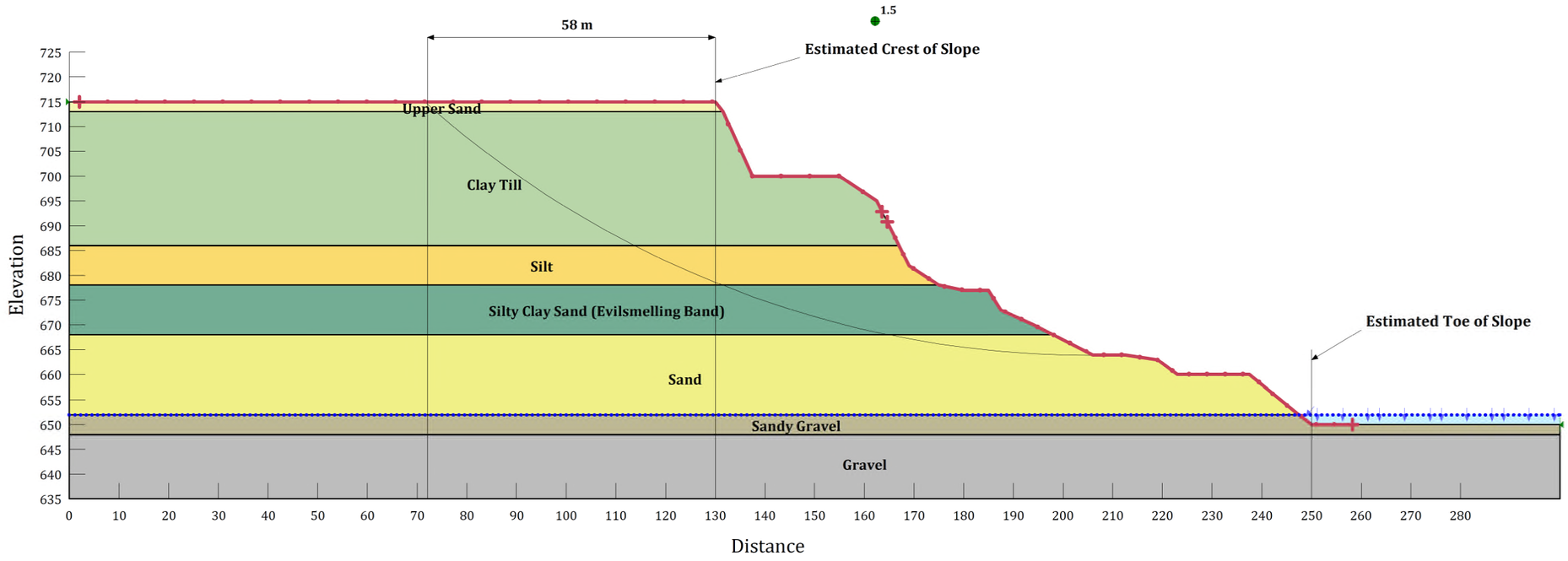
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-24A

Cross Section SSR-1B

Evilsmelling Bluff Slide
South Saskatchewan River
C1201372



Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Silty Clay Sand (Evilsmelling Band)
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-1B
Setback Slip Surface

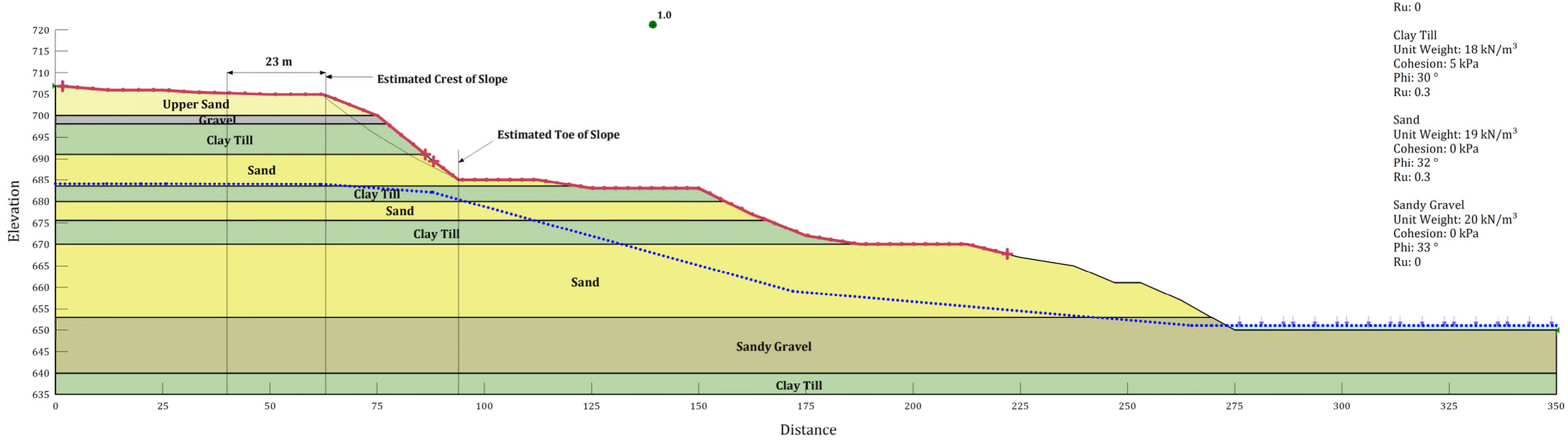
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-24B

Cross Section SSR-1C

Rattlesnake Slide
South Saskatchewan River
C1201372



Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.3

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °
Ru: 0

Clay Till
Unit Weight: 18 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.3

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °
Ru: 0

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

eba
A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-1C
Critical Slip

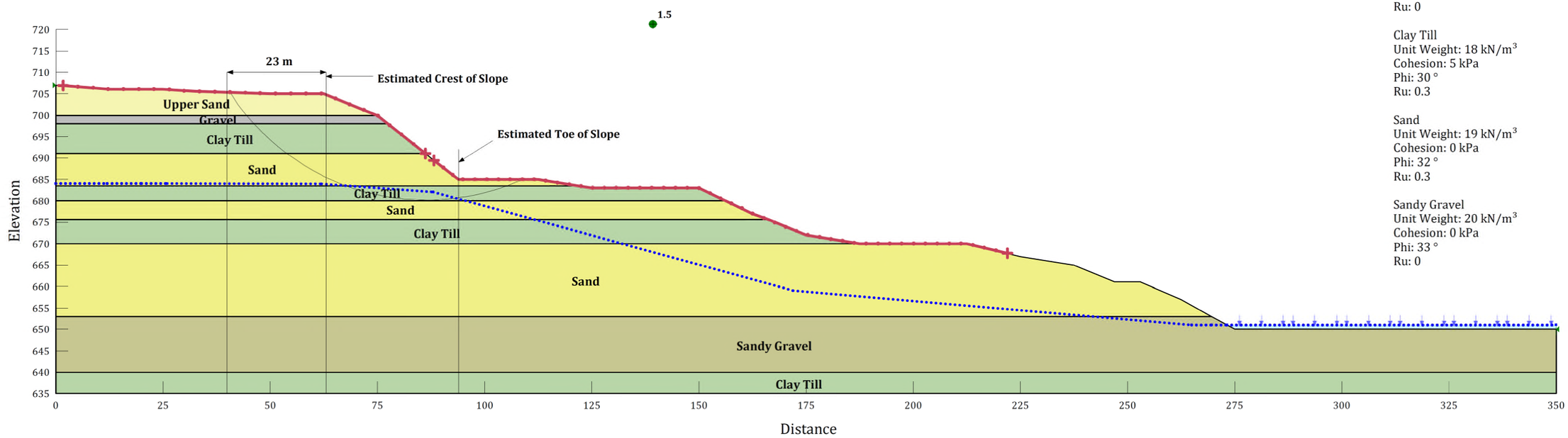
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-25A

Cross Section SSR-1C

Rattlesnake Slide
South Saskatchewan River
C1201372



Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.3

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °
Ru: 0

Clay Till
Unit Weight: 18 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.3

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °
Ru: 0

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-1C
Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-25B

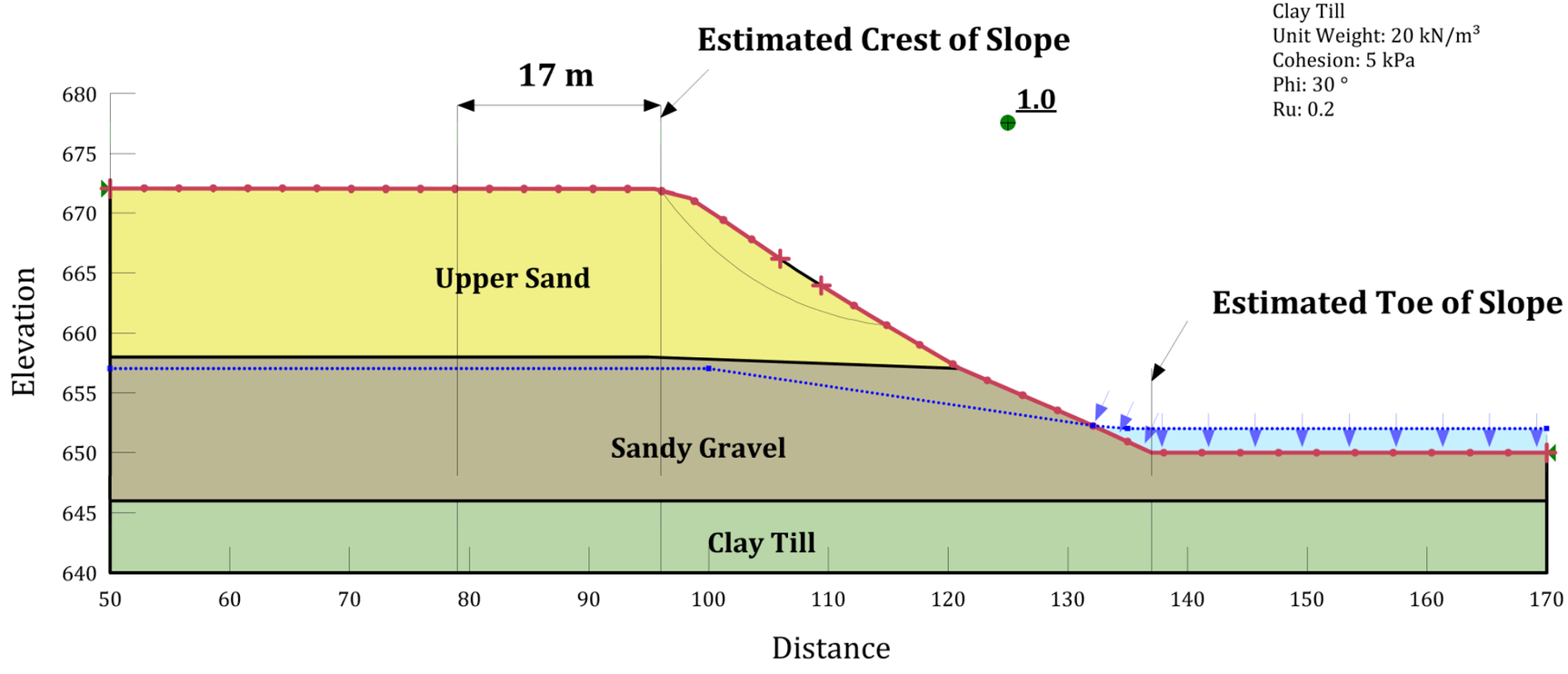
Cross Section SSR-2

South Saskatchewan River
C12101372

Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat Slope Setback Report

Cross Section SSR-2 Critical Slip

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE: EBA-Riverbend
DATE: April 2014

Appendix K-26A

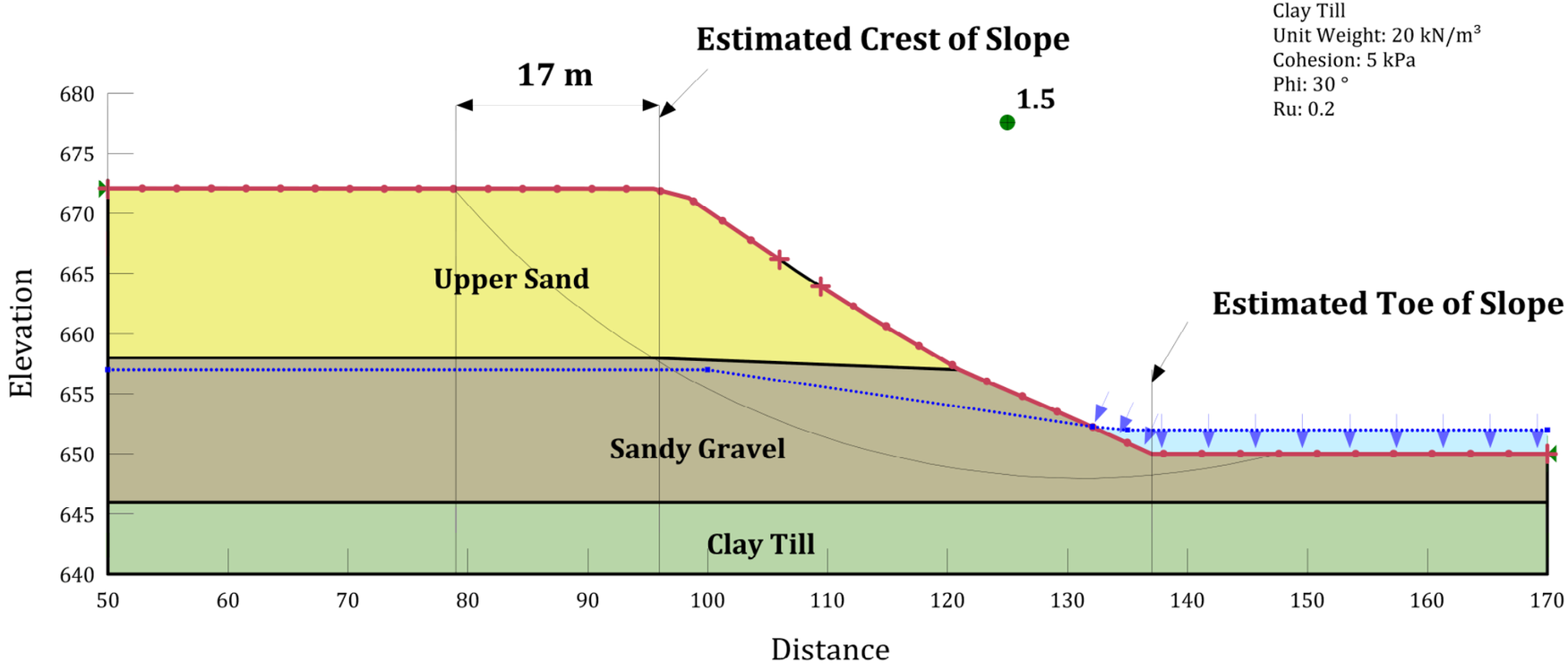
Cross Section SSR-2

South Saskatchewan River
C12101372

Upper Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Sandy Gravel
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 33 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat Slope Setback Report

Cross Section SSR-2 Setback Slip Surface

A TETRA TECH COMPANY

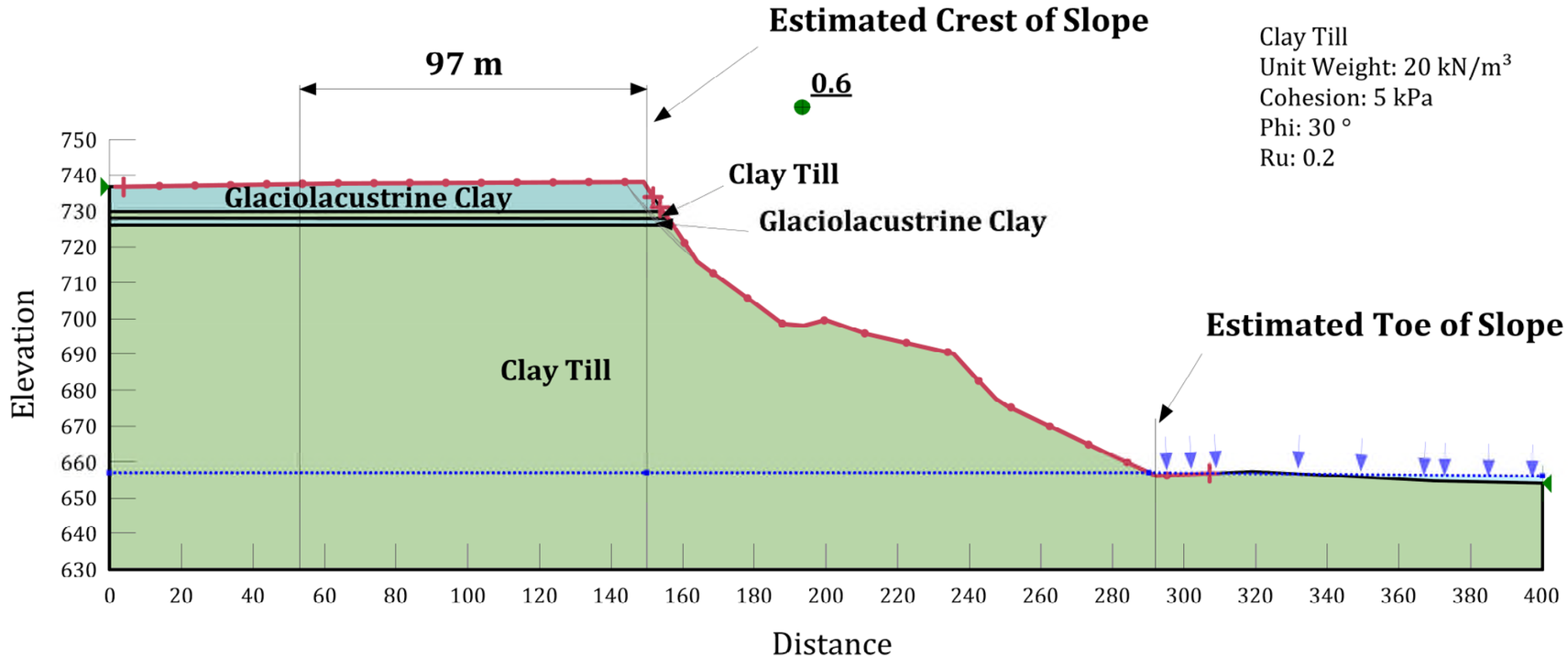
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE: EBA-Riverbend
DATE: April 2014

Appendix K-26B

Cross Section SSR-3

Police Point Slide
South Saskatchewan River
C12101372



Glaciolacustrne Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-3
Critical Slip

A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

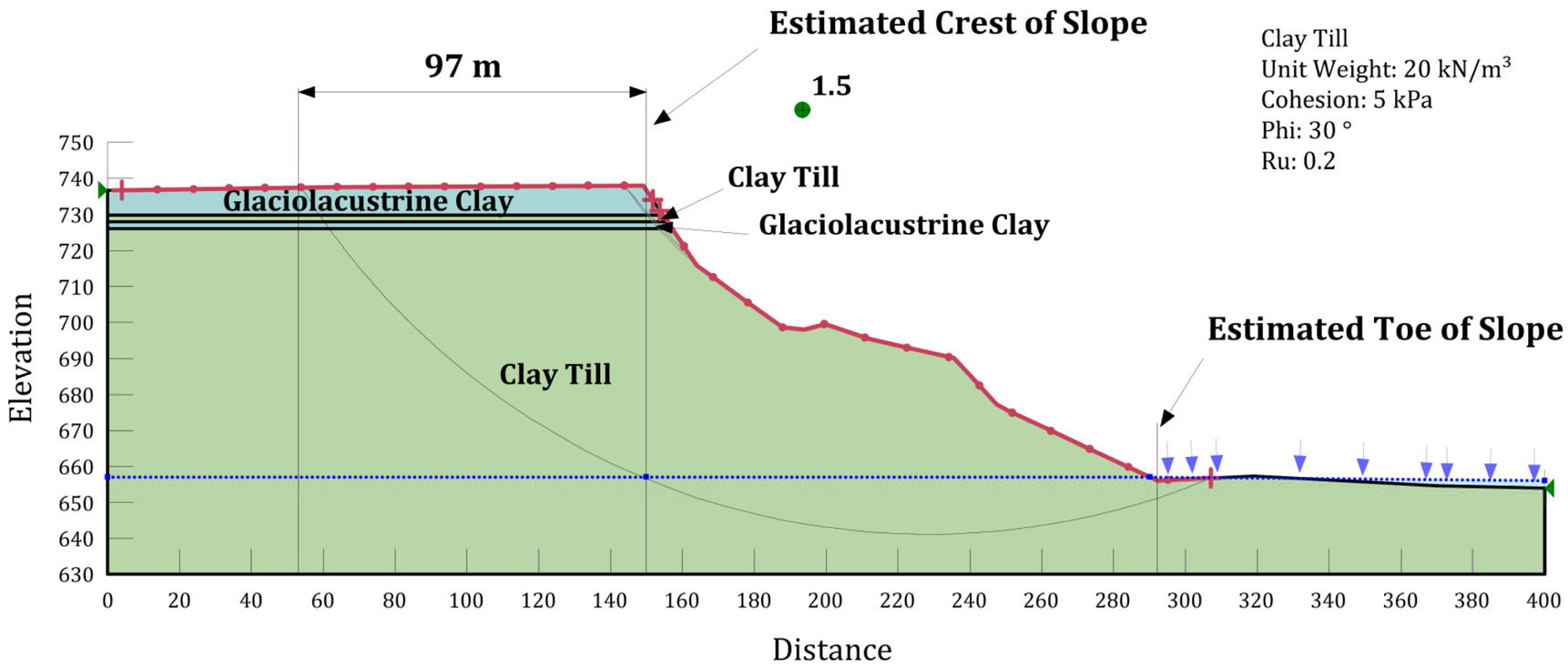
OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-27A

C:\Users\becky.wohlgemuth\Desktop\App K\K-27A.doc

Cross Section SSR-3

Police Point Slide
South Saskatchewan River
C12101372



Glaciolacustrne Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-3
Setback Slip Surface

A TETRA TECH COMPANY

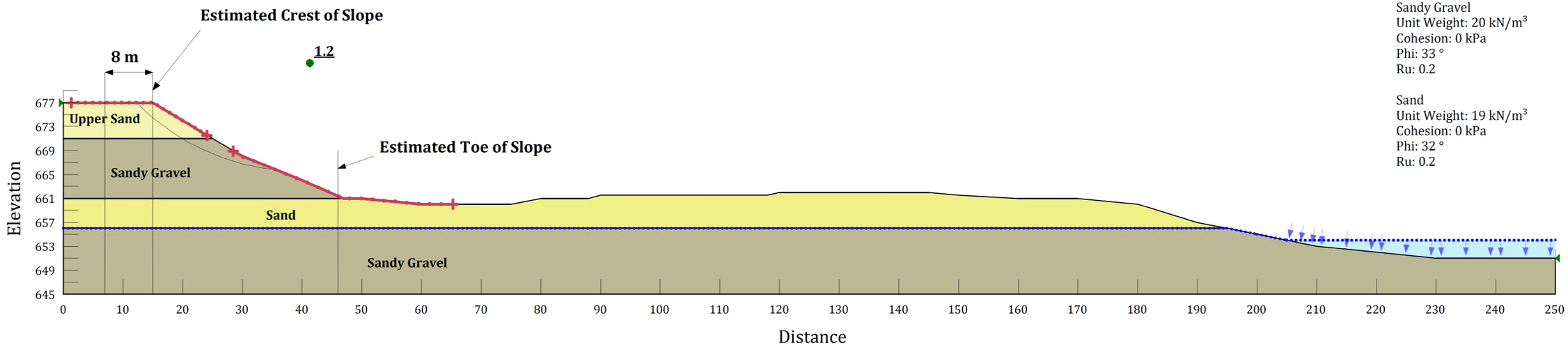
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-27B

Cross Section SSR-4

South Saskatchewan River
C12101372



Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-4
Critical Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE
EBA-Riverbend

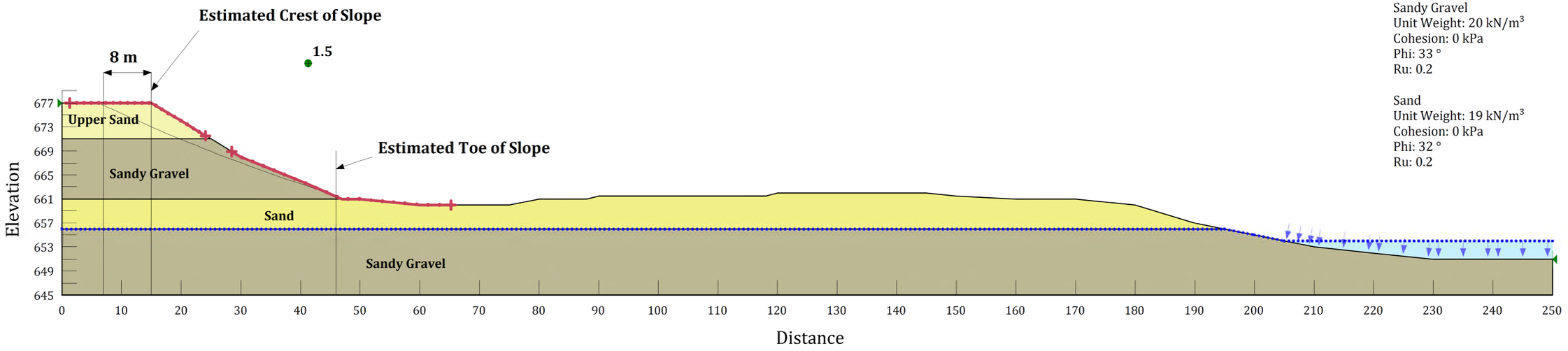
DATE
April 2014

Appendix K-28A

C:\Users\becky.wohlgemuth\Desktop\App K\K-28A.doc

Cross Section SSR-4

South Saskatchewan River
C12101372



Upper Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Sandy Gravel
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 33 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-4
Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

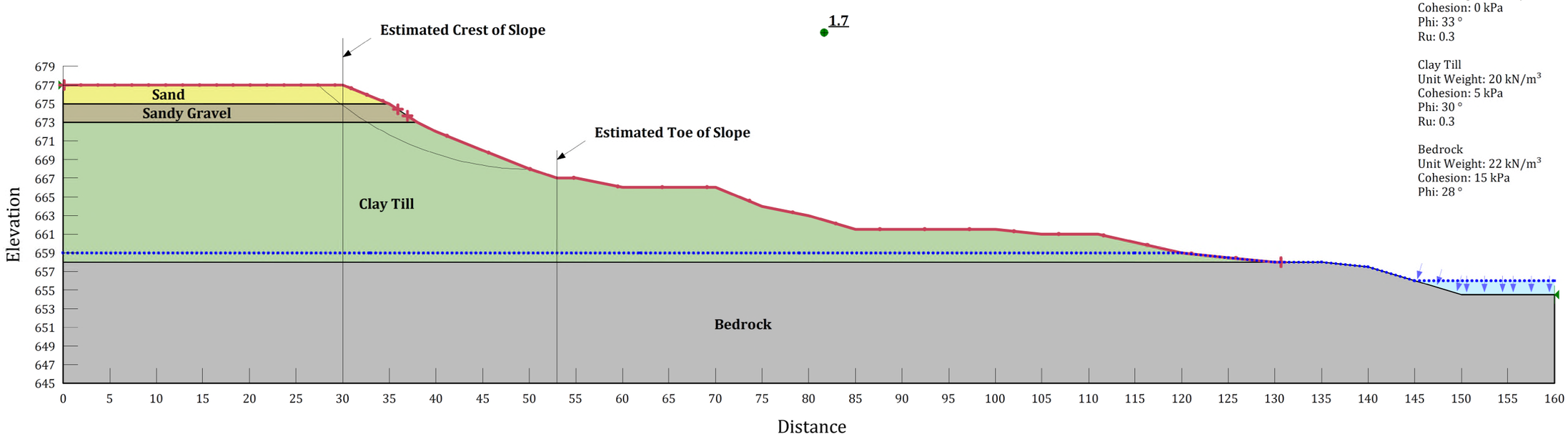
OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-28B

C:\Users\becky.wohlgemuth\Desktop\App K\K-28B.doc

Cross Section SSR-5A

South Saskatchewan River
C12101372



Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.3

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °
Ru: 0.3

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

Bedrock
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-5A
Setback Slip Surface

A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

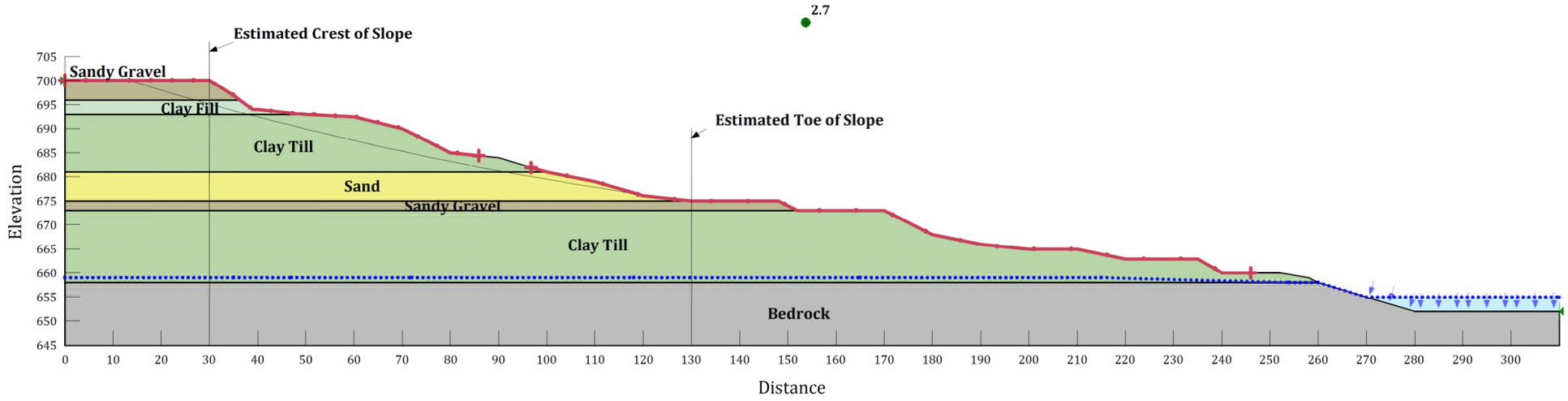
OFFICE
EBA-Riverbend

DATE
April 2014

Appendix K-29

Cross Section SSR-5B

South Saskatchewan River
C12101372



Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °

Clay Fill
Unit Weight: 19 kN/m^3
Cohesion: 1 kPa
Phi: 27 °
Ru: 0.2

Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °

Bedrock
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-5B
Setback Slip Surface

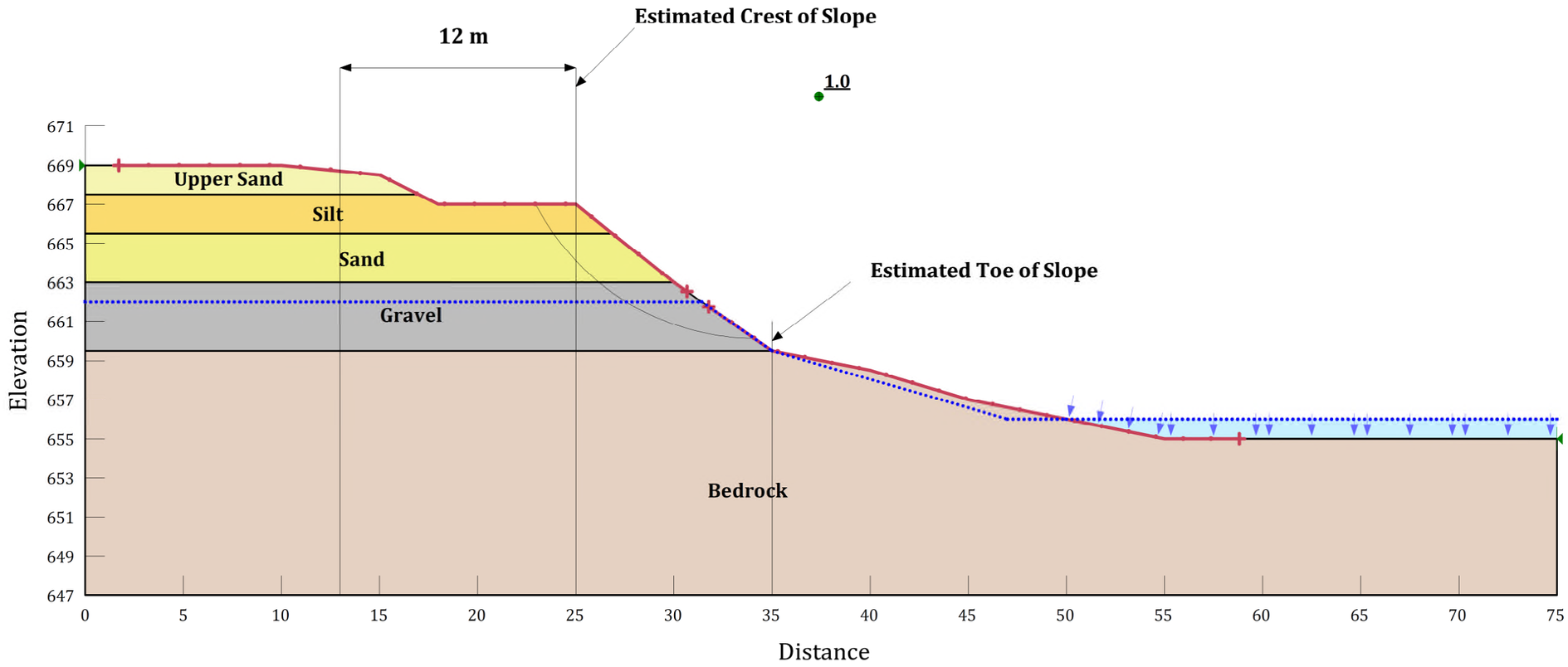
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-30

Cross Section SSR-6

South Saskatchewan River
C12101372



Upper Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Silt
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Gravel
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Bedrock
Unit Weight: 22 kN/m³
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-6
Critical Slip

A TETRA TECH COMPANY

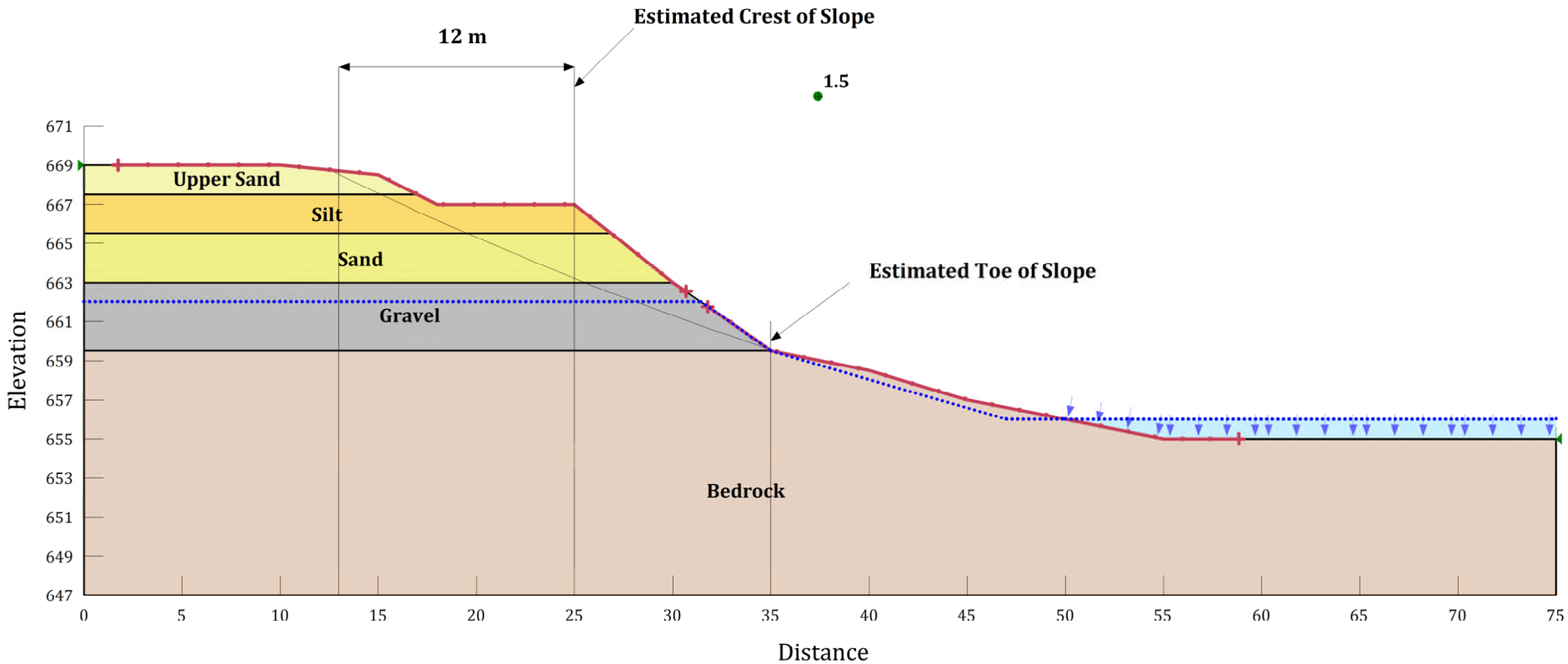
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-31A

Cross Section SSR-6

South Saskatchewan River
C12101372



Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °

Bedrock
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-6
Setback Slip Surface

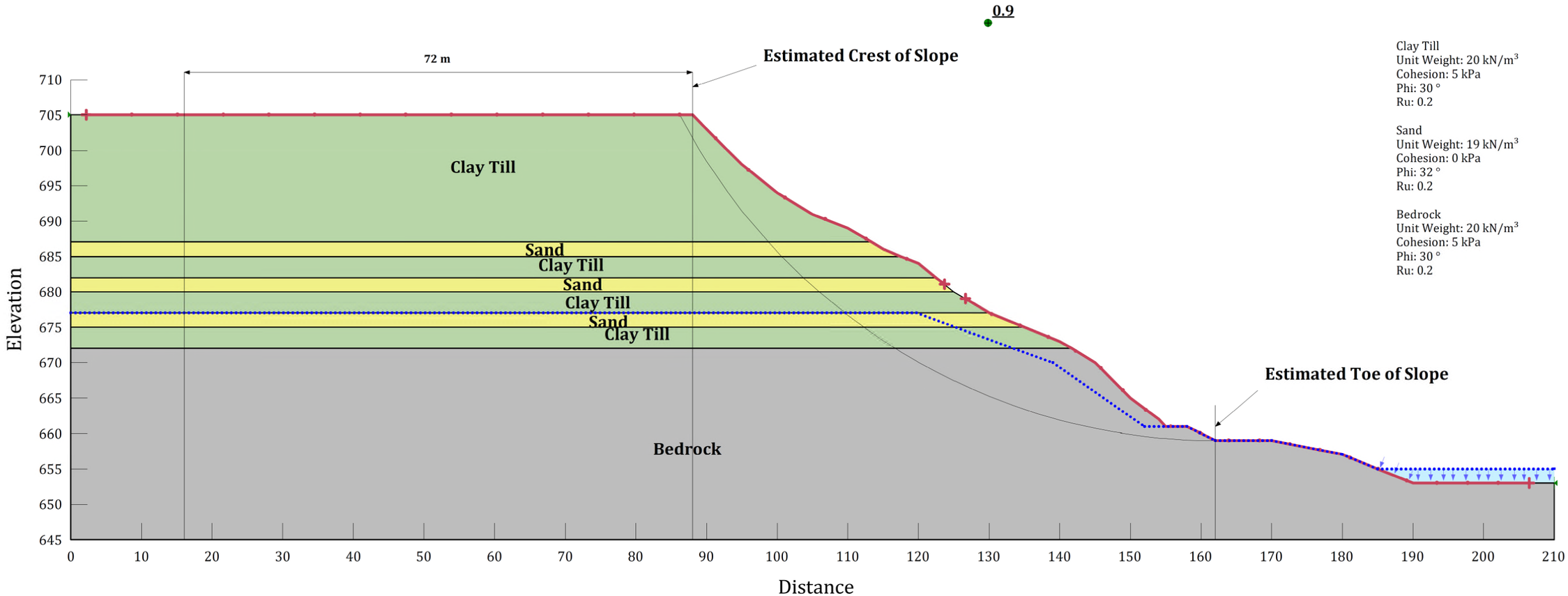
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-31B

Cross Section SSR-7

South Saskatchewan River
C12101372



Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Bedrock
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

eba
A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-7
Critical Slip

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

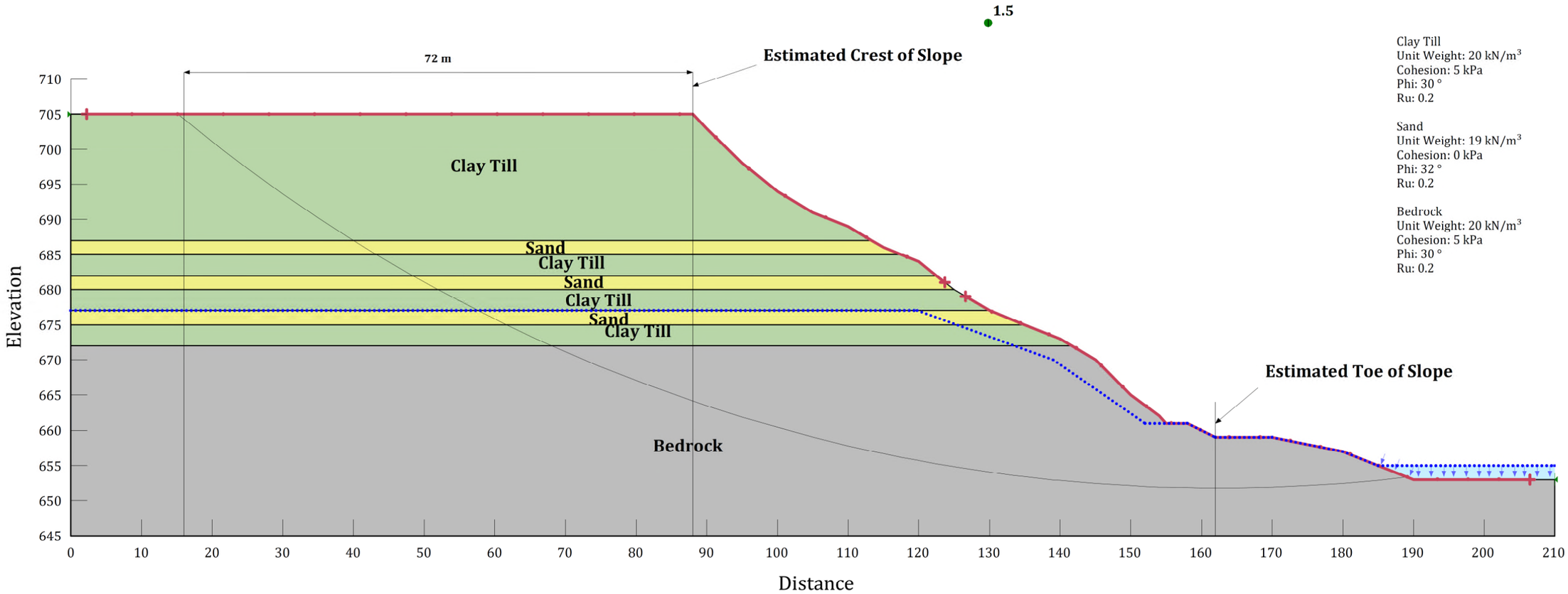
OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-32A

C:\Users\becky.wohlgemuth\Desktop\App K\K-32A.doc

Cross Section SSR-7

South Saskatchewan River
C12101372



Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Bedrock
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.2

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

eba
A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-7
Setback Slip Surface

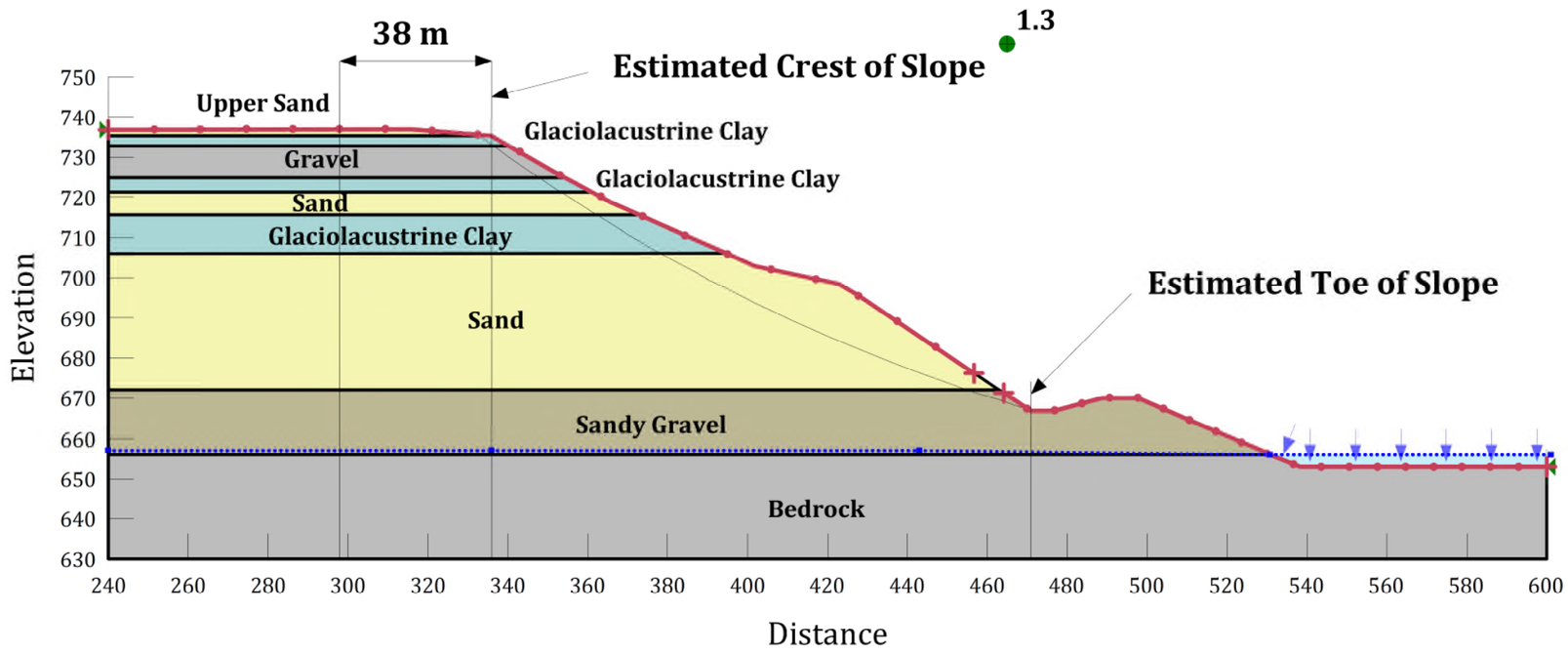
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-32B

Cross Section SSR-8

Surprise Bluffs
South Saskatchewan River
C12101372



Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °

Bedrock
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-8
Critical Slip

eba
A TETRA TECH COMPANY

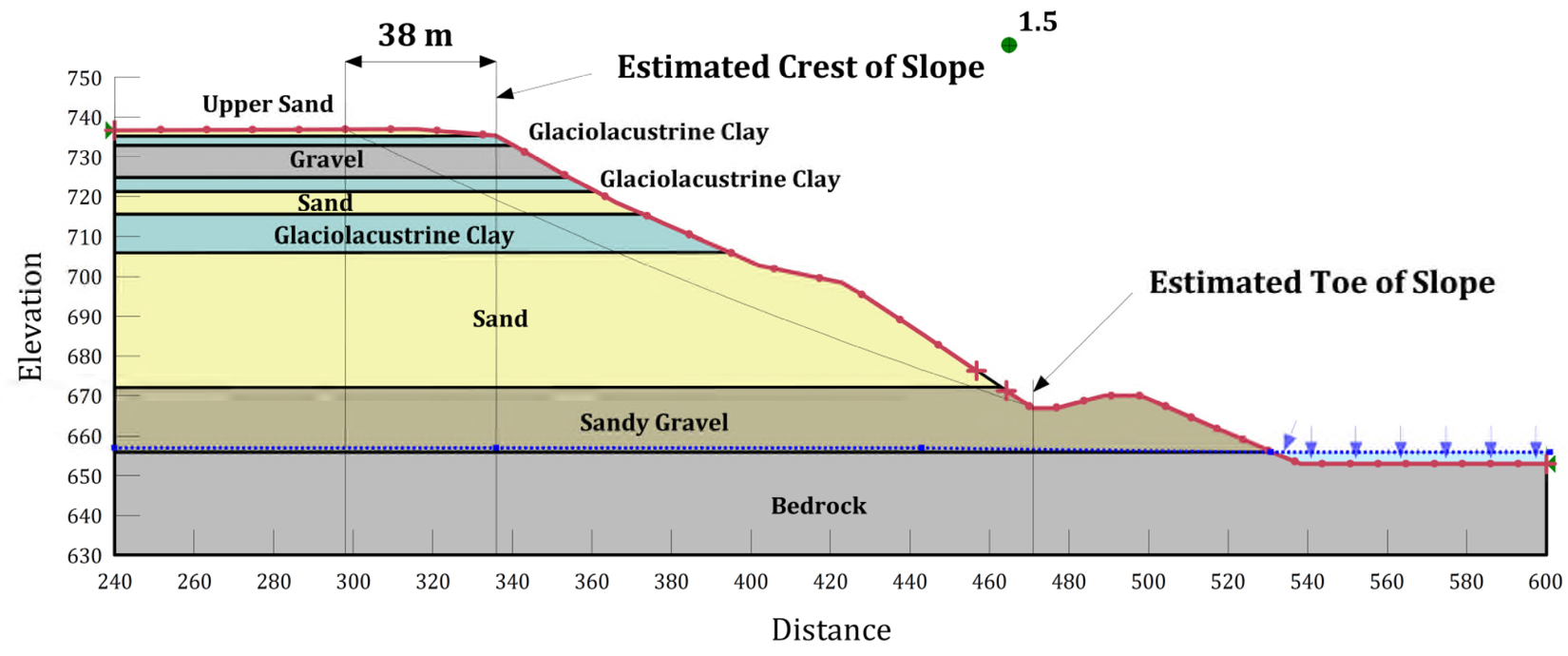
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE: EBA-Riverbend
DATE: April 2014

Appendix K-33A

Cross Section SSR-8

Surprise Bluffs
South Saskatchewan River
C12101372



Upper Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 30 °
Ru: 0.2

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 34 °

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °

Bedrock
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-8
Setback Slip Surface

A TETRA TECH COMPANY

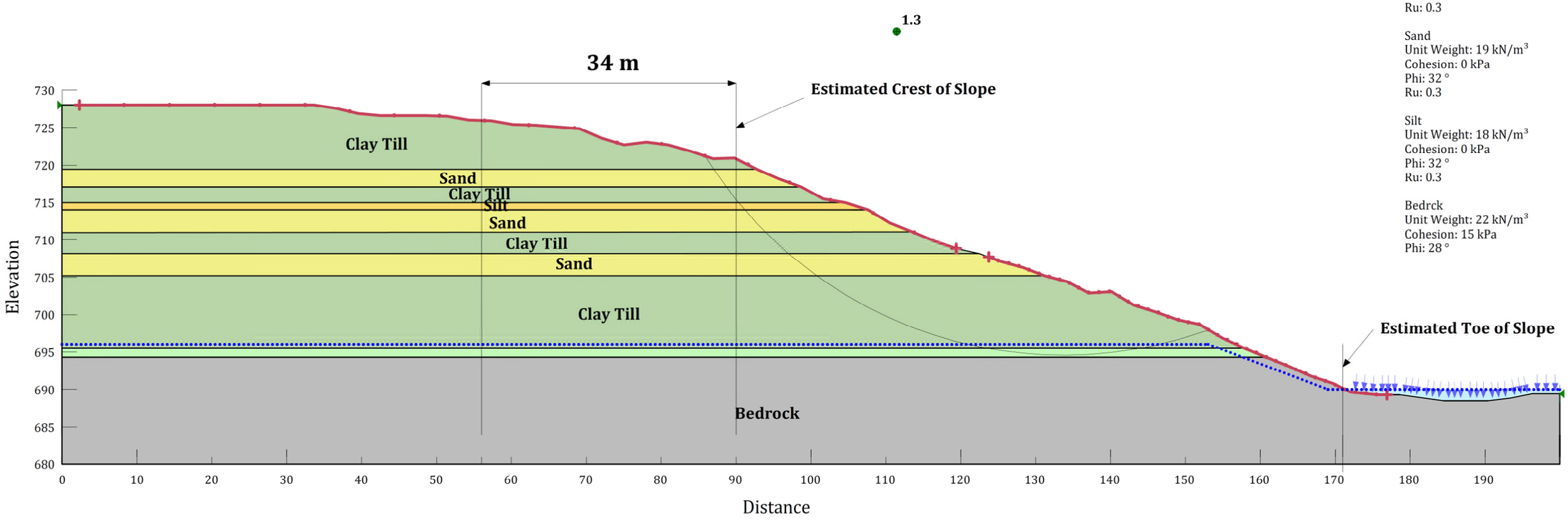
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE EBA-Riverbend
DATE April 2014

Appendix K-33B

Cross Section SSR-9A

South Saskatchewan River
C12101372



Clay Till
Unit Weight: 20 kN/m^3
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.3

Silt
Unit Weight: 18 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.3

Bedrck
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-9A
Critical Slip

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

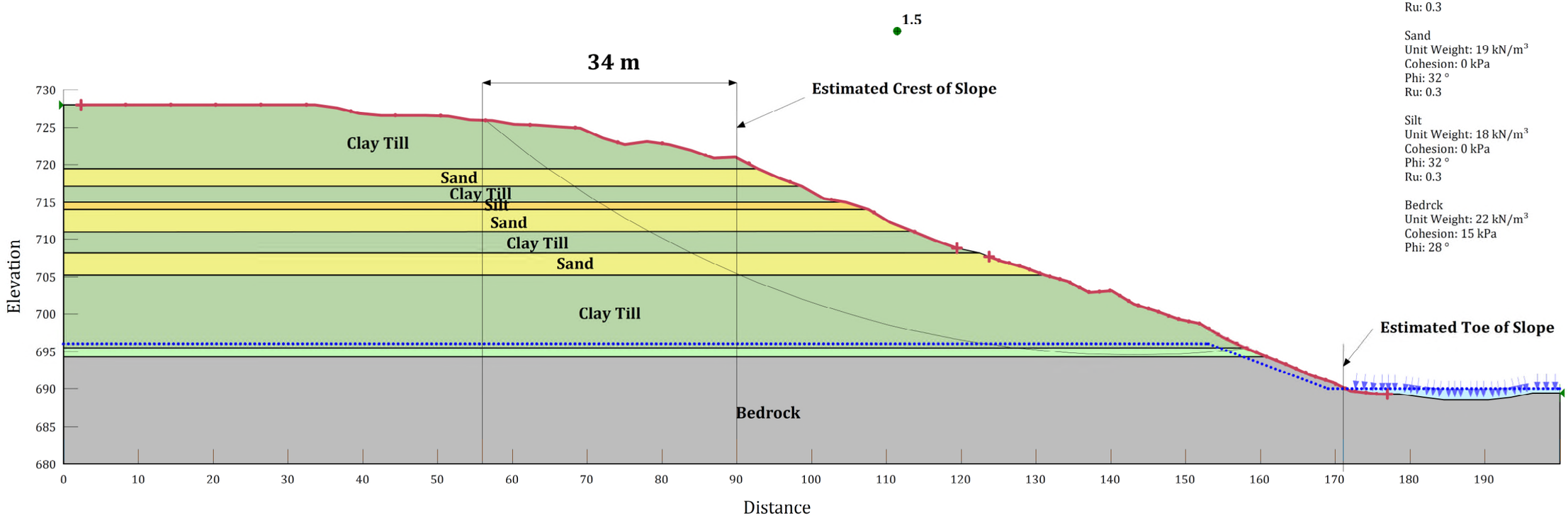
OFFICE
EBA-Riverbend

DATE
April 2014

Appendix K-34A

Cross Section SSR-9A

South Saskatchewan River
C12101372



Clay Till
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 30 °
Ru: 0.3

Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.3

Silt
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.3

Bedrck
Unit Weight: 22 kN/m³
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-9A
Setback Slip Surface

A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE
EBA-Riverbend

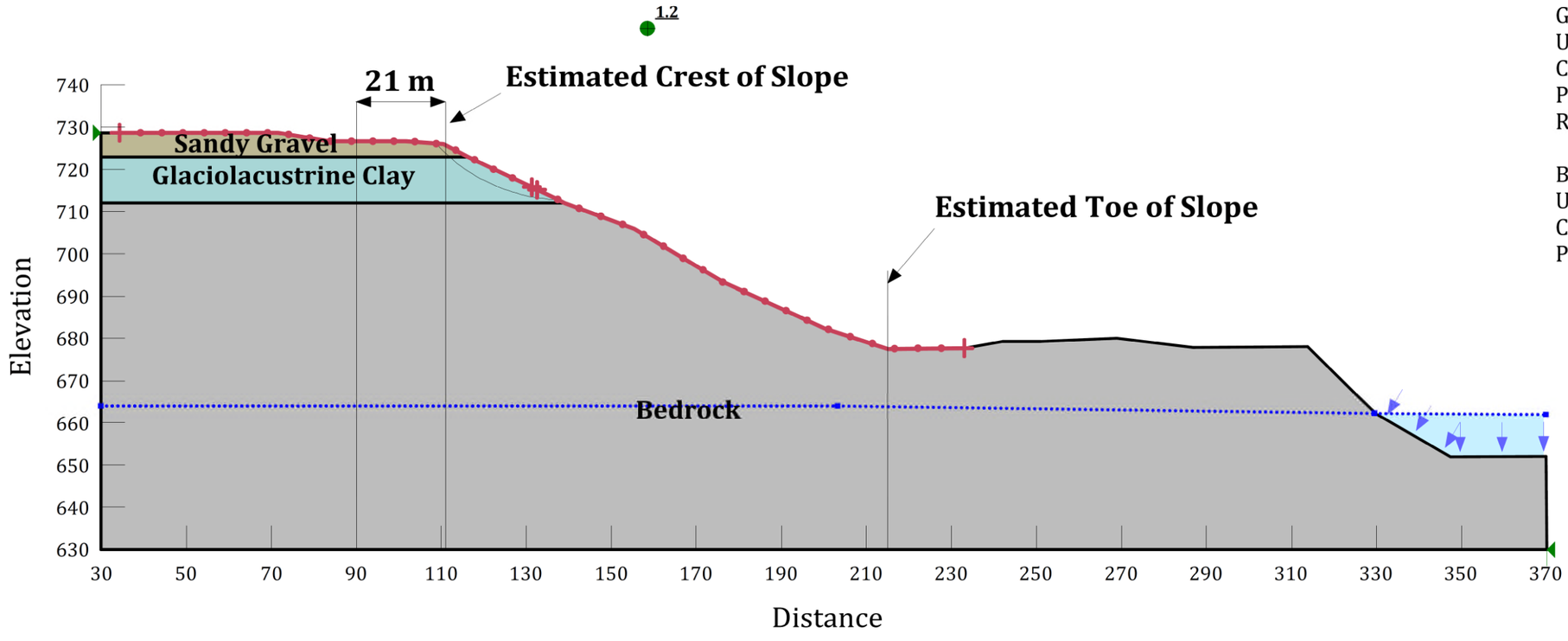
DATE
April 2014

Appendix K-34B

Cross Section SSR-9B

South Saskatchewan River

C12101372



Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Bedrock
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-9B
Critical Slip

A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

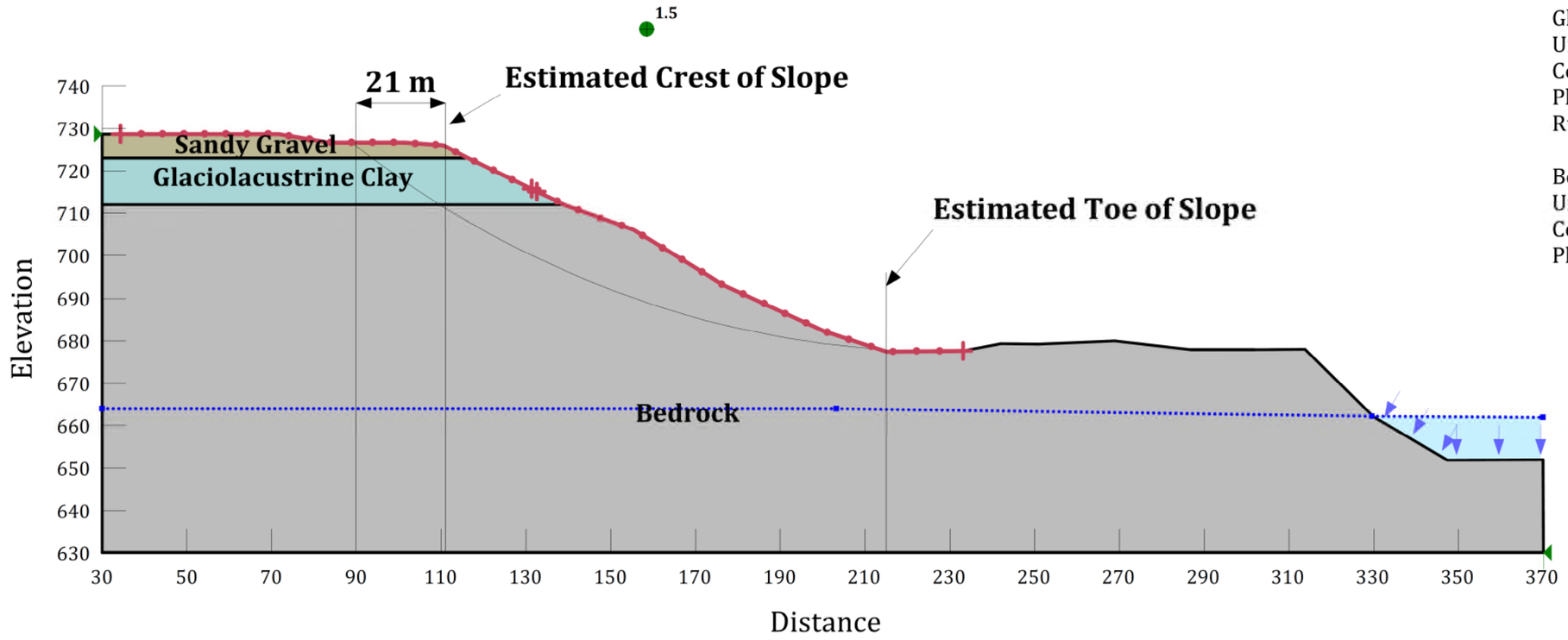
OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-35A

Cross Section SSR-9B

South Saskatchewan River

C12101372



Sandy Gravel
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 33 °

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Bedrock
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-9B
Setback Slip Surface

eba
A TETRA TECH COMPANY

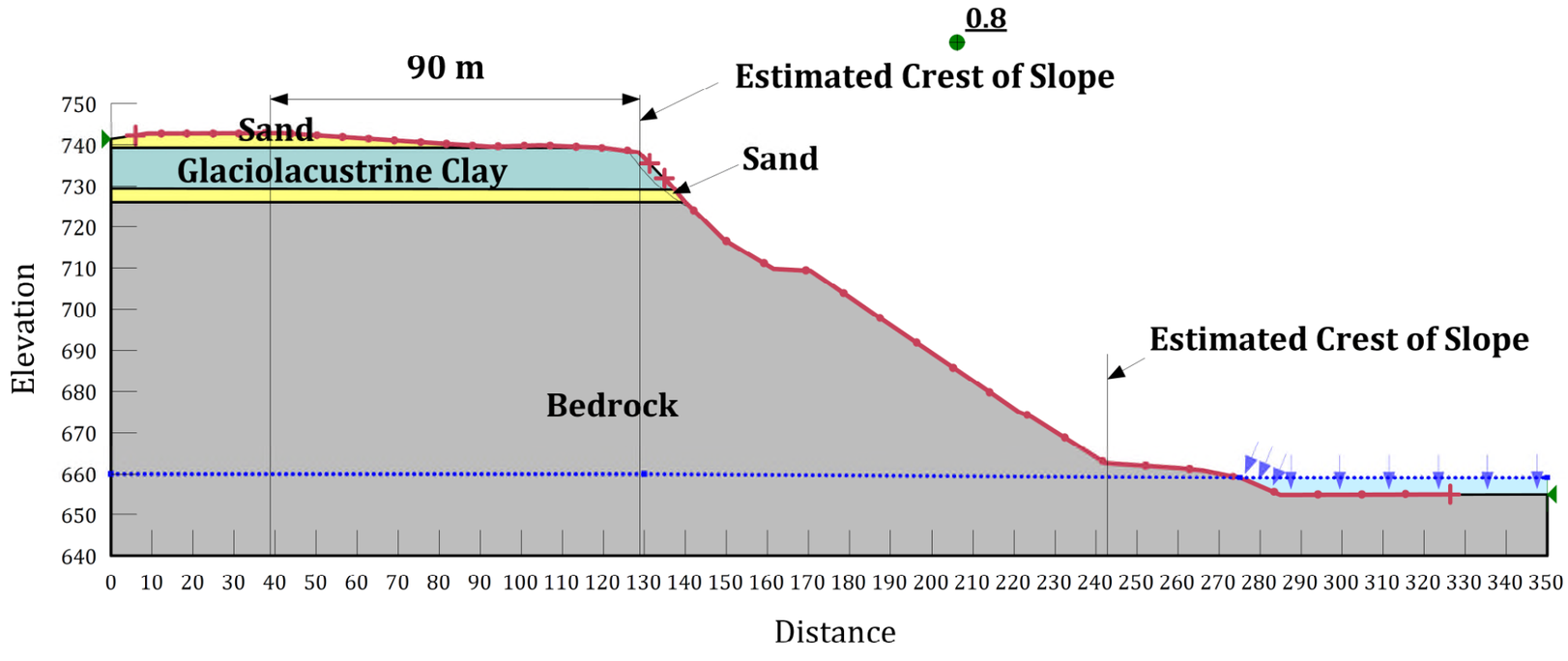
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-35B

Cross Section SSR-10

Redcliff Pumphouse Slide
South Saskatchewan River
C12101372



Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Bedrock
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat Slope Setback Report

Cross Section SSR-10 Critical Slip

A TETRA TECH COMPANY

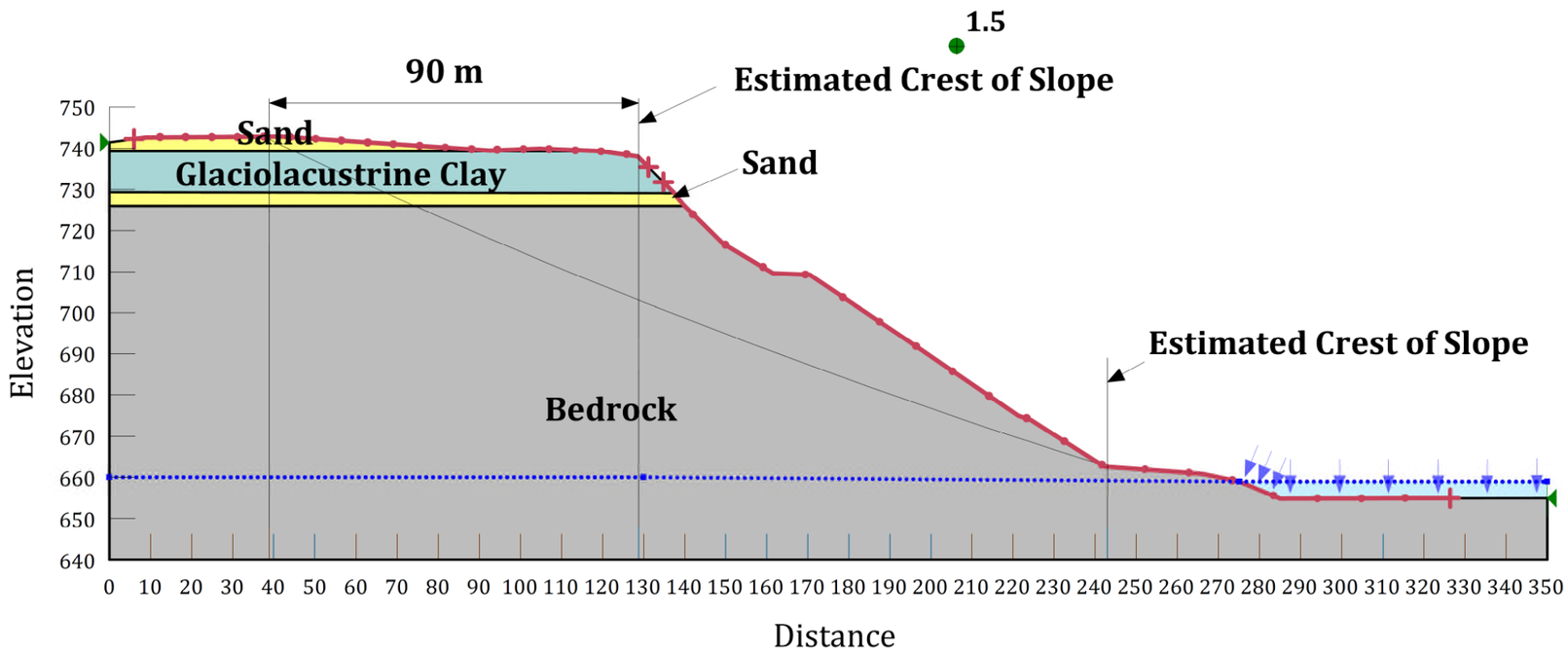
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-36A

Cross Section SSR-10

Redcliff Pumphouse Slide
South Saskatchewan River
C12101372



Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °
Ru: 0.2

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Bedrock
Unit Weight: 22 kN/m^3
Cohesion: 15 kPa
Phi: 28 °

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-10
Setback Slip Surface

A TETRA TECH COMPANY

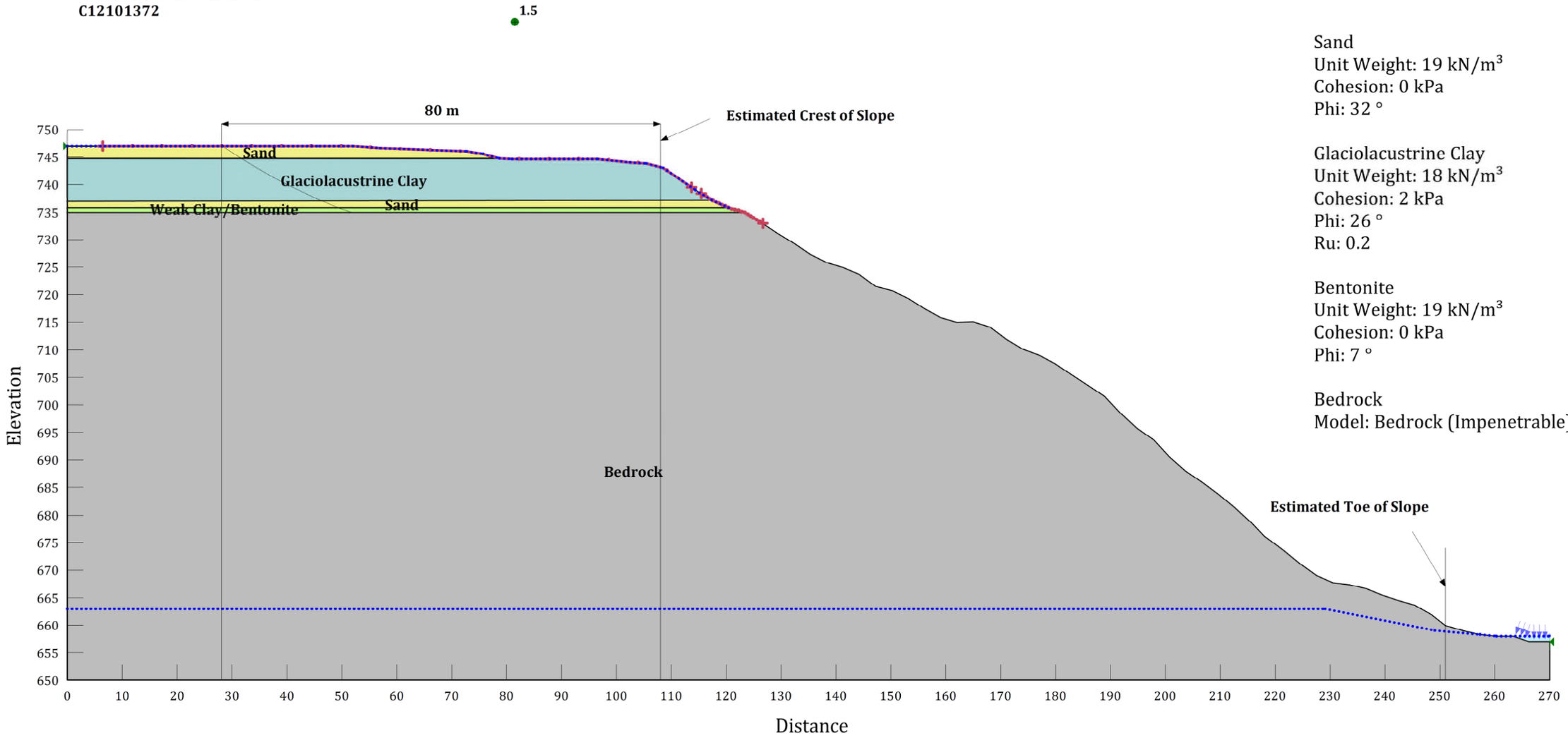
PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-36B

Cross Section SSR-11

Cypress County Slide
South Saskatchewan River
C12101372



Sand
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 32 °

Glaciolacustrine Clay
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 26 °
Ru: 0.2

Bentonite
Unit Weight: 19 kN/m^3
Cohesion: 0 kPa
Phi: 7 °

Bedrock
Model: Bedrock (Impenetrable)

LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT
The City of Medicine Hat

eba
A TETRA TECH COMPANY

The City of Medicine Hat
Slope Setback Report

Cross Section SSR-11
Setback Slip Surface

PROJECT NO.	DWN	CKD	APVD	REV
C12101372	KL	MG	MG	0

OFFICE	DATE
EBA-Riverbend	April 2014

Appendix K-37B

APPENDIX L

APPENDIX L HOW TO USE THIS REPORT

TECHNICAL MEMO

EBA, A Tetra Tech Company
#1 - 4376 Boban Drive
Nanaimo, BC V9T 6A7 CANADA
p. 250.756.2256 f. 250.756.2686

ISSUED FOR USE

TO:	The City of Medicine Hat	**DATE:**	April 7, 2014
C:		**MEMO NO.:**	
FROM:	EBA Medicine Hat Project Team	**EBA FILE:**	C12101372

SUBJECT: How to Use This Report

1.0 GENERAL

- Use the GIS data rather than the figures provided in the report. The figures are provided as a guide, but the GIS will allow review of the setback information at an appropriate scale.

2.0 HOW TO DETERMINE THE SETBACK

- Select your slope of interest within the limits of the City of Medicine Hat.
- Review Figure 26/GIS data to determine what setback (for the top or bottom of the escarpment) has been specified for the slope of interest.
- The specified setback can be checked by:
  - Determining the slope category of the slope of interest, specifically whether the:
    - Overall Slope Gradient <15%, then– no setback required from a geotechnical perspective;
    - Overall Slope Gradient 15% to 33%, then a 6 m setback plus the associated lateral migration as per the applicable reach sections outlined in Table 17, measured horizontally, from the top of the escarpment; or
    - Overall Slope Gradient >33%, then the setback shall be established according to the Geotechnical Setback Sectors defined in Table 17, and outlined below.
  - If the overall slope gradient is >33%, then the specified setback on Figure 26 can be checked by:
    1. Determining which Geological Sector the slope of interest falls within (Figure 21/GIS).
    2. Determining which Geotechnical Setback Sector applies based on the result from Item 1, then consulting the corresponding figure (Figure 22, Figure 23, Figure 24, or Figure 25) or reviewing the GIS information.
    3. Reviewing Table 17 to determine the appropriate Setback Equation for the top of the escarpment for the specific Geotechnical Setback Sector of interest. Note the setback from the toe of the escarpment is equivalent to the height of the escarpment, regardless of Geotechnical Setback Sector.

4. Reviewing Figure 20 for consideration of the Lateral Migration (LM) factor to use in the Setback Equation – Figure 20 (or GIS) shows the applicable stream reach and proximity of the toe of the slope of interest to the stream.
5. (If interested) Reviewing Table 16 to understand how the LM was derived for the applicable stream reach.
6. Reviewing Table 17 to determine which cross-sectional profile is representative of the slope of interest.
7. Reviewing Appendix K to see the applicable cross-sectional profile that shows:
   - Cross-sectional profile of the ground surface;
   - Stratigraphy and approximate location of the groundwater table (determined from representative borehole information); and
   - Each cross-sectional profile is represented by two sections:
     - A: critical failure (or slip) surface and the associated Factor of Safety (FoS); and
     - B: the setback from the crest of the escarpment for FoS = 1.5.
8. Reviewing Table 13 for the summary of results of the slope stability analysis as it relates to each of the cross-sectional profiles completed and the slope of interest.

3.0 EXAMPLE

As an example, consider the case where a new development is being proposed in an undeveloped area along the South Saskatchewan River (SSR) near Surprise Bluffs within reach R4 (where stream reaches are identified on Figure 20). In this particular example, the slope of interest has an overall slope gradient of 41% (i.e., >33%) and the terrain has been rated as having a moderate hazard. Therefore, the slope of interest is within the South Saskatchewan River Geological Sector (Figure 21) and the Geotechnical Sector is identified as SSR-f (from Figure 23), such that the setback would be 2.6H:1V plus 18.2 m for lateral migration (from Table 17). If the height of the slope is 48 m (as measured from the 33% toe of slope line), then the setback for slope stability would be 124.8 m, as measured horizontally from the toe of slope (the 33% line) plus 18.2 m (measured horizontally) for lateral migration, equaling a total setback of 142.9 m (which in this example, would be about 33 m from the top of the escarpment). The comparative cross-section, from Figure 19, is SSR-8, which is shown in detail in Appendix K. For this cross-section, Table 13 indicates a setback of 38 m (in order to achieve a FoS of 1.5). We then must add the 18.1 m for lateral migration, resulting in a total setback of about 56 m at the location of the cross-section.

APPENDIX M

APPENDIX M DVD POCKET

- GIS files
- PDFs of All Maps
- Videos
- Photographs