

Ravenswood

Comprehensive Development Review

May 2022

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Executive Summary

Blackstone Investments Inc. (the Developer) is applying to rezone NE 28-35-5-W3M from AG – Agricultural District to CR-1 – Country Residential 1 District to support the subdivision of 45 country residential lots. The proposed country estate subdivision known as Ravenswood encompasses 55.19 ha (136.4 ac) and is intended to include the existing Walter Lane Community Care Facility which serves young adults with physical and intellectual challenges.

Although the subdivision of the property is intended to be phased, the entire subject property is proposed to be rezoned with a holding provision applied to the remaining as represented in the attached development concept plan figure (Appendix A).

Ravenswood is situated within the jurisdiction of the RM of Corman Park No. 344, approximately 3.2 km south of the City of Saskatoon, and immediately west of Clarence Avenue. There are several existing multi-parcel country residential developments located in the immediate vicinity of Ravenswood including: Edgemont Park Estates (under development), Casa Rio and Wood Meadows. Additional surrounding multi-parcel country residential development includes Grasswood Estates, the Organized Hamlet of Grasswood and Crossmount Estates. The proposed development is consistent with the predominant form of development in this area of the RM which reduces the potential for land use conflicts and expands the tax revenue generated to support the maintenance of public infrastructure in this area.

The subdivision layout was deliberate and was designed to take advantage of the local topography seeking to minimize site grading and displacement of existing natural vegetation. The varied topography within the site creates visual interest to residents and the undulating terrain combined with the abundance of tree cover creates a sense of privacy for residents with little or no alteration to the natural landscape.

The plan provides for two public park areas to support passive and field-based active recreational pursuits. Both proposed municipal reserve parcels are planned to include crusher dust trails accompanied by maintenance-free park furniture, including benches and garbage receptacles. The western park space will also include a 9-hole disc golf course designed to integrate itself in to the natural setting provided with the park space and eliminate any need for ongoing maintenance. Off-street parking will be accommodated at each park location by widening the shoulder of the road adjacent to the municipal reserve spaces.

A Storm Water Management Plan (SWMP) was prepared by WSP Canada Inc. in collaboration with Associated Engineering Ltd. The SWMP was prepared according to the RM zoning standards and in consultation with the Water Security Agency (WSA). Stormwater storage is available to accommodate a 1:100-year storm event without generating increased runoff resulting from the property's full development. The proposed subdivision layout has been designed to optimize natural low-lying areas for common storage using stormwater retention ponds constructed within dedicated municipal reserve and utility parcels. By following the natural drainage paths and situating stormwater ponds in existing low-lying areas, development of the site effectively mimics the natural pre-development drainage system and reduces the need for extensive grading.

The stormwater retention ponds were designed and sized to consider the possibility that the numerous natural basins situated within each lot could potentially be displaced by lot development. The likelihood of this occurring is very limited given the propensity for property owners to limit site grading within their properties to creating the housing site and retaining as of many of the natural features as possible. Despite this fact, the ponds have been sized to compensate for this possibility and minimum building elevations have been established for each site to

ensure that housing construction occurs above the flood elevation of each of the formal ponding areas.

Catterall & Wright was contracted to prepare a Traffic Impact Assessment (TIA) in the spring of 2019. This study concluded that the overall impact of the proposed development does not significantly impact the capacity, operations, or safety of the municipal road network or study intersections. The analysis concluded that the study intersections will continue to operate at an acceptable level of service with all individual movements operating at the highest level of service (LOS A). The report further concluded that the erection of intersection lighting is not warranted as a result of the development of Ravenswood.

Potable water will be supplied by a private water line that services the Wood Meadows development via the Casa Rio water supply line. It has been communicated by SaskWater to the RM administration that additional low-pressure water supplies will be provided to meet the demands of the subdivision.

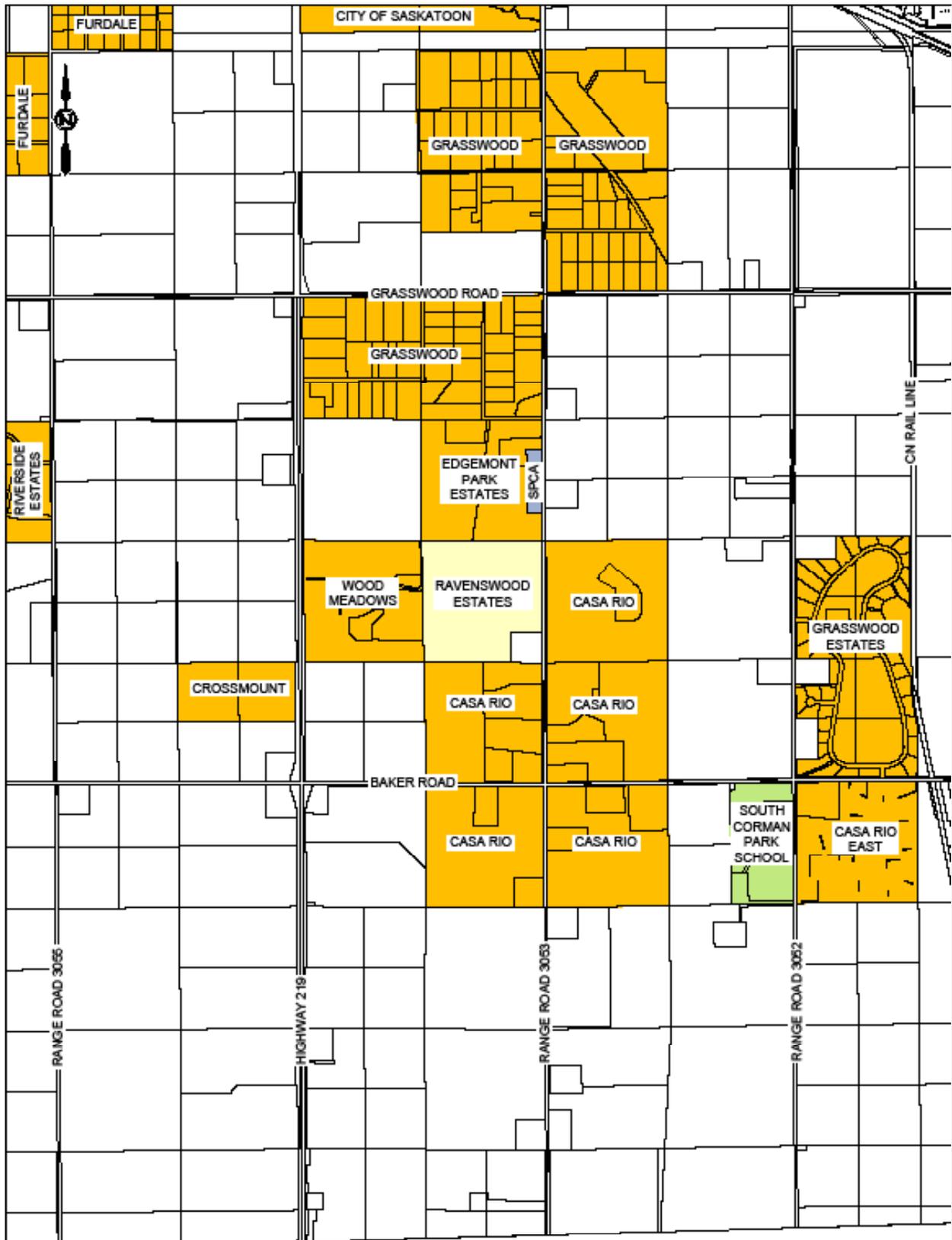
SaskPower and SaskEnergy have provided the developer with quotes for the installation of services at the proposed development.

The proposed development is not located on land considered to be heritage sensitive, according to the Heritage Conservation Branch at the Ministry of Parks Culture and Sport.

A hydrogeological investigation was completed by P. Machibroda Engineering Ltd. (PMEL) in June of 2017, updated in May 2020, then again in December of 2020 to confirm that the site is suitable for the intended use of on-site wastewater treatment systems (OWTS). The conclusions represented in the PMEL report were further substantiated by a separate investigation conducted by Imagine Contacting Inc.(Imagine) on Aug 16, 2020.

Table 1-1: Development Summary

Registered Property owner	Larry Grozell
Developer	Blackstone Investments Inc.
Legal Land Location	NE ¼ Sec 28 – 35 – 5 – W3M
Current Zoning	Agricultural District (AG)
Proposed Zoning	Country Residential District (CR1)
Proposed Lots	45
Minimum Lot Area	0.49 ha (1.21 acres)
Maximum Lot Area	3.43 ha (8.48 acres)
Average Lot Area (Concept Plan)	1.0 ha (2.47 acres)
Phases	Minimum 2
Gross Land Area	55.19 ha (136.37 acres)
Dedicated Municipal Utility	0.7 ha (1.73 acres)
Net Developable Area (for MR)	54.49 ha (133.28 acres)
Municipal Reserve Requirement (10%)	5.45 ha (13.46 acres)
Water Distribution	Private Contract (Water Supplied by RM)
Wastewater Disposal	Private On-site Wastewater Treatment Systems (Advanced)
Internal Road ROW	30 m



1.0 Introduction

1.1 Purpose

The purpose of this document is support an application submitted by Blackstone Investments Inc. (the Developer) to rezone NE 28-35-5-W3M from AG – Agricultural District to CR-1 – Country Residential 1 District and to enable the future subdivision of 45 country residential lots including the existing Walter Lane Community Care Facility which serves young adults with physical and intellectual challenges. This Comprehensive Development Review (CDR) report is intended to provide the R.M. Council and Administration with a complete overview of how the proposed development successfully integrates itself physically, socially, and financially with existing properties, owners, and development in the immediate vicinity and has been prepared in compliance with Section 5.2.3.1 of the RM of Corman Park Official Community Plan.

1.2 Overview

The subject property is situated approximately 3.2 km south of Saskatoon within the RM of Corman Park and encompasses 55.19 ha (136.4 ac). Subdivision and development of the site is intended to occur over a minimum of three phases. The size and timing for subsequent phases will depend upon market conditions and the rate of lot absorption.

Although subdivision and development within Ravenswood is intended to be phased, this submission anticipates that the RM Council will consent to rezoning the entire subject property in conjunction with the initial phase of subdivision with a holding provision applied to the lands located outside of the initial phase. It is our understanding that Council will consider the removal of this holding provision upon receipt of subsequent subdivision applications accompanied by updated servicing cost estimates for each additional phase to be used to inform the preparation of servicing agreements for each successive phase. It is acknowledged that these subsequent subdivision plans will be required to align with the direction presented in this report and any significant deviation may require an amendment to this report.

2.0 Existing Conditions and Development Influences

2.1 Physical Conditions

The subject property is situated in the Saskatchewan Rivers Plain physiographic region and is characterized as gently undulating to rolling plains. The height of land within the site lies at an elevation of approximately 510 metres above sea level in the southwestern portion of the property with the lowest elevation being at or slightly below 502.5 metres above sea level in the northeast and northwest areas of the property as represented on Figure 2-1. The topography of the property is considered knob and kettle containing numerous small hills and depressions throughout the property.

The local soils are classified as a combination of loam, sandy loam, silty clay loam and silty clay which have a relatively high hydraulic conductivity and rate of infiltration. The soil conditions contribute to the site being an area of ground water recharge. As a ground water recharge area, the site has a reduced propensity to collect and store run-off with much of the collected run-off being absorbed into the underlying soils where it percolates into the ground water table.

Ground cover within the site consists of a mixture of pasture grasses and tree bluffs containing predominantly

deciduous trees. The southern portion of the subject property has been cultivated in the past while preserving significant bush areas to enhance the overall aesthetics. According to the Canada Land Inventory Soil Class Rating System the land is rated as "Class 4" which is deemed to have severe limitations that restrict the range of crops or require special conservation practices, or both in order to be productive.

Figure 2-1 Existing Physical Conditions



Based upon the on-line screening tool published by the Heritage Conservation Branch, the subject property is not considered heritage sensitive and no further consultation or approvals are required prior to development of the site. A copy of this query is attached in Appendix G.

A desktop biophysical survey was completed using the on-line HABISask mapping application on the Saskatchewan Conservation Data Centre website. The search indicated that the subject property is classified and ranked provincially as "S3" for the possibility of a rare and endangered species vertebrate animal which represents a moderate risk of extinction. On the ranking scale, S1 rankings are considered very high risk and S5 are deemed to be demonstrably secure. Communications with Mr. Jeff Keith, Senior Ecologist with the Fish, Wildlife and Lands Branch Ministry of Environment indicated the occurrence in question is a historic occurrence (1955) of the Olive-backed Pocket Mouse and based on the location of the site and the historic nature of the observation indicated the Ministry of the Environment would not oppose a subdivision application at this location. A copy of this query and written correspondence with Mr. Jeff Keith is attached in Appendix G.

Based on the farming history of the site and surrounding area there is no evidence that any activities on the property or in the immediate vicinity would have created the potential for ground contamination. As such a Phase I Environmental Site Assessment was deemed to be unnecessary.

Existing development within the site includes the main house, a detached garage, steel quonset, barn, riding arena and small unserviced guest cottage. Figure 2-1 illustrates the site topography as well as the distribution of tree cover and existing buildings and structures within the site.

Geotechnical Report

A geotechnical investigation and follow up report was completed in June, 2017 by P. Machibroda Engineering Ltd. (see attached report in Appendix H). The objective of the investigation was to confirm the suitability of the site for development and to provide geotechnical recommendations to support construction activities.

A total of 12 boreholes were drilled to record the soil stratification, the groundwater conditions, the position of unstable sloughing soils and the depths at which cobblestones and/or boulders were encountered. Disturbed samples of auger cuttings were collected during test drilling and were taken to the laboratory for analysis. Standpipe piezometers were installed in 10 of the test holes to monitor the existing groundwater conditions. Lastly, piezometers penetration tests (CPTu tests) were conducted to depths of 12.2 to 15.3 metres below ground surface.

The general soil profile consists of approximately 300 mm of topsoil overlying variable deposits of sand, silt and clay extending to depths of 18 m below existing ground surface which was the maximum depth drilled at the site.

Extensive groundwater seepage and sloughing conditions were encountered in saturated sand and/or silt layers/lenses during test drilling. The depths at which groundwater seepage and sloughing conditions were encountered fell between 498.5 m to 504.0 m on May 5, 2017 and 501.2 m to 503.0 m on June 5, 2017, or 1.5 to 6.7 m below the existing ground surface. One test hole (test 17-5) was dry on both occasions. It was noted that higher groundwater conditions could be encountered, particularly during or following spring thaw or periods of precipitation. Cobblestones and boulders were not encountered to the full depth explored within the test holes at the site.

Based on the results of the geotechnical investigation several foundation design recommendations were made. A shallow foundation system consisting of standard strip spread footings bearing on undisturbed, naturally occurring sand and/or silt soils above the groundwater table could be considered as a foundation system at this site and should perform satisfactorily. Where highly plastic clay is encountered at the design footing elevation and the potential differential foundation movements are not considered acceptable, construction of a pile foundation is recommended. It was noted that construction of a shallow footing foundation below the elevation of the

groundwater table will encounter construction difficulties associated with groundwater seepage, sloughing and unstable/softened soil and was therefore not recommended. Alternatively, a deep foundation system consisting of drive, treated timber piles, helical screw piles or driven, open-ended steel pipe piles should perform satisfactorily at the site. Drilled, cast-in-place concrete piles were also considered as a foundation support but were not recommended due to the extensive groundwater seepage and sloughing conditions anticipated below the groundwater table in saturated sand/silt deposits.

Recommendations were also made concerning basement floor slabs. It was determined that basement floor slabs based on sand and/or silt should perform satisfactorily. However, basement floor slabs based on highly plastic clay will be susceptible to differential movements associated with moisture fluctuation in the soil profile. As such, measures should be taken to minimize the effects of differential floor movements by constructing structural elements such as partition walls, staircases, grade beams, columns, etc. independent of the slab. Additionally, providing positive drainage alongside the foundation, extending downspouts well away from the building and eliminating irrigation alongside the foundation would serve to minimize the potential for increased soil moisture content adjacent to the foundation and potential swelling.

A copy of the geotechnical report is attached as Appendix H.

2.2 Existing Development

Land use in the area surrounding the subject property consists primarily of multi-parcel country residential developments. These existing residential developments include Edgemont Park Estates (under development), Casa Rio and Wood Meadows. Additional multi-parcel country residential development in the larger surrounding area includes Grasswood Estates, the Organized Hamlet of Grasswood and Crossmount Estates. The proposed development of Ravenswood is consistent with the predominant form of development in this region of the RM which reduces the potential for land use conflicts and expands the tax revenues generated to support the maintenance of public infrastructure in this area.

Other uses include agricultural operations (both grain farming and pastureland) in addition to the Saskatoon SPCA, located to the north of the proposed development. The closest highways to the proposed development are Provincial Highway #219, approximately 800 m to the west of the west boundary and Provincial Highway #11, located approximately 2.0 km east of the east boundary of the subject parcel.

2.3 Community Consultation

In the fall of 2013, a letter was sent to residents within one mile of the subject property requesting that neighbours provide input as to whether they were in favour of two potential development options (letter attached in Appendix J). The first option included 33 single family lots, approximately 1 acre in size in addition to a residential care facility to provide for individuals with spinal cord injuries who are capable of working and living independently with evening attendant care services. An additional 9-acre lot was proposed to feature 24 buildings, including 16 small orchard homes and 8 country cottages. The Developer indicated that life lease and land leases were both being considered as options at the time. The second development option included 28 single family homes and one lot dedicated as a residential care facility to provide for individuals with spinal cord injuries.

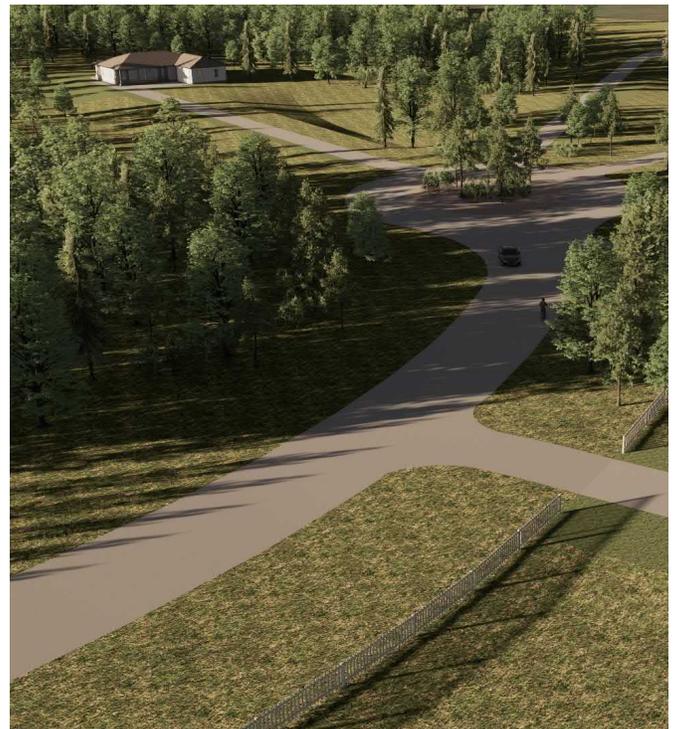
Several letters were received by the applicant, mostly in support of one of the two development options with a small number of letters opposing both options. Following the letter distribution, a public open house was held on November 21, 2013 at the Grasswood Esso Meeting room. Following this meeting, a presentation was provided to

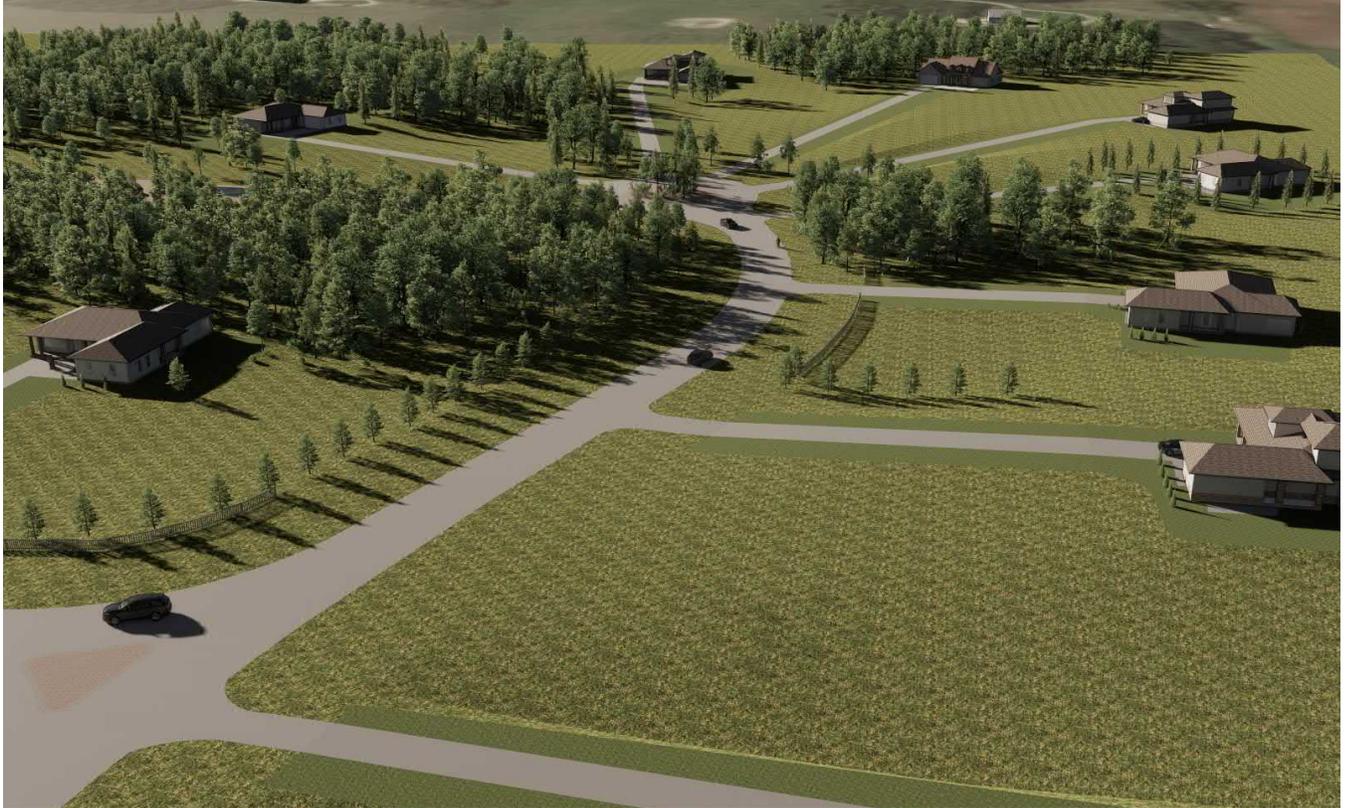
the RM of Corman Park Council to provide a brief overview of the project and summary of the public consultation that was undertaken. Ratepayers within 1.6 km of the site were again provided with an invitation to attend the Council meeting. The RM of Corman Park provided a letter to the Developer indicating that revisions to the concept be undertaken.

Since the initial development proposal, Mr. Grozell has revisited his concept and recently held a Public Open House on May 15, 2019 on-site at the facility (garage) adjacent to the Walter Lane facility to once again solicit feedback. Prior to the Open House, a letter was drafted and distributed to residents within one mile of the proposed development approximately three weeks prior to the Public Open House. The letter is also attached in Appendix J. A total of 15 people attended the Open House (boards are also attached in Appendix J). One individual had questions related to the proposed drainage plan and other residents had questions surrounding the nature of the Seniors Care Home and the timeline surrounding the proposed Seniors Housing. No written responses were received following the Open House. The sign in sheet is also attached in Appendix J, although it is noted that not everybody who attended the open house signed in.

Leading up to the Public Open House, and in an effort to gather input from surrounding community members, Mr. Grozell also met with a number of rate-payers from the Grasswood Community at the Sakundiak residence at 4890 Prairie Lane, in November, 2017. The concept plan illustrated the proposed density of the proposed subdivision (CR1), and also provided information concerning the potential of providing seniors housing, a senior care facility, and an additional community centre that would support the existing Walter Lane facility. Mr. Grozell provided his contact information following this meeting and there were no further comments received.

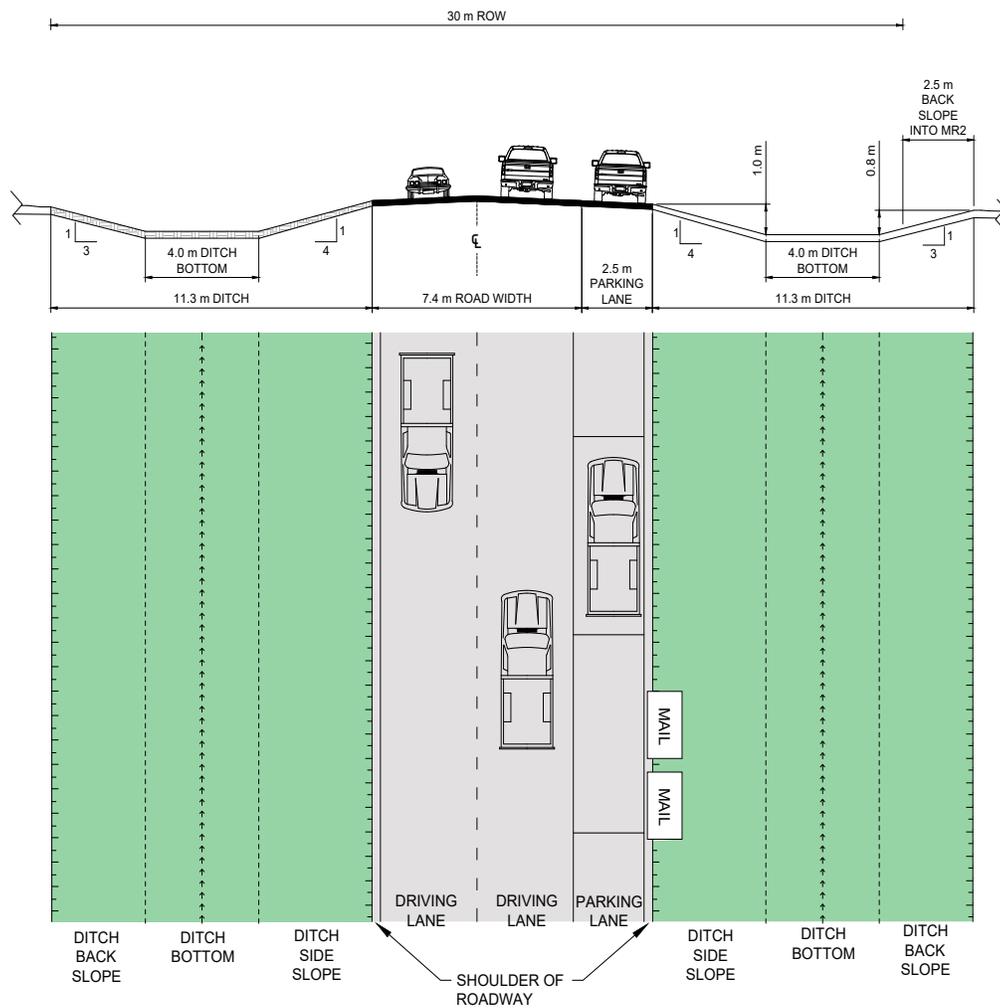
It is noted that since the above noted meetings, plans to include the additional community facilities including the proposed seniors housing facility have been abandoned and potentially revisited in conjunction with future phases of development.





With sites ranging in size between 0.49 ha (1.21 acres) and 3.43 ha (8.48 acres), Ravenswood offers a sufficient variety of lot sizes to meet the diverse needs of the market and to support a variety of housing styles and site configurations. Although each site offers sufficient area to meet the personal recreational needs of residents, the plan includes the dedication of two public park spaces.

The proposed eastern park space represented in Figure 3-1 as MR2 is planned to include a an open green space area and integrated pathway loop to accommodate a variety of informal field sports and navigation of the area by pedestrians. The fields are intended to be seeded with drought resistant grass to eliminate the need for irrigation and reduce maintenance. It is anticipated that the grass can be mowed in conjunction with regular ditch mowing within the subdivision. The crusher dust pathway network will include benches and trash receptacles constructed using maintenance-free materials. The trails can be groomed during the winter months by residents to support cross country skiing and the area will also include a toboggan hill at the south end to further support four season use of the space. As generally illustrated below, a portion of the internal roadway will be widened to include a pull-out to accommodate centralized mailboxes and off-street parking for park users.



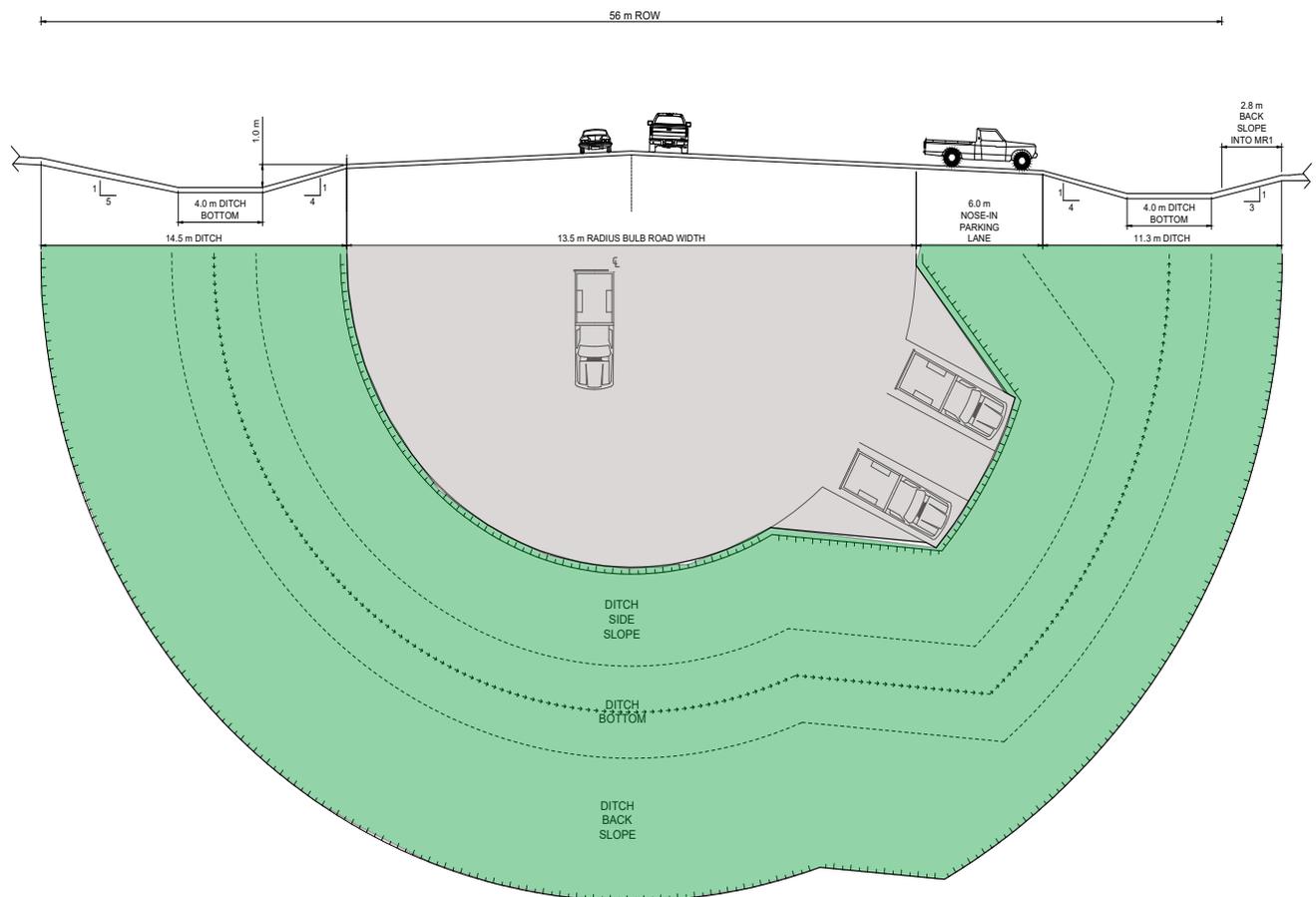
The parkland noted as MR1 in Figure 3-1 is also intended to include a crusher dust trail network accompanied by typical park furniture including benches and trash receptacles. The use of a crusher dust surface is intended to minimize maintenance costs and to respect the natural surroundings. The area is also planned to include a 9-hole disc golf course designed to integrate into the natural setting intended for this space. The introduction of a disc golf course allows the ground cover to remain in a semi-natural state, eliminating the need for irrigation and drastically reducing the maintenance requirements in this area. In addition to serving a recreational purpose, the land within MR1 is also being designed to serve a stormwater management function following major weather events. The illustrations below are provided to depict how the land within the proposed new MR1 would be used.



This area of the property is naturally low and offers a suitable location to temporarily collect and store runoff following spring thaw and storm events. As noted in the geotechnical and hydrogeological reports, the development is situated on sandy soil and in an area of groundwater recharge meaning that the rate of infiltration of surface water is high and water percolates downward through the soils and into the underlying aquifer rather than remaining on the surface or running off. We note that in the WSA drainage report, there are a series of photographs of the property following a 25-year storm event in 2017 demonstrating the lack of surface water within the site and reinforcing the rate of infiltration. The intention is to raise the elevation of the pathways above natural ground to ensure that they are accessible regardless of season or weather. The internal areas of the park will be graded to limit any sustained ponding to specific areas associated with planned points of discharge, leaving the balance of the site usable for disc golf shortly following storm events.

The design creates flexibility to act primarily as a recreational space for the residents and public while also serving a stormwater function. Recognizing the principal use of the site for recreational purposes (based upon the relative duration of use as a park versus acting as a stormwater pond), we are seeking to designate the entire park as municipal reserve. A revised conceptual drainage plan was prepared and submitted to WSA for review and endorsement reflecting the intended dual use of the land.

The following figure illustrates the intention to provide several off-street parking spaces along the south side of the north cul-de-sac to support nonresident use of the disc-golf facility without impeding normal traffic function in the area or disrupting the use and enjoyment of the nearby acreages.



The development utilizes a crescent road layout combined with cul-de-sacs to reduce the overall roadway length while enabling development to extend deeper into the development property. This closed internal roadway configuration ensures that internal traffic is limited to local residents and is similar to surrounding developments. One consequence of this type of internal road network is that perimeter properties within adjacent developments abut one another along the rear yard.

Properties within the adjacent Wood Meadows Estates to the west are larger in size than what is proposed in Ravenswood but the abutting lots are quite deep (~350 m) with existing homes situated centrally within the property, providing a significant separation from the common rear property boundary. Although the proposed properties within the Ravenswood development are smaller in size, they share a similar frontage to depth ratio along the interface, creating an opportunity to maintain a significant separation and sense of privacy.

Properties to the north in the Edgemont Estates development share a similar size to those proposed in Ravenswood, creating similar expectations between abutting residents in each development and reducing the potential for land use conflict.

Casa Rio Estates lies to the south of Ravenswood. Properties in this existing development are significantly larger than what is represented in Ravenswood. Many of the existing residential acreages in Casa Rio have well established shelter belt plantings surrounding the sites, providing a suitable physical and visual barrier between properties, mitigating any potential negative impacts or conflicts between neighbours. Overall, based upon the common residential use of these properties, the likelihood of land use conflict should be minimal.



4.0 Servicing Concept

4.1 Community Access and Traffic

The proposed internal road network has been configured as a crescent using cul-de-sacs to extend development into internal areas of the property. The paved internal roads are to be constructed within a 30-metre right-of-way and designed in compliance with the RM's current Country Residential Road Standard. A copy of the applicable road standard is attached as Appendix M.

The proposed development is located immediately west of Clarence Avenue (Range Road 3053). Catterall & Wright was contracted to complete a Traffic Impact Assessment (TIA) in the spring of 2019 to forecast future traffic generated by the proposed development to identify any improvements that may be necessary to the existing municipal road network.

The TIA assumed that full build-out of the subject property would occur within a ten year period. In addition the report assumed a 2.0% annual growth in background traffic volumes at the study intersections. Site-generated trips from the proposed development were established using the Institute of Transportation Engineers Trip Generation Manual, 10th Edition (ITE Manual). Anticipated vehicle trips to be generated from the proposed development during the weekday AM and PM peak hours were assigned. Total forecast volumes for the long-term horizon (2029) were obtained by combining the background traffic growth with the new trips associated with the development.

Existing traffic, future background traffic (without projected trips) and total forecasted traffic (with projected trips) operations were assessed at the study intersections. The intersection level-of-service (LOS) was examined for both AM and PM peak hour volumes with no additional turning lanes. It was concluded that all of the study intersections are currently operating at acceptable conditions (LOS A). Volume over Capacity (V/C) ratios and 95th percentile queue lengths were within the acceptable range.

It was also concluded that for future background conditions (year 2029), the study intersections will continue to operate at acceptable conditions (LOS A during AM and PM peak hours). V/C ratios and 95th percentile queue lengths will be within the acceptable range. For full build-out conditions (year 2029), the study intersections are expected to continue to operate with little or no delays during the AM and PM peak hours. V/C ratios and 95th percentile queue lengths are expected to be within the acceptable range with less than one vehicle (2 m) queuing on the approaches of the proposed North Access Road and South Access Road.

Free flow movements along Clarence Avenue will continue to operate at LOS A during the AM and PM peak hours. Lastly, the stop-controlled intersections at Eldorado Lane North, Eldorado Lane South, North Access Road and South Access Road are all anticipated to operate at LOS A during both the peak hours.

The report recommended that the RM consider extending the existing 60 km/h posted speed limit along Clarence Avenue south of Baker Road to improve safety and reduce potential conflicts along the Clarence Avenue corridor.

A lighting warranty assessment was also completed and concluded that delineation lighting at the access intersections is not warranted as a result of this development. A copy of the Traffic Impact Assessment report is attached to this report as Appendix B.

4.2 Potable Water Supply and Distribution

Potable water will be supplied by a private low pressure water line that presently services the Wood Meadows development via the Casa Rio water supply line. The Water Supply Agreement between the RM of Corman Park and the Developer is attached in Appendix D, which details the terms of agreement for supplying treated water for any additional development in the subject property. Individual lots will be supplied with a typical low pressure rural service of 720 gallons per day and with between 300 and 1000 gallons of reserve. As the source is low pressure, each property owner will be required to install a privately owned cistern and pressure system within their properties. This system does not offer sufficient pressure to be utilized for centralized firefighting services.

4.3 Wastewater Collection and Treatment

The collection and disposal of wastewater within each proposed residential site will be managed through the construction of privately owned advanced treatment on-site wastewater treatment systems (OWTS). A hydrogeological investigation was performed by P. Machibroda Engineering Ltd. (PMEL) to confirm that the physical conditions within the subject property are suitable to support this form of sewage treatment. The scope of this investigation included a desktop study, multiple field investigations involving the installation and monitoring of ground water monitoring wells equipped with piezometers, laboratory testing, an OWTS feasibility assessment, and preparation of a summary report.

An additional field investigation, nitrate assessment and analysis was completed by Imagine Contracting Inc. to supplement and confirm the analysis and recommendations provided by the initial PMEL hydrogeological report. Eight (8) test pits were excavated across the site as part of this supplemental investigation and multiple soil samples were submitted for additional lab analysis from each test pit to assist with the detailed soils assessment. The complete assessment is documented in the Imagine Wastewater Management Evaluation Assessment Report and is provided in Appendix A of the hydrology report.

Given the amount and proximity of existing country residential development in the vicinity combined with the fact that the development overlies an unconfined aquifer, a Level II Assessment was required. This assessment included a cumulative nitrate assessment based on the estimated probability of an OWTS system intercepting a potential down gradient water well.

The general soil profile within the subject property consists of up to approximately 300 mm of topsoil overlying variable deposits of sand, silt and clay extending to depths of 18 metres below ground surface (mbg). Soils encountered at the site were comprised of predominately sand and silt with intermittent clay layers typically 1 to 2 m thick.

Ground water measurements taken in June 2017 indicated groundwater elevations ranged between approximately 1.5 to 5 mbg with average median values of 3.7 and 3.8 mbg respectively. Additional testing in July of 2020 reported groundwater depths ranging between 1.9 mbg to 5.8 mbg with average median values of 4.0 and 4.2 mbg respectively suggesting that the tested values accurately reflect general groundwater conditions at the site.

Hydraulic conductivity and the hydraulic retention time testing concluded that the depth to the uppermost groundwater table at the site is expected to be sufficiently deep to provide adequate unsaturated soil (vadose zone) below each OWTS.

A cumulative nitrate assessment was completed to predict the potential transport of the nitrates contained

within the discharged effluent through the vadose (unsaturated) zone and into the groundwater system beyond the site boundaries. A previous nitrate evaluation using OWTS without advanced treatment packages indicated nitrate concentration in the groundwater would exceed the safe levels at the boundary of the site. Based on the assessment of individual lots adjacent to the property boundary it was determined that systems constructed adjacent to the boundary would require additional pretreatment prior to release into an absorption field to further reduce the effluent nitrate quality and protect down gradient groundwater users and/or the environment.

The results of these investigations suggest that each lot has the physical space, adequate soil consistency and vertical separation (vadose zone) to accommodate the use of OWTS for the management/treatment of sanitary waste generated at this site. However, based on the results of the cumulative nitrate assessment, conducted as part of this hydrological investigation, advanced treatment systems (treatment plant coupled with a standard soil treatment system) will be required to ensure that effluent quality entering the receiving environment will not adversely impact downstream groundwater users and/or the environment.

Image Contracting Inc. identified the following types of soil treatment systems were suitable for use at the site. Holding tanks, pressure treatment field, pressurized raised treatment field, pressurized type II mound, advanced enviro-septic field and advanced enviro-septic mound. Due to sensitivity of the site and density, lagoons, jets and type I mounds are not to be considered.

The following additional recommendations were made by PMEL based on the results of this assessment.

- An advanced package treatment system meeting or exceeding NSF-40, NSF245 and NSF 350 standards (Bio-Microbics BioBarrier -N or equivalent) with an average effluent nitrate concentration of less than or equal to 9 mg/L will be required for lots where the OWTS would be constructed within 220 meters of the property boundary.
- An advanced package treatment system meeting or exceeding NSF-40, and NSF245 standards (Ecoflo, Coco filter ECDn Model or equivalent) with an average of effluent nitrate concentration of less than or equal to 18.9 mg/L. will be required for lots where the OWTS would be constructed greater than 220 meters from the property boundary.
- The type of advanced treatment system required for each lot should be specified in each lot purchase agreement.
- In accordance with Government of Saskatchewan regulations; prior to receiving approval for a building permit, a detailed soils assessment will be required for each individual lot to confirm the soil and groundwater conditions for selection and design of an appropriate soil treatment system. The detailed soils assessment and system installation should be conducted by a certified septic system contractor or qualified professional.

It is noted that the investigations described above presumed that a multi-unit seniors care facility and another community care facility would be established on two of the lots. At this point, these facilities are unconfirmed and in the event that they are not pursued on the site, the volume of septic used to model the nitrate migration in the hydrogeological report has been overestimated.

The report was submitted to the local Health Region for review and comment and was subsequently endorsed in support of the subdivision. It is noted that each property owner will be responsible for applying for and obtaining all necessary permits from the Health Region prior to installing or operating these systems. A copy of this report is

attached as Appendix C

4.4 Stormwater Management and Drainage

A Drainage and Storm Water Management Report was prepared by WSP Canada Inc. in collaboration with Associated Engineering. The stormwater management plan (SWMP) was completed in accordance with the RM of Corman Park zoning regulations and current provincial standards.

As per the geotechnical report prepared for the site by PMEL, the local conditions on the site can be described as follows:

- The site features a knob and kettle landscape with natural depressions that collect and store run-off.
- Local soils consist primarily of silt, sand and clay.
- The site is situated in an area of ground water recharge and soils are considered to have a relatively high conductivity resulting in a high rate of infiltration.

The following assumptions were made in preparing the conceptual drainage design:

- The proposed country residential development is intended to be an acreage style development with little or no lot grading other than what is required to build access and building improvements.
- Excavation of natural low-lying areas within the site offers a suitable means of storing run-off associated with the development.
- Run-off generated by development will be conveyed overland via the internal road ditches and constructed swales to retention ponds located within dedicated municipal utility properties.
- A 1:100-year 24-hour storm event was used to define the pre and post development flood extents within the site as per the RM of Corman Park zoning regulations.
- A class A hydrologic soil group (HSG- A) was used to represent the high infiltration rates and low run-off potential.
- The rational method was used to calculate run-off volumes for the pre-development and post development scenarios.
- Predevelopment calculations are based upon rolling farmland whereas post development calculations will consider the addition of streets, driveways and minimal changes to the land grades within each property.
- The percent of impervious surfaces of the average residential lot is estimated to be 15%.

The SWMP considers and maintains the current permanent storage on the site as well as providing additional on-site storage to respond to the reduction in permeable surface resulting from road and acreage development within the site. The proposed subdivision layout was designed to optimize natural low-lying areas for common storage as a means of mimicking the natural drainage system and reducing substantial alteration of the landscape. As part of the drainage and stormwater management design for the site, overland flow will follow natural drainage courses, swales, and/or roadways to constructed stormwater ponds in each catchment area. The system design incorporates natural depressions in each catchment area that would be enlarged by size and depth to contain the water volume generated during a 1:100-year storm event. These stormwater ponds would be designated as municipal utilities and as public land, development in these areas is restricted.

The SWMP assumes that all natural depressions (storage) situated within private properties could be potentially filled in by the homeowner during lot development thus reducing the existing permanent storage within the site. Based upon the assumption that land grading within the lots will be minimal, it is likely that many of the existing natural storage areas (depressions) within the lots will be left undisturbed as a result of site development; offering an additional level of protection beyond the calculated pre and post development conditions.

In addition to having to account for the existing permanent storage provided on the subject property, the SWMP also accounts for the on-site storage of the additional run-off generated by road and housing construction and the general reduction of pervious land cover resulting from development. Each catchment area will be required to have sufficient on-site permanent storage to contain the difference between pre-development and post-development runoff using a 1:100-year storm event as the basis for quantifying the incremental increase in run-off. In cases where the difference between the pre-development and post-development condition plus the lost permanent storage is greater than the total amount of runoff generated by the 1:100 year event a single pond will be constructed to hold the entire 1:100 year event.

As part of the SWMP, minimum building elevations were also determined for each proposed lot based on their elevation relative to the high water level of each of the ponds plus an additional 0.5 meters of freeboard as an additional factor of safety. The use of a 0.5 m freeboard as an additional factor of safety is consistent with the Provincial Statements of Interest Regulations. It is recommended and typical that the OWTS for each home is situated nearby the residence within an area deemed to be suitable for housing construction based on the minimum building elevation.

The SWMP was submitted to Water Security Agency for review and comment and was subsequently endorsed in support of the subdivision. A copy of this report and correspondence with WSA is attached as Appendix E.

4.5 Shallow Utilities

The Developer has been in contact with SaskPower and SaskEnergy and they have provided quotes identifying the necessary costs of undertaking the work to service the development. As such, it is anticipated that this development can be easily serviced by both power and gas utilities. An existing fibre optic network is also currently on the site and will be made available to the residents.

4.6 Solid Waste

Contracting domestic garbage collection will be the responsibility of each property owner and it is assumed that this service will be contracted to one of several service providers in the Saskatoon Area. A letter is attached in Appendix F confirming that Loraas Disposal can provide Waste and Recycling removal services at the proposed Ravenswood Development.

4.7 Fire and Protective Services

The Saskatoon Fire Department provides emergency service response to the City of Saskatoon as well as having service agreements with other municipalities and First Nation Reserves in the region including a large portion of the RM. The subject property is situated within this service area.

Police services for this location falls within the jurisdiction and would be provided by the Corman Park Police Services and the Saskatoon Detachment of the Royal Canadian Mounted Police.

5.0 Municipal Compliance

Ravenswood is located within an area where land use and development is regulated by the RM of Corman Park Official Community Plan and Zoning Bylaw. The following section details how the proposed development has been planned in compliance with both of these presiding documents.

5.1 Corman Park Official Community Plan

Policy	Compliance Notes
Section 5: Country Residential Objectives and Policies	
<p>5.2.1.1. Any new country residential development or subdivision for country residential use on parcels in the Municipality zoned Agricultural District (AG) will require an amendment to the Zoning Map to a District which provides for this activity. The proposals will be subject to all policies and criteria herein.</p>	<p>This CDR has been prepared in compliance with the OCP policies in support of an application to rezone the subject property from an AG - Agricultural District to a CR1 - Country Residential 1 District.</p>
<p>5.2.1.5. Country Residential subdivisions shall not be allowed:</p> <ul style="list-style-type: none"> a) within the distance of an intensive livestock operation as outlined in Section 4.2.3.; or b) on hazard lands, unless Council determines the lands are acceptable for remediation, and remedial measures and construction standards are prescribed by Council in accordance with Section 9.2.9 and registered as an interest on the title(s) to the lands. 	<p>Correspondence with RM of Corman Park administration indicated there is an ILO on the subject property (see correspondence and an associated map from the RM of Corman Park attached as Appendix I). While the existing landowner does operate a farm and care facility for individuals with intellectual and physical disabilities, there are no provincial records of an ILO in existence at this location.</p>
<p>5.2.1.6. Country Residential subdivisions should be directed to:</p> <ul style="list-style-type: none"> a) locate on lands of “marginal” soil capability as defined by the Canada Land Inventory (CLI) Soil Class Rating System; b) locate contiguous to existing residential development on the quarter section to limit agricultural fragmentation and minimize the disruption of agricultural operations; and c) locations along existing municipally maintained roadways. 	<p>According to the CLI, the soils within the subject property are Class 4 and as such considered marginal.</p> <p>The proposed development is situated within an area where country residential development is the predominant use.</p> <p>The proposed development lies adjacent to Clarence Avenue.</p>

Policy	Compliance Notes
<p>5.2.3.5. The number and arrangement of approved lots shall be determined on a case by case basis and shall have consideration for:</p> <p>a) the carrying capacity of the lands proposed for development based on site conditions, environmental considerations and potential impacts, and other factors that may warrant consideration in the design of the proposal;</p> <p>b) the suitability and availability of municipal and other services and infrastructure necessary to support the proposal; and</p> <p>c) the compatibility of the proposed subdivision design with that of the surrounding area.</p>	<p>The two key components used to define the carrying capacity of the subject property included the effective management of stormwater and on-site wastewater treatment. The hydrogeological and stormwater management plans for the site confirmed the ability to effectively manage both of these conditions.</p> <p>The site is situated in an area in which country residential development is the predominant land use. A consequence of previous country residential development in this area is that all of the services and infrastructure needed to support this form of development are present in the area.</p>
<p>5.2.3.6. The Municipality will ensure that new multi-parcel country residential subdivision proposals incorporate environmentally sustainable subdivision design principles including but not limited to the following:</p> <p>a) the subdivision design shall respond to and incorporate existing natural resources including: wildlife corridors and habitat, topographic features and environmentally sensitive lands with particular attention to hydrologic features and systems; and</p> <p>b) the design of lots and internal roadways shall seek to minimize the length of roads constructed within the subdivision and to arrange house sites effectively relative to natural features and efficient roadway networks.</p>	<p>The subdivision layout was designed to follow the natural contours within the property to reduce the need for extensive regrading and to enable the retention of existing tree cover within the residential sites.</p> <p>The SWMP has been designed to mimic the natural hydrological characteristics within the site with planned storm retention ponds situated within natural low-lying areas. The proposed municipal utility properties have been configured to enable the retention ponds to be constructed with the recommended 5:1 length to width ratio which increases their pollutant removal efficiency.</p>
<p>5.2.3.7. The maximum size of the development area for an individual multi-parcel country residential development shall be 64.8 ha (160 acres).</p>	<p>The subject property comprises 55.19 ha (136.4 ac).</p>
<p>5.2.3.10. Comprehensive Development Reviews shall include a clear record of substantial public consultation including involvement in concept development, public review of the development options, and evidence of conflict resolution initiatives where necessary.</p>	<p>See Section 2.3</p>

Policy	Compliance Notes
<p>5.2.3.13. All new proposals for multi-parcel country residential subdivision shall be serviced by a common potable water system in a legal form that is acceptable to the Municipality.</p>	<p>See Section 4.2</p>
<p>5.2.3.15. Where a multi-parcel country residential development is proposed on lands near or abutting an existing multi-parcel country residential development, the proposed development shall be designed to complement the existing development and respond to the reasonable concerns and interests of the residents of the existing development and where required by Council, shall provide visual buffering, house site separation, complementary lot sizing or any other measures necessary to achieve compatible land use and development.</p>	<p>All of the surrounding country residential subdivisions have been designed to utilize the same crescent road network as represented in Ravenswood. This results in properties situated along the outer boundary of each development having common and abutting rear property boundaries.</p> <p>Properties within the adjacent Wood Meadows Estates to the west are larger in size than what is proposed in Ravenswood but the abutting lots are quite deep (~350 m) with existing homes situated centrally within each property, providing a significant distance from the common rear property boundary. Although the proposed properties within the Ravenswood development are smaller in size, they share a similar frontage to depth ratio in this area, creating an equal opportunity to maintain a significant separation and sense of privacy.</p> <p>Properties to the north in the Edgemont Estates development share a similar size to those proposed in Ravenswood, creating similar expectations between abutting residents in each development and reducing the potential for land use conflict.</p> <p>Casa Rio Estates lies to the south of Ravenswood. Properties in this existing development are significantly larger than what is represented in Ravenswood. Many of the existing residential acreages in Casa Rio have well established shelterbelt plantings surrounding the sites, providing a physical and visual barrier between properties, mitigating any potential negative impacts or conflicts between neighbours.</p>

Policy	Compliance Notes
<p>5.2.3.17. Subdivision for a multi-parcel country residential development shall not result in the creation of any residential parcel located:</p> <p>a) within the distance of an Intensive Livestock Operation as outlined in Section 4.2.3.;</p> <p>b) on Hazard Land;</p> <p>c) within 1 km (0.6 mile) of a Hazardous Industry measured from the property boundary of the Hazardous Industry to the property boundary of the closest developable parcel;</p> <p>d) within 1 km (0.6 mile) of a rural industrial park measured from the property boundary of the closest developable parcel located within the rural industrial park to the closest property boundary of a multi-parcel country residential parcel;</p> <p>e) within 457 m (1500 ft.) of the property boundary of a Solid Waste Disposal Facility or a Liquid Waste Disposal Facility measure from the property boundary of the Solid Waste Disposal Facility or the Liquid Waste Disposal Facility to the closest property boundary of a residential parcel; and</p> <p>f) on conservation lands.</p>	<p>Correspondence with RM of Corman Park administration indicated there is an ILO on the subject property. While the existing landowner does operate a farm and care facility for young adults with intellectual and physical disabilities, there are no provincial records of an ILO in existence at this location.</p> <p>The subject property lies outside of the setback distances from a Hazardous Industry, rural industrial park or solid, or liquid waste disposal facility.</p> <p>The subject property is not designated as conservation land.</p>
<p>5.2.3.18. Development must recognize and conserve areas containing significant wildlife habitat, cultural and historic resources.</p>	<p>A desktop environmental and heritage screening confirmed that the subject property is not considered environmentally or heritage sensitive.</p>
<p>5.2.3.19. Multi-parcel country residential subdivisions shall not be permitted on lands predominantly identified as prime agricultural lands according to the Canada Land Inventory (C.L.I) Soil Class Rating System and under agricultural production except where food production is an essential component of the development or where the development requires location on prime lands.</p>	<p>The proposed development is located on land considered as 'Class 4' according to the Canada Land Inventory (CLI) Soil Class Rating System. Class 4 soils have severe limitations that restrict the range of crops or require special conservation practices, or both in order to be productive.</p>

Policy	Compliance Notes
<p>5.2.3.21. Council shall consider the capacity of existing school and bus facilities or the feasibility of expanding this capacity to suit a development when reviewing multi- parcel country residential subdivision proposals.</p>	<p>The proposed development was referred to the Prairie Spirit School Division for review. It was confirmed that two schools would serve any students living at the proposed Ravenswood Development, including South Corman Park School (K to Grade 6) and Clavet Composite School (Grade 7 to Grade 12). See attached correspondence in Appendix L.</p>
<p>5.2.3.22. Approved multi-parcel developments shall be phased to ensure that roadway development and the provision of other services does not unnecessarily precede lot development.</p>	<p>The development of the site is intended to occur within at least two phases. The size and timing of the phases will consider market conditions, the efficient expansion of municipal services and the rate of absorption of marketed properties.</p>
<p>SECTION 11: SERVICING OBJECTIVES AND POLICIES</p>	
<p>11.2.1. All new development proposals in close proximity to any road in the Municipality shall allow for expansion of those roads to standards designated by Council.</p>	<p>Access to the proposed development will be provided from Clarence Avenue / Range Road 3053. The TIA prepared in support of this project confirmed that the current municipal road network will continue to provide a suitable level of service at full build-out and that no improvements are required as a result of the proposed development.</p>
<p>11.2.2. Any person proposing a subdivision and/or development of land shall, as a condition of approval, construct at his or her own expense and to standards established by the Council such roads as may be required by the subdivision and/or development.</p>	<p>The planned internal road network will be constructed according to the RM's current published Country Residential Road standard.</p>
<p>11.2.3. All development proposals shall have regard to existing school and school bus capacity.</p>	<p>The proposed development was referred to the Prairie Spirit School Division for review. It was confirmed that two schools would serve any students living within the proposed Ravenswood development, including South Corman Park School (K to Grade 6) and Clavet Composite School (Grade 7 to Grade 12). See attached correspondence in Appendix K.</p>

5.2 Corman Park Zoning Bylaw

Development within Ravenswood is required to comply with the site regulations represented in the CR1 - Country Residential 1 District which has been established to accommodate a country residential development in a rural environment where the essential land requirement is for a building site and space rather than for productive agricultural purposes.

The principal permitted uses in this district include a single detached country residence excluding a mobile or modular home. Residential development within Ravenswood will be limited to single detached dwellings. The existing Walter Lane Community Care Facility was previously approved as a discretionary form of development. Given that a community facility is also a discretionary form of development in the CR1 district, the proposed rezoning supports the transfer of this approval.

Planned properties within Ravenswood range in size between 0.49 ha (1.21 acres) and 3.43 ha (8.48 acres) which complies with the minimum site area requirements represented by the CR1 district which are 0.4 ha (1 acre) to 4.05 ha (10 acres).

The CR1 district requires a minimum overall average site area of 1.0 ha (2.47 acres) for the entire development and that the maximum size of the development area for an individual multi-parcel country residential development shall not exceed 64.8 ha (160 acres). The average overall lot area within Ravenswood is 1.0 ha (2.47 acres) and the plan area comprises 55.19 ha (136.4 acres).

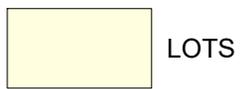
Appendix A: Land Use Concept

S.E. 1/4 Sec 33-35-5-3

A



LEGEND



Appendix B: Traffic Impact Assessment



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1221 – 8th STREET EAST | SASKATOON, SK S7H 0S5

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April 18, 2019

Ravenswood Development
RM of Corman Park, SK

via email: grozell55@gmail.com

Attention: Mr. Larry Grozell

Re: Traffic Impact Assessment for Ravenswood Development – RM of Corman Park, SK

Catterall & Wright (C&W) is pleased to submit the following letter report outlining the results of the Traffic Impact Assessment (TIA) for the proposed Ravenswood Developments in the RM of Corman Park, SK.

Larry Grozell is proposing to develop Ravenswood Development including country residence, senior housing, community/senior care and community center facilities, located south of Clarence Avenue and Grasswood Road intersection, south of Saskatoon city limit and bordered by Clarence Avenue on the east boundary as shown in **Figure 1**.

As part of the development process, Larry Grozell retained C&W to complete the TIA report to determine the impact of the traffic generated by the proposed development on the study intersections. The results of the impact assessment will be used to develop strategies to mitigate the adverse impact, if any. This report is best described as a complementary technical document and should be reviewed in conjunction with the Comprehensive Development Review (CDR) of the proposed site.

C&W contacted the RM of Corman Park (RM) on November 1, 2018 to discuss the scope of the study. The RM requested C&W to conduct a turning lane warrant analysis at the proposed access intersections and also review the potential impact of site-generated traffic on Highway 219. In addition, the RM mentioned that the turning movement counts recently collected for an adjacent development (Edgemont Estates) should be used for this study so that the generated trips from the adjacent development will be included in the background traffic forecast of the Ravenswood Development.

STUDY BACKGROUND



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1221 – 8th STREET EAST | SASKATOON, SK S7H 0S5

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PROPOSED DEVELOPMENT

The development site is proposed to be built within NE 28-35-5 W3M in the RM of Corman Park. The proposed development includes country residential, senior housing, community/senior care and community center facilities. The proposed site is assumed to be fully developed in 10 years.

At full build-out condition, the Ravenswood Development will consist of 40 single family country residential lots, an assisted living facility with 18 beds, two senior housing facilities consisting of 32 dwelling units and a community center with a gross floor area (GFA) of 10,000 sq. ft. The community center is intended for a non-profit entity which will provide services primarily to the disabled community for day programming as well as making it available to the broader community to share and connect through common, innovative and creative experiences.

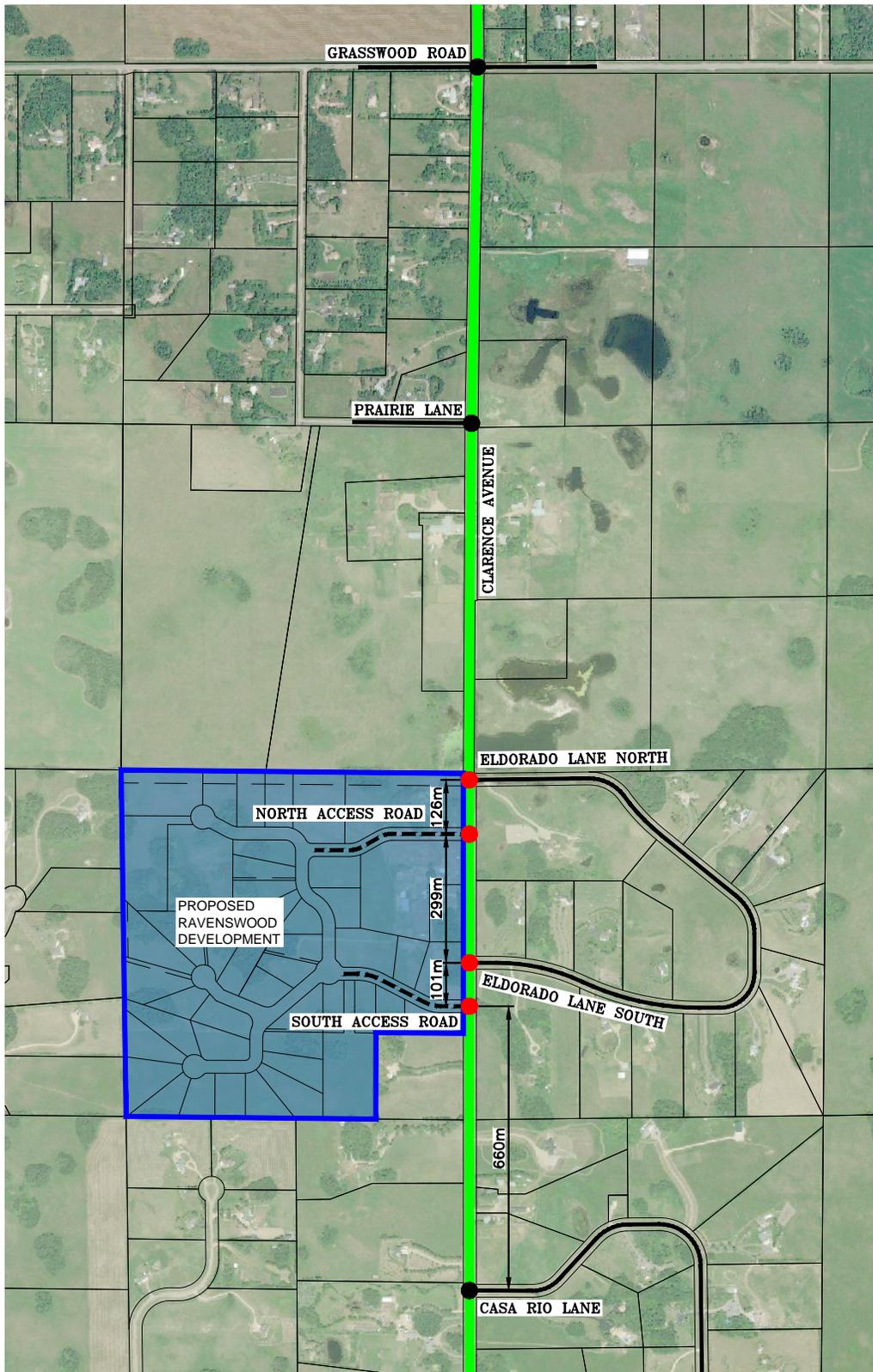
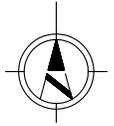
The study area of this TIA includes four intersections with Clarence Avenue; proposed North Access Road, proposed South Access Road, Eldorado Lane North and Eldorado Lane South. The proposed access roads will directly intersect Clarence Avenue. The North Access Road will be located at approximately 126 meters south of Eldorado Lane North and South Access Road will be located at approximately 101 meters south of Eldorado Lane South. **Figure 2** illustrates the site plan and study intersections.

Based on the information provided by Client, the design speeds along the North Access Road and other internal roads will be 50 km/h. However, the speed limit along the South Access Road will be reduced to 40 km/h due to presence of special pedestrian generators such as senior/community care, senior housing and community center along this road.

EXISTING SYSTEM

Clarence Avenue is a two-lane undivided paved roadway that runs north-south direction with a posted speed of 80 km/h south of Grasswood Road and 60 km/h to the north. The Clarence Avenue and Grasswood intersection is a four-way stop-controlled intersection where Grasswood Road is posted at 80 km/h on the west leg and 60 km/h on the east leg. Eldorado Lane and Casa Rio Lane form stop-controlled T-intersections with Clarence Avenue which operates free-flow.

Based on the information provided by the Client and confirmed by the RM, the Clarence Avenue will have a speed reduction from 80 km/h to 60 km/h from Grasswood Road to Baker Road after completion of the Phase 1 of Edgemont Estates development located north of the proposed Ravenswood Development.



LEGEND:

- STUDY INTERSECTIONS
- PROPOSED ACCESS ROAD
- PROJECT BOUNDARY

DATE	REVISION

SCALE VERIFICATION

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DRAWING NUMBER	FIGURE 2		

CATTERALL & WRIGHT
 CONSULTING ENGINEERS

1221 - 8th Street East
 SASKATOON SK S7H 0S5

Tel: (306) 343-7280, Fax: (306) 956-3199



OWNER/CLIENT
LARRY GROZELL

LOCATION
 RM OF CORMAN PARK

PROJECT
**RAVENSWOOD
 TRAFFIC IMPACT
 ASSESSMENT**

SHEET TITLE
 SITE PLAN



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The latest turning movement counts and historic collision data (year 2017) along Clarence Avenue were taken from a recently submitted report for an adjacent development (Edgemont Estate). The 2017 traffic counts were projected to 2019 with 2% growth to replicate the existing traffic conditions. In addition, in and out traffic volumes were collected at a study intersection of Eldorado Lane South and Clarence Avenue on November 1, 2018 which were also projected to year 2019. The existing morning (AM) and evening (PM) peak hour counts at study intersections are illustrated in **Figure 3**.

BACKGROUND TRAFFIC

The background traffic growth reflects the growth in traffic volumes over time that are not related to the project trips. As the proposed site is anticipated to be developed in 10 years, an annual 2% growth was applied to the existing traffic volumes at study intersections to determine the future background traffic volumes for year 2029 without the project trips. The background trips include the future horizon trips from the adjacent Edgemont Estates development. The future background volumes for AM and PM peak hours are shown in **Figure 4**.

DEVELOPMENT TRIPS

Site-generated trips from the proposed development were established using the Institute of Transportation Engineers Trip Generation Manual, 10th Edition (ITE Manual). The ITE average trip generation rates, units and directional distribution are illustrated in **Table 1**.

Table 1 – ITE Average Trip Generation Rates

Land Use Type	ITE Code	Unit	AM Peak Hour			PM Peak Hour		
			Rate	In %	Out %	Rate	In %	Out %
Single-Family Detached Housing	210	No. of Units	0.74	25	75	0.99	63	37
Assisted Living (Care Facility)	254	No. of Beds	0.19	63	37	0.26	38	62
Senior Housing - Attached	252	No. of Units	0.20	35	65	0.26	55	45
Community Center	495	1000 sq. ft. GFA	1.76	66	34	2.31	47	53

Table 2 summarizes the two-way vehicle trips anticipated to be generated from the proposed development during the weekday AM and PM peak hours.



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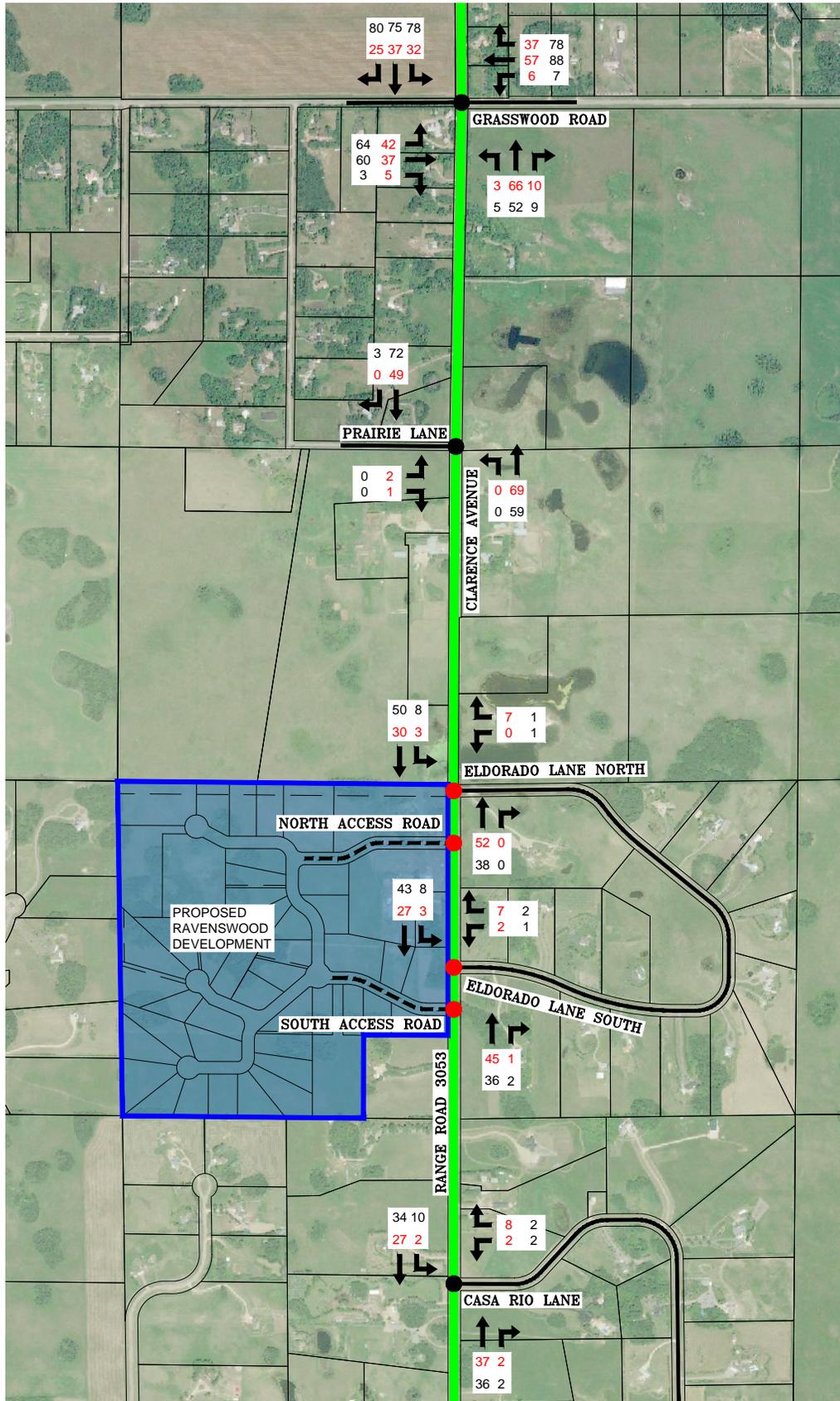
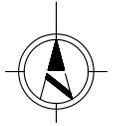
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Table 2 – Trip Generation Estimate

Land Use Type	Size	AM Peak Hour				PM Peak Hour			
		Rate	In	Out	Total	Rate	In	Out	Total
Single-Family Detached Housing	40	0.74	8	22	30	0.99	25	15	40
Assisted Living (Care Facility)	18	0.19	2	1	3	0.26	2	3	5
Senior Housing - Attached	35	0.20	2	5	7	0.26	5	4	9
Community Center	10	1.76	12	6	18	2.31	11	12	23
Total			24	34	58		43	34	77

As shown in Table 2, the proposed site is expected to generate 58 trips during AM peak hour and 77 Trips during PM peak hour. 24 vehicles will enter and 34 vehicles will depart from the proposed site during AM peak hour. During the PM peak hour, 43 vehicles will enter and 34 vehicles will depart. As the proposed site has two access intersections, the generated trips were split 50/50 on each access intersection.



LEGEND:

- STUDY INTERSECTIONS
- 20 AM PEAK HOUR VOLUME
- 20 PM PEAK HOUR VOLUME
- PROJECT BOUNDARY

DATE	REVISION

SCALE VERIFICATION	
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DRAWING NUMBER	FIGURE 3

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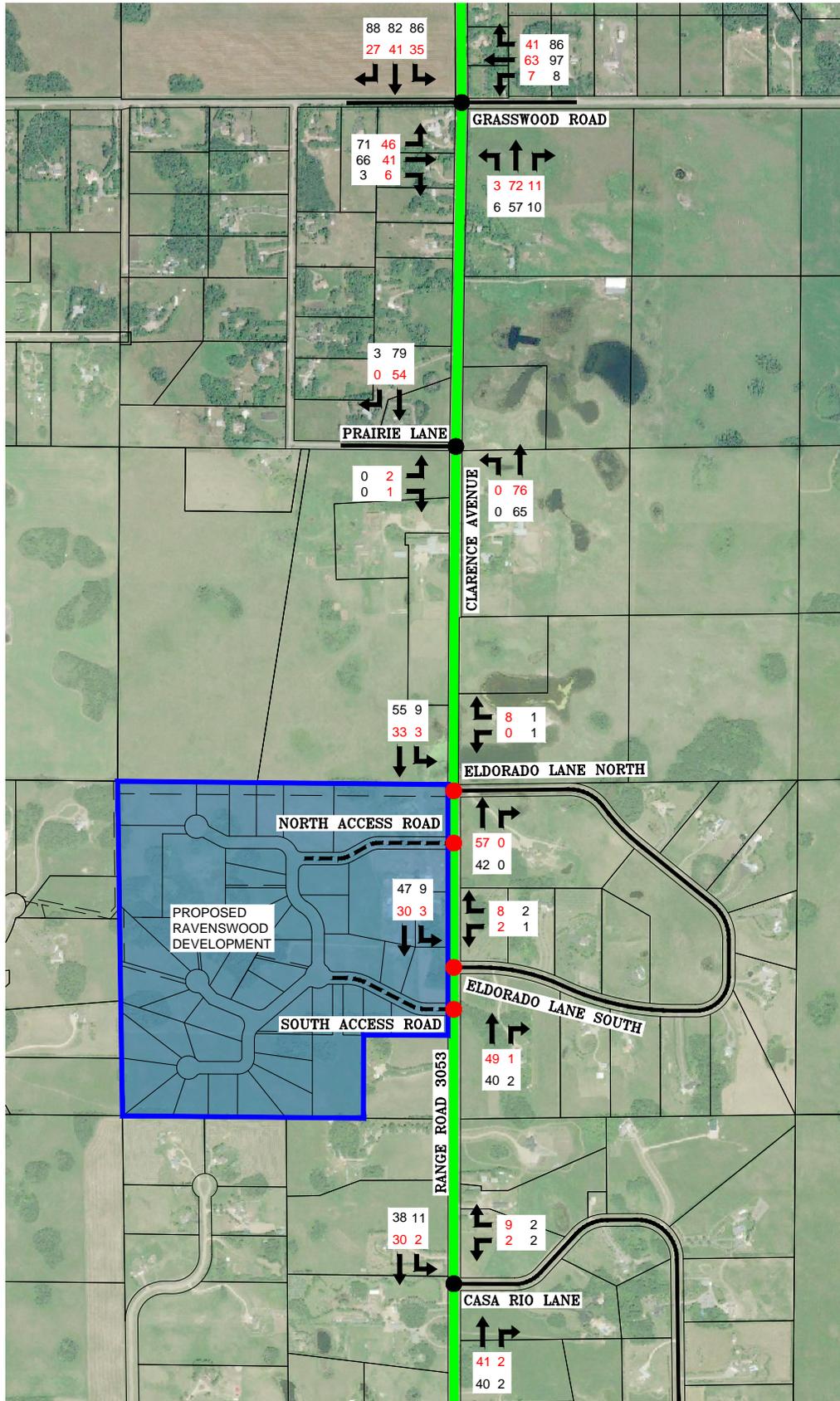
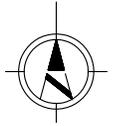


OWNER/CLIENT
LARRY GROZELL

LOCATION
RM OF CORMAN PARK

PROJECT
RAVENSWOOD TRAFFIC IMPACT ASSESSMENT

SHEET TITLE
EXISTING PEAK HOUR VOLUMES (2019)



LEGEND:

- STUDY INTERSECTIONS
- 20 AM PEAK HOUR VOLUME
- 20 PM PEAK HOUR VOLUME
- PROJECT BOUNDARY

DATE	REVISION

SCALE VERIFICATION	
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19/03/13	1 of 1
DRAWING NUMBER	FIGURE 4

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OWNER/CLIENT
LARRY GROZELL

LOCATION
RM OF CORMAN PARK

PROJECT
**RAVENSWOOD
TRAFFIC IMPACT
ASSESSMENT**

SHEET TITLE
**10 - YEAR BACKGROUND
FORECAST VOLUMES (2029)**



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TRIP DISTRIBUTION

The site-generated traffic volumes were assigned to the study intersections based on the assessment of how a vehicle would enter or exit the site. The direction from which the traffic will approach and depart the project site depends upon several factors such as existing travel pattern, size of development, type of business, type of customers and surrounding population.

The generated trips were assumed to be 65% to/from the north, 5% to/from the south, 20% to/from the east and 10% to/from the west. **Figure 5** presents the distribution and assignment of new trips generated by the proposed development during the AM and PM peak hour at the study intersections.

TOTAL FORECAST VOLUMES

Total forecast volumes for the long-term horizon (year 2029) are obtained by combining the background traffic growth with the new trips associated with the development. **Figure 6** illustrates the total forecast volumes for the AM and PM peak hour at the study intersections.

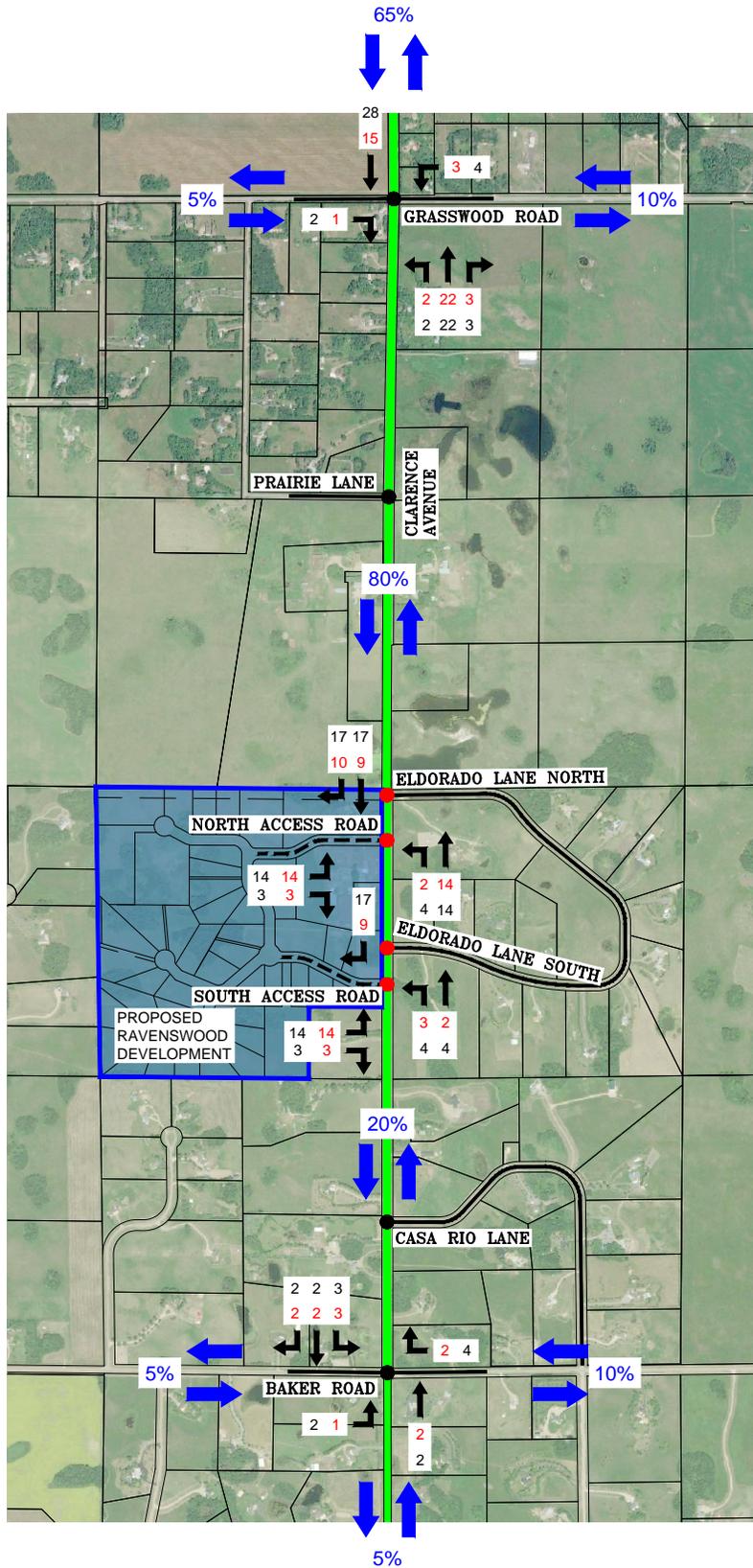
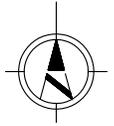
TRAFFIC OPERATIONS

Existing traffic, future background traffic (without project trips) and total forecasted traffic (with project trips) operations were assessed at the study intersections using Synchro 10.0 software. The intersection level of service (LOS) was examined for AM and PM peak hour volumes with no additional turning lanes.

LOS for a stop-controlled intersection is determined by the computed or measured control delay and is defined for each movement. LOS is not defined for the intersection as a whole. With only low turning volumes to/from the minor road and high through volumes on the main road, delays to turning vehicles can become excessive. As delays increase, turning vehicles will attempt to turn across unacceptable gaps which can present safety concerns. LOS D is typically considered the limit of acceptable operation and excessive delays tend to occur beyond this threshold. **Table 3** illustrates the relationship between level of service and average delay.

Table 3 - Level of Service vs. Average Delay

LOS	Delay Definition	Stop Controlled Intersection Controlled Delay Per Vehicle (sec/veh)
A	Little or no delay	<=10.0
B	Short traffic delay	> 10.0 and <= 15.0
C	Average traffic delay	> 15.0 and <= 25.0
D	Long traffic delay	> 25.0 and <= 35.0
E	Very long traffic delay	> 35.0 and <= 50.0
F	Failure	> 50.0



LEGEND:

- 20 AM PEAK HOUR VOLUME
- 20 PM PEAK HOUR VOLUME
- 20% DIRECTIONAL DISTRIBUTION
- PROJECT BOUNDARY

DATE	REVISION

SCALE VERIFICATION	
WHEN DRAWING IS PLOTTED FULL SIZE THIS LINE IS 30mm IN LENGTH.	
SCALE NTS	DESIGNED SNH
DRAWN ERL	CHECKED SNH
DATE 19/03/13	SHEET 1 of 1
DRAWING NUMBER	FIGURE 5

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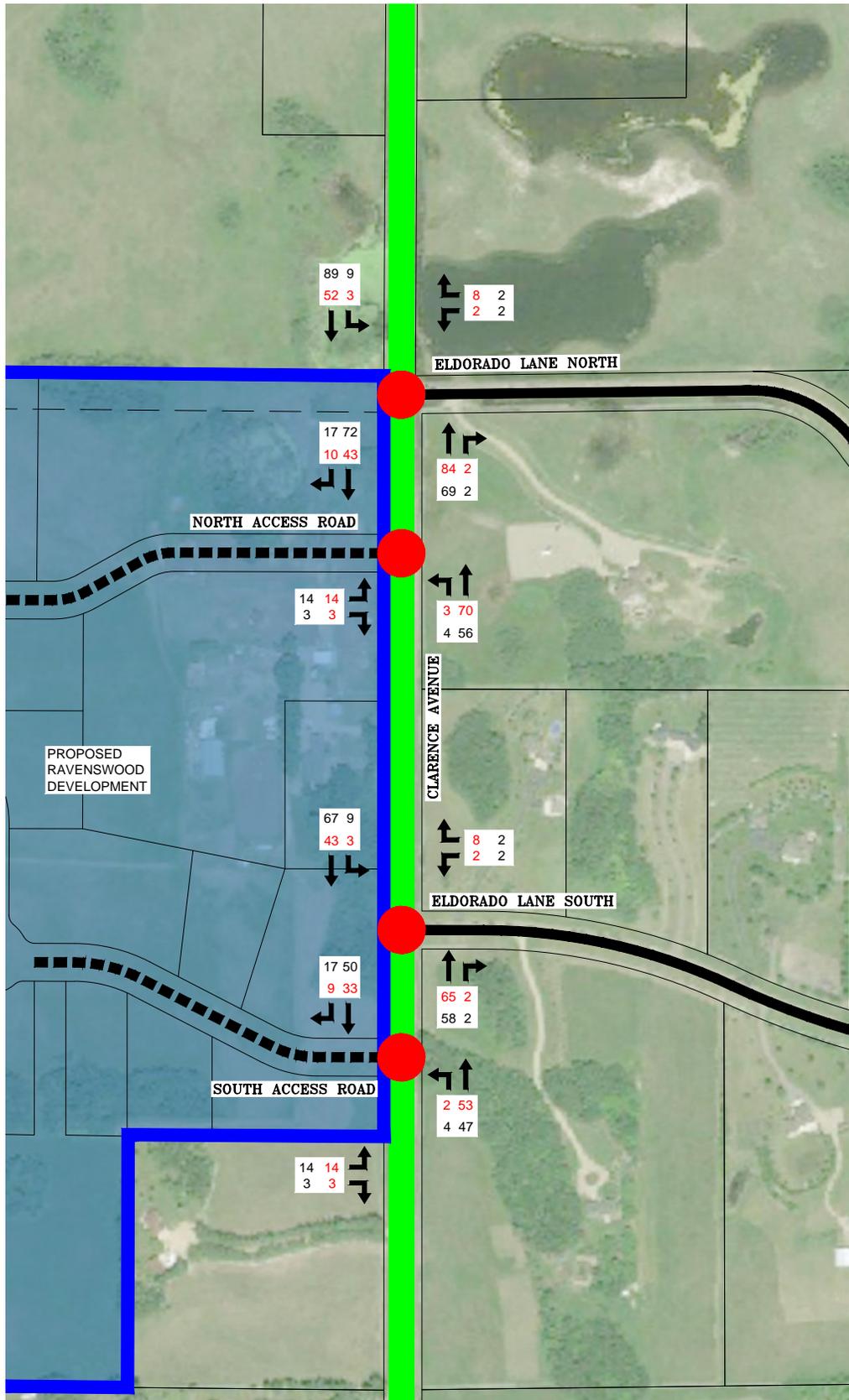
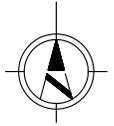
OWNER/CLIENT
LARRY GROZELL

PROJECT
**RAVENSWOOD
TRAFFIC IMPACT
ASSESSMENT**

LOCATION
RM OF CORMAN PARK

SHEET TITLE
**TRIP DISTRIBUTION
AND ASSIGNMENT**

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LEGEND:

- STUDY INTERSECTIONS
- 20 AM PEAK HOUR VOLUME
- 20 PM PEAK HOUR VOLUME

DATE	REVISION

SCALE VERIFICATION
 WHEN DRAWING IS PLOTTED FULL SIZE
 THIS LINE IS 30mm IN LENGTH.

SCALE	NTS	DESIGNED	SNH
DRAWN	ERL	CHECKED	SNH
DATE	19/03/13	SHEET	1 of 1
DRAWING NUMBER	FIGURE 6		

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OWNER/CLIENT
LARRY GROZELL

PROJECT
RAVENSWOOD TRAFFIC IMPACT ASSESSMENT

SHEET TITLE
FUTURE TOTAL TRAFFIC VOLUME (2029)

LOCATION
RM OF CORMAN PARK



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LOS analysis for the study intersections for AM and PM peak hours are summarized in **Table 4** and **Table 5** respectively and results of Synchro analysis are attached in **Appendix A**.

Table 4 – LOS Results for AM Peak Hour

Parameters	Eastbound			Westbound			Northbound			Southbound		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Clarence Avenue and Eldorado Lane North												
Existing Condition												
V/C Ratios	-	-	-	0.01	-	0.01	-	0.03	0.03	0.00	0.00	-
95th Queue (m)	-	-	-	1	-	1	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Future Background (without project)												
V/C Ratios	-	-	-	0.01	-	0.01	-	0.04	0.04	0.00	0.00	-
95th Queue (m)	-	-	-	1	-	1	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Future Total (with project)												
V/C Ratios	-	-	-	0.01	-	0.01	-	0.05	0.05	0.00	0.00	-
95th Queue (m)	-	-	-	1	-	1	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Clarence Avenue and Proposed North Access Road												
Future Total (with project)												
V/C Ratios	0.02	-	0.02	-	-	-	0.00	0.00	-	-	0.03	0.03
95th Queue (m)	2	-	2	-	-	-	0	0	-	-	0	0
LOS	A	-	A	-	-	-	A	A	-	-	A	A
Clarence Avenue and Eldorado Lane South												
Existing Condition												
V/C Ratios	-	-	-	0.01	-	0.01	-	0.03	0.03	0.00	0.00	-
95th Queue (m)	-	-	-	1	-	1	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Future Background (without project)												
V/C Ratios	-	-	-	0.01	-	0.01	-	0.03	0.03	0.00	0.00	-
95th Queue (m)	-	-	-	1	-	1	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Future Total (with project)												
V/C Ratios	-	-	-	0.01	-	0.01	-	0.04	0.04	0.00	0.00	-
95th Queue (m)	-	-	-	1	-	1	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Clarence Avenue and Proposed South Access Road												
Future Total (with project)												
V/C Ratios	0.02	-	0.02	-	-	-	0.00	0.00	-	-	0.03	0.03
95th Queue (m)	2	-	2	-	-	-	0	0	-	-	0	0
LOS	A	-	A	-	-	-	A	A	-	-	A	A



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Table 5 – LOS Results for PM Peak Hour

Parameters	Eastbound			Westbound			Northbound			Southbound		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Clarence Avenue and Eldorado Lane North												
Existing Condition												
V/C Ratios	-	-	-	0.00	-	0.00	-	0.03	0.03	0.01	0.01	-
95th Queue (m)	-	-	-	0	-	0	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Future Background (without project)												
V/C Ratios	-	-	-	0.00	-	0.00	-	0.03	0.03	0.01	0.01	-
95th Queue (m)	-	-	-	0	-	0	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Future Total (with project)												
V/C Ratios	-	-	-	0.00	-	0.00	-	0.05	0.05	0.01	0.01	-
95th Queue (m)	-	-	-	0	-	0	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Clarence Avenue and Proposed North Access Road												
Future Total (with project)												
V/C Ratios	0.02	-	0.02	-	-	-	0.00	0.00	-	-	0.06	0.06
95th Queue (m)	2	-	2	-	-	-	0	0	-	-	0	0
LOS	A	-	A	-	-	-	A	A	-	-	A	A
Clarence Avenue and Eldorado Lane South												
Existing Condition												
V/C Ratios	-	-	-	0.00	-	0.00	-	0.02	0.02	0.01	0.01	-
95th Queue (m)	-	-	-	0	-	0	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Future Background (without project)												
V/C Ratios	-	-	-	0.00	-	0.00	-	0.03	0.03	0.01	0.01	-
95th Queue (m)	-	-	-	0	-	0	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Future Total (with project)												
V/C Ratios	-	-	-	0.00	-	0.00	-	0.04	0.04	0.01	0.01	-
95th Queue (m)	-	-	-	0	-	0	-	0	0	0	0	-
LOS	-	-	-	A	-	A	-	A	A	A	A	-
Clarence Avenue and Proposed South Access Road												
Future Total (with project)												
V/C Ratios	0.02	-	0.02	-	-	-	0.00	0.00	-	-	0.04	0.04
95th Queue (m)	2	-	2	-	-	-	0	0	-	-	0	0
LOS	A	-	A	-	-	-	A	A	-	-	A	A

As shown in above tables, all the study intersections are currently operating at acceptable conditions. Volume over Capacity (V/C) ratios and 95th percentile queue lengths are within the acceptable range. Free flow northbound and southbound movements on Clarence Avenue are operating at LOS A during both AM and PM peak hours. The stop-controlled westbound movements on Eldorado Lane North and Eldorado Lane South are also operating at LOS A during both peak hours.



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For future background condition (year 2029), the study intersections will continue to operate at acceptable conditions. V/C ratios and 95th percentile queue lengths will be within the acceptable range. Northbound and southbound movements on Clarence Avenue will operate at LOS A during both AM and PM peak hours. The stop-controlled westbound movements on Eldorado Lane North and Eldorado Lane South will operate at LOS A during both peak hours

For full build-out condition (year 2029), the study intersections are expected to continue operate with little or no delays during the AM and PM peak hours. V/C ratios and 95th percentile queue lengths are expected to be within the acceptable range with less than one vehicle (2 m) queuing on the approaches of North Access Road and South Access Road. Free flow movements on Clarence Avenue will continue to operate at LOS A during AM and PM peak hours. The stop-controlled movements on Eldorado Lane North, Eldorado Lane South, North Access Road and South Access Road are anticipated to operate at LOS A during both the peak hours.

Since the proposed subdivision will mainly be a residential development, the majority of trips (65%) generated by the proposed development will likely travel north along the Clarence Avenue. Only 10% of the generated traffic (approximately 8 vehicles per hour during PM peak) is expected to travel west via Grasswood Road and Baker Road and will likely use Highway 219 for onward journey. Based on the trip distribution pattern, it is anticipated that the impact of development trips on Highway 219 will be insignificant.

Capacity analysis indicates that there is minimal queuing along Clarence Avenue at the study intersections and left-turning vehicles at North Access Road and Eldorado Lane South intersections are not expected to block upstream intersections. However, with the existing number of accesses and future growth along Clarence Avenue, the RM may consider extending the existing 60 km/h posted speed along Clarence Avenue south of Baker Road to improve safety and reduce potential conflicts along the Clarence Avenue corridor.

Intersection illumination and turning lanes warrants were assessed to improve the potential traffic safety at the proposed access intersections. The warrants were conducted for full build-out condition using the total forecast design hour volumes, existing intersection configuration and alignment. As the proposed site generates more trips during evening peak hour, the evening design hour volumes for year 2029 were used to conduct the warrant analysis. The daily traffic (AADT) volumes were estimated based on the evening peak hour volumes assuming the evening peak is 10% of the daily traffic.

WARRANT ANALYSIS



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Illumination Warrant Assessment

Intersection area lighting is the illumination of the intersection area and the adjacent through and auxiliary lanes of the through highway to a specified lighting criteria. **Table 6** illustrates the illumination warrant for the intersection area lighting at the North Access Road and South Access Road intersections.

Table 6 – Intersection Area Lighting Warrant Analysis

Intersection	Traffic Volume Warrant	Raised Channelization Warrant	Traffic Accident Rate Warrant
North Access Road	No	No	No
South Access Road	No	No	No

Based on the warrant analysis, the access intersections to proposed site do not meet the Area Lighting warrant criteria. However, the access intersections qualify for intersection delineation lighting based on Ministry's criteria (DM 2621-1) as the traffic volumes on access roads exceed 150 vehicles per day (vpd). The ranking points are 45 points at the North Access Road intersection and 42 points at the South Access Road intersection. The warrant analysis for intersection area lighting is attached in **Appendix B** and warrant analysis for intersection delineation lighting is included in **Appendix C**.

Turning Lane Warrants

The Ministry's System Improvement Warrants provide the Standard Plans used to analyse the right-turn lanes (Plan No. 20614) and bypass lanes (Plan No. 20612) intersection treatment. Warrants are based on design hour volumes for the 10th year after the proposed construction date. Right-turn lane and bypass lane warrant analyses of the access intersections are included in **Appendix D** and results of the analysis are shown in **Table 7**.

Table 7 – Intersection Treatment Warrant Results

Intersection	Right-Turn Lane (Plan 20614)	Bypass Lane (Plan 20612)
North Access Road	No	No
South Access Road	No	No

The results of warrant analysis show that the right-turn lane and bypass lane are not warranted at any of the access intersection.



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SIGHT DISTANCE

Based on the details provided by Client, the sight triangles were drawn using 50 km/h design speed on North Access Road and 40 km/h design speed on South Access Road. As the speed limit on Clarence Avenue is approved to be reduced from 80 km/h to 60 km/h in the vicinity of the project, a speed limit of 70 km/h (10 km/h more than the posted speed) was assumed to draw the sight triangle to account for some variation in operating speed along the Clarence Avenue.

Plan 20630 from MHI Design Manual was used to determine the sight distance for entering vehicles at intersections based on the design speed of intersecting roadway. A driver entering a through highway must have sufficient sight distance to make a left or right turn. This sight distance is called a departure sight distance. Based on the required sight triangle, it was noted that the departure sight distances at the access intersections are clear from any sort of obstruction that has potential to block a driver's view. The departure sight triangles are illustrated in **Appendix E1**.

Figure 4 from Zoning Bylaws of the RM of Corman Park was used to draw a sight triangles at intersections to make sure the sight distances along both roadways are adequate to allow the drivers of vehicles approaching simultaneously to see each other in time to prevent a collision at the intersections. The required sight triangles of the access intersections are illustrated in **Appendix E2**. It was noted that some bushes and a portion of property fence are located within the sight triangles that may create a safety issue. It is recommended that the bushes within the sight triangles be removed and the property fence be replaced by some other type of fence such as chain link fence so that the driver's view will remain clear or removed in its entirety.

SUMMARY OF RECOMMENDATIONS

The purpose of the Traffic Impact Assessment was to ensure that the study intersections will operate at a satisfactory Level of Service for existing and future traffic conditions at full build-out.

The access to the proposed site will be provided from the North Access Road and the South Access Road. The study area includes four intersections with Clarence Avenue; North Access Road, South Access Road, Eldorado Lane North and Eldorado Lane South. Based on the details provided by Client, the design speeds along the North Access Road and other internal roads will be 50 km/h. However, the speed limit along the South Access Road will be reduced to 40 km/h due to presence of special pedestrian generators such as senior/community care, senior housing and community center along this road.

Based on this study, the overall impact of the proposed development is minimal and does not significantly impact the capacity, operations, or safety of the study intersections. Analysis completed within this TIA identifies no



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capacity issues and in the long-term horizon (year 2029) the study intersections will continue to operate at an acceptable level of service with all individual movements operating at LOS A.

The access intersections do not meet the Intersection Area Lighting warrant requirements; however, they qualify for intersection delineation lighting warrants with 45 ranking points for the North Access Road and 42 ranking points for the South Access Road.

Based on the turning lane warrant analysis, a right-turn lane and bypass lane are not warranted at North Access Road and South Access Road intersections.

Based on the information provided by Client and confirmed by RM, the Clarence Avenue will have a speed reduction from 80 km/h to 60 km/h from Grasswood Road to Baker Road after completion of the Phase 1 of Edgemont Estates development located north of the proposed site.

The sight triangles were drawn using 50 km/h design speed on North Access Road and 40 km/h design speed on South Access Road. For Clarence Avenue, a speed limit of 70 km/h (10 km/h more than the posted speed) was assumed to draw the sight triangle to account for some variation in operating speed. It is recommended that the speed limit reduction to 60 km/h on Clarence Avenue be implemented before completion of any of the developments in the proposed Ravenswood site.

It was observed that a portion of property fence and some bushes are located within the sight triangles of the access intersections, which should remain clear from any sort of obstruction that has potential to block a driver's view. It is recommended that the bushes within the sight triangles be removed and the property fence be replaced by some other type of fence which will not obstruct the driver's view or removed in its entirety.

Since the Ravenswood development will mainly be a residential development, the majority of generated traffic will likely travel north along the Clarence Avenue. Based on the trip distribution pattern, it is anticipated that the impact of development trips on Highway 219 will be insignificant.

Should any questions or concerns arise from this report, please contact Catterall & Wright and we would be more than happy to discuss.



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Yours truly;

Catterall & Wright

Per:

Nadeem Hyder, P.Eng.



Reviewed by:

Brett LaRoche, P. Eng.



Association of Professional Engineers & Geoscientists
of Saskatchewan

CERTIFICATE OF AUTHORIZATION
CATTERALL & WRIGHT

Number C848

Permission to Consult held by:

Discipline

Sk. Reg. No.

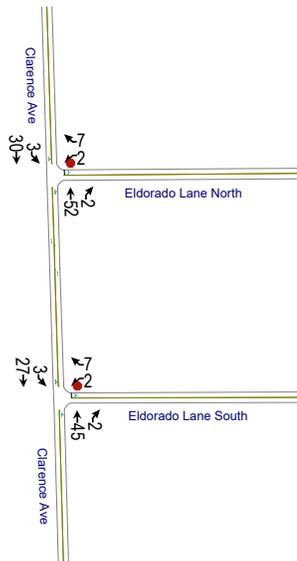
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Appendix A

Results of Synchro Analysis



HCM Unsignalized Intersection Capacity Analysis

Timing Plan: AM

03/18/2019

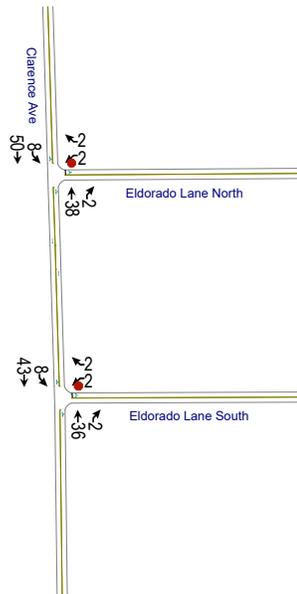
						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	7	52	2	3	30
Future Volume (Veh/h)	2	7	52	2	3	30
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	8	57	2	3	33
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	97	58			59	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	97	58			59	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	900	1008			1545	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	10	59	36			
Volume Left	2	0	3			
Volume Right	8	2	0			
cSH	984	1700	1545			
Volume to Capacity	0.01	0.03	0.00			
Queue Length 95th (ft)	1	0	0			
Control Delay (s)	8.7	0.0	0.6			
Lane LOS	A		A			
Approach Delay (s)	8.7	0.0	0.6			
Approach LOS	A					
Intersection Summary						
Average Delay			1.0			
Intersection Capacity Utilization			14.1%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

Timing Plan: AM

03/18/2019

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	7	45	2	3	27
Future Volume (Veh/h)	2	7	45	2	3	27
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	8	49	2	3	29
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	85	50			51	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	85	50			51	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	915	1018			1555	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	10	51	32			
Volume Left	2	0	3			
Volume Right	8	2	0			
cSH	996	1700	1555			
Volume to Capacity	0.01	0.03	0.00			
Queue Length 95th (ft)	1	0	0			
Control Delay (s)	8.7	0.0	0.7			
Lane LOS	A		A			
Approach Delay (s)	8.7	0.0	0.7			
Approach LOS	A					
Intersection Summary						
Average Delay			1.2			
Intersection Capacity Utilization		13.9%		ICU Level of Service		A
Analysis Period (min)			15			



HCM Unsignalized Intersection Capacity Analysis

Timing Plan: PM

03/18/2019

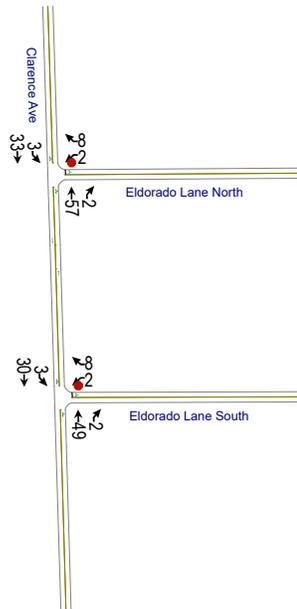
						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	2	38	2	8	50
Future Volume (Veh/h)	2	2	38	2	8	50
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	2	41	2	9	54
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	114	42			43	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	114	42			43	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			99	
cM capacity (veh/h)	877	1029			1566	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	4	43	63			
Volume Left	2	0	9			
Volume Right	2	2	0			
cSH	947	1700	1566			
Volume to Capacity	0.00	0.03	0.01			
Queue Length 95th (ft)	0	0	0			
Control Delay (s)	8.8	0.0	1.1			
Lane LOS	A		A			
Approach Delay (s)	8.8	0.0	1.1			
Approach LOS	A					
Intersection Summary						
Average Delay			0.9			
Intersection Capacity Utilization			19.4%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

Timing Plan: PM

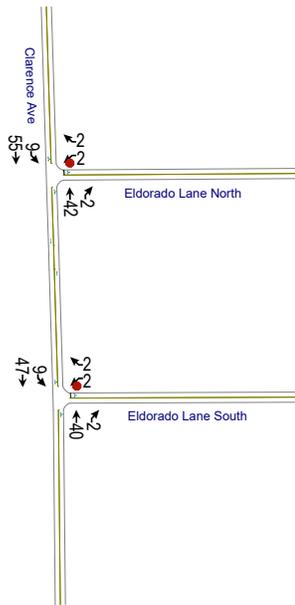
03/18/2019

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	2	36	2	8	43
Future Volume (Veh/h)	2	2	36	2	8	43
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	2	39	2	9	47
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	105	40			41	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	105	40			41	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			99	
cM capacity (veh/h)	888	1031			1568	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	4	41	56			
Volume Left	2	0	9			
Volume Right	2	2	0			
cSH	954	1700	1568			
Volume to Capacity	0.00	0.02	0.01			
Queue Length 95th (ft)	0	0	0			
Control Delay (s)	8.8	0.0	1.2			
Lane LOS	A		A			
Approach Delay (s)	8.8	0.0	1.2			
Approach LOS	A					
Intersection Summary						
Average Delay			1.0			
Intersection Capacity Utilization			19.1%	ICU Level of Service	A	
Analysis Period (min)			15			



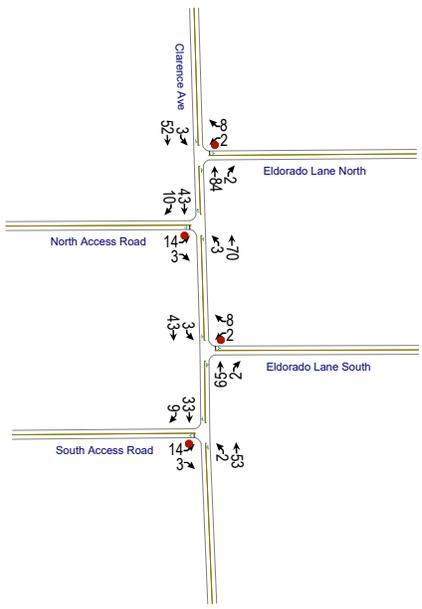
						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	8	57	2	3	33
Future Volume (Veh/h)	2	8	57	2	3	33
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	9	62	2	3	36
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	105	63			64	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	105	63			64	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	891	1002			1538	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	11	64	39			
Volume Left	2	0	3			
Volume Right	9	2	0			
cSH	980	1700	1538			
Volume to Capacity	0.01	0.04	0.00			
Queue Length 95th (ft)	1	0	0			
Control Delay (s)	8.7	0.0	0.6			
Lane LOS	A		A			
Approach Delay (s)	8.7	0.0	0.6			
Approach LOS	A					
Intersection Summary						
Average Delay			1.0			
Intersection Capacity Utilization			14.2%	ICU Level of Service	A	
Analysis Period (min)			15			

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	8	49	2	3	30
Future Volume (Veh/h)	2	8	49	2	3	30
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	9	53	2	3	33
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	93	54			55	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	93	54			55	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	905	1013			1550	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	11	55	36			
Volume Left	2	0	3			
Volume Right	9	2	0			
cSH	992	1700	1550			
Volume to Capacity	0.01	0.03	0.00			
Queue Length 95th (ft)	1	0	0			
Control Delay (s)	8.7	0.0	0.6			
Lane LOS	A		A			
Approach Delay (s)	8.7	0.0	0.6			
Approach LOS	A					
Intersection Summary						
Average Delay			1.2			
Intersection Capacity Utilization			14.1%	ICU Level of Service		A
Analysis Period (min)			15			



						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	2	42	2	9	55
Future Volume (Veh/h)	2	2	42	2	9	55
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	2	46	2	10	60
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	127	47			48	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	127	47			48	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			99	
cM capacity (veh/h)	862	1022			1559	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	4	48	70			
Volume Left	2	0	10			
Volume Right	2	2	0			
cSH	935	1700	1559			
Volume to Capacity	0.00	0.03	0.01			
Queue Length 95th (ft)	0	0	0			
Control Delay (s)	8.9	0.0	1.1			
Lane LOS	A		A			
Approach Delay (s)	8.9	0.0	1.1			
Approach LOS	A					
Intersection Summary						
Average Delay			0.9			
Intersection Capacity Utilization			20.1%		ICU Level of Service	A
Analysis Period (min)			15			

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	2	40	2	9	47
Future Volume (Veh/h)	2	2	40	2	9	47
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	2	43	2	10	51
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	115	44			45	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	115	44			45	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			99	
cM capacity (veh/h)	876	1026			1563	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	4	45	61			
Volume Left	2	0	10			
Volume Right	2	2	0			
cSH	945	1700	1563			
Volume to Capacity	0.00	0.03	0.01			
Queue Length 95th (ft)	0	0	0			
Control Delay (s)	8.8	0.0	1.2			
Lane LOS	A		A			
Approach Delay (s)	8.8	0.0	1.2			
Approach LOS	A					
Intersection Summary						
Average Delay			1.0			
Intersection Capacity Utilization			19.6%	ICU Level of Service	A	
Analysis Period (min)			15			



HCM Unsignalized Intersection Capacity Analysis

Timing Plan: AM

03/18/2019

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	8	84	2	3	52
Future Volume (Veh/h)	2	8	84	2	3	52
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	9	91	2	3	57
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	155	92			93	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	155	92			93	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	835	965			1501	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	11	93	60			
Volume Left	2	0	3			
Volume Right	9	2	0			
cSH	939	1700	1501			
Volume to Capacity	0.01	0.05	0.00			
Queue Length 95th (ft)	1	0	0			
Control Delay (s)	8.9	0.0	0.4			
Lane LOS	A		A			
Approach Delay (s)	8.9	0.0	0.4			
Approach LOS	A					
Intersection Summary						
Average Delay			0.7			
Intersection Capacity Utilization			15.2%	ICU Level of Service	A	
Analysis Period (min)			15			



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	14	3	3	70	43	10
Future Volume (Veh/h)	14	3	3	70	43	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	15	3	3	76	47	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	134	52	58			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	134	52	58			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	100	100			
cM capacity (veh/h)	857	1015	1546			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	18	79	58			
Volume Left	15	3	0			
Volume Right	3	0	11			
cSH	880	1546	1700			
Volume to Capacity	0.02	0.00	0.03			
Queue Length 95th (ft)	2	0	0			
Control Delay (s)	9.2	0.3	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.2	0.3	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			1.2			
Intersection Capacity Utilization			16.1%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

Timing Plan: AM

03/18/2019

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	8	65	2	3	43
Future Volume (Veh/h)	2	8	65	2	3	43
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	9	71	2	3	47
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	125	72			73	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	125	72			73	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	868	990			1527	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	11	73	50			
Volume Left	2	0	3			
Volume Right	9	2	0			
cSH	966	1700	1527			
Volume to Capacity	0.01	0.04	0.00			
Queue Length 95th (ft)	1	0	0			
Control Delay (s)	8.8	0.0	0.5			
Lane LOS	A		A			
Approach Delay (s)	8.8	0.0	0.5			
Approach LOS	A					
Intersection Summary						
Average Delay			0.9			
Intersection Capacity Utilization			14.7%		ICU Level of Service	A
Analysis Period (min)			15			

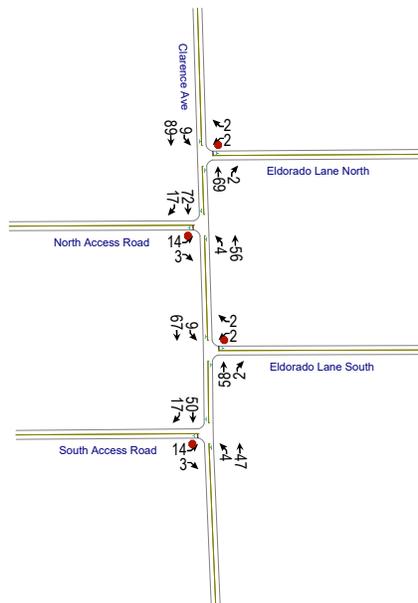
HCM Unsignalized Intersection Capacity Analysis

Timing Plan: AM

03/18/2019



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	14	3	2	53	33	9
Future Volume (Veh/h)	14	3	2	53	33	9
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	15	3	2	58	36	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	103	41	46			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	103	41	46			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	100	100			
cM capacity (veh/h)	894	1030	1562			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	18	60	46			
Volume Left	15	2	0			
Volume Right	3	0	10			
cSH	914	1562	1700			
Volume to Capacity	0.02	0.00	0.03			
Queue Length 95th (ft)	2	0	0			
Control Delay (s)	9.0	0.3	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.0	0.3	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			1.4			
Intersection Capacity Utilization			14.4%	ICU Level of Service	A	
Analysis Period (min)			15			



HCM Unsignalized Intersection Capacity Analysis

Timing Plan: PM

03/18/2019

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	2	69	2	9	89
Future Volume (Veh/h)	2	2	69	2	9	89
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	2	75	2	10	97
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	193	76			77	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	193	76			77	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			99	
cM capacity (veh/h)	791	985			1522	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	4	77	107			
Volume Left	2	0	10			
Volume Right	2	2	0			
cSH	877	1700	1522			
Volume to Capacity	0.00	0.05	0.01			
Queue Length 95th (ft)	0	0	0			
Control Delay (s)	9.1	0.0	0.7			
Lane LOS	A		A			
Approach Delay (s)	9.1	0.0	0.7			
Approach LOS	A					
Intersection Summary						
Average Delay			0.6			
Intersection Capacity Utilization			21.8%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

Timing Plan: PM

03/18/2019



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	14	3	4	56	72	17
Future Volume (Veh/h)	14	3	4	56	72	17
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	15	3	4	61	78	18
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	156	87	96			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	156	87	96			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	100	100			
cM capacity (veh/h)	833	971	1498			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	18	65	96			
Volume Left	15	4	0			
Volume Right	3	0	18			
cSH	853	1498	1700			
Volume to Capacity	0.02	0.00	0.06			
Queue Length 95th (ft)	2	0	0			
Control Delay (s)	9.3	0.5	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.3	0.5	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			1.1			
Intersection Capacity Utilization			16.2%	ICU Level of Service	A	
Analysis Period (min)			15			

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	2	58	2	9	67
Future Volume (Veh/h)	2	2	58	2	9	67
Sign Control	Stop		Free		Free	
Grade	0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	2	63	2	10	73
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	157	64			65	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	157	64			65	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			99	
cM capacity (veh/h)	829	1000			1537	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	4	65	83			
Volume Left	2	0	10			
Volume Right	2	2	0			
cSH	907	1700	1537			
Volume to Capacity	0.00	0.04	0.01			
Queue Length 95th (ft)	0	0	0			
Control Delay (s)	9.0	0.0	0.9			
Lane LOS	A		A			
Approach Delay (s)	9.0	0.0	0.9			
Approach LOS	A					
Intersection Summary						
Average Delay			0.7			
Intersection Capacity Utilization			20.7%		ICU Level of Service	A
Analysis Period (min)			15			



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	14	3	4	47	50	17
Future Volume (Veh/h)	14	3	4	47	50	17
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	15	3	4	51	54	18
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	122	63	72			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	122	63	72			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	100	100			
cM capacity (veh/h)	871	1002	1528			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	18	55	72			
Volume Left	15	4	0			
Volume Right	3	0	18			
cSH	890	1528	1700			
Volume to Capacity	0.02	0.00	0.04			
Queue Length 95th (ft)	2	0	0			
Control Delay (s)	9.1	0.6	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.1	0.6	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			1.3			
Intersection Capacity Utilization			15.8%	ICU Level of Service	A	
Analysis Period (min)			15			

Appendix B

Warrant for Intersection Area Lighting

FIGURE 2621-2-1

WARRANTS FOR INTERSECTION AREA LIGHTING

1. Traffic Volume Warrant Not Warranted
 - 1.1 Through Highway North Access AADT = 1470 < 1500

$$\frac{\text{Leg 1 AADT} + \text{Leg 2 AADT}}{2} = X1 \geq 1500 \text{ AADT,}$$
South Access AADT = 1160 < 1500
, and
 - 1.2 Intersecting Roadway North Access AADT = 382 < 1000

$$\text{Leg 1 AADT} + \text{Leg 2 AADT} = X2 \geq 1000 \text{ AADT}$$
South Access AADT = 382 < 1000
Note: For T intersections leg 1 or leg 2 = 0 AADT

2. Raised Channelization/Median Curbing Warrant Not Warranted
 - 2.1 Traffic Speed
 Posted speed limit or actual 85th percentile speed ≥ 60 km/h, and
 - 2.2 Traffic Engineering Assessment
 Traffic engineering assessment supports retention of the raised islands/median and the provision of area lighting.

Note: The limits of the area lighting for raised islands should extend to the limits of the raised islands/media.

3. Traffic Accident Rate Warrant Not Warranted
 - 3.1 Traffic Volume North Access AADT = 1470 > 1000
 Through highway traffic volume ≥ 1000 AADT, and South Access AADT = 1160 > 1000
 - 3.2 Accident Rate
 The intersection accident rate is ≥ 1.5 accidents/million entering vehicles/year. The ratio of the last three year average night to day accident rate is > 1.5 . A traffic engineering study supports area lighting as an acceptable expenditure.

Only one night accident within last 3 years
Only one night accident within last 3 years

Appendix C

Warrant for Partial Lighting (Intersection Delineation)



Design Manual

Section:

PARTIAL OR AREA LIGHTING

Subject:

Intersection Delineation

DEFINITIONS

Partial lighting is the illumination of key decision areas that demand full driver care and alertness by the placement of a limited number of luminaires.

Intersection delineation lighting consists of the installation of high pressure sodium (HPS) luminaire(s) over the intersecting roadway or median connector of divided highways for the purpose of illuminating vehicles entering or crossing the through highway route.

The luminaires provide the secondary benefit of visibly marking the location of the intersecting roadway on the provincial highway system.

POLICY

Partial roadway lighting, in the form of intersection delineation lighting, shall be provided at provincial highway intersections in accordance with the candidate and design criteria as noted herein and within Standard Plans 2621-1-1, 2621-1-2 and 2621-1-3.

**CANDIDATE
CRITERIA**

All provincial highway to highway intersections qualify for intersection delineation lighting.

All intersections of the designated community access road with the provincial highway system qualify for intersection delineation lighting.

All rural and urban public highway intersections with a provincial highway with an intersecting roadway traffic volume greater than 150 AADT or 250 SADT for seasonal recreational roads qualify for intersection delineation lighting.

Section:

**PARTIAL OR AREA
LIGHTING**

Subject:

Intersection Delineation

**COMMUNITY ACCESS
ROADS**

All intersections of the designated community access road with the provincial highway system qualify for intersection delineation lighting. Community access roads are assigned the 40 highway subsection identifier.

Intersection delineation lights for alternate access routes are subject to satisfying the minimum traffic volume criteria and priority ranking with all other provincial candidates.

PRIORITY RANKING

First priority should be given to any outstanding or new provincial highway to highway intersections where the availability of power permits an economical installation.

Next priority should be given to outstanding designated community access road intersections with a provincial highway where the availability of power permits an economical installation.

Other intersecting roadways that satisfy the 150 AADT or greater traffic criteria should be ranked on the basis of priority points. The candidate priority points are determined by use of Figure 2621-1-1 Intersection Delineation Lighting Priority Points.

A guideline for an acceptable price premium to bring power to the site is \$1,000 to \$2,000 per 100 AADT on the intersecting roadway.

Section:

PARTIAL OR AREA LIGHTING

Subject:

INTERSECTION DELINEATION

Clarence Avenue & North Access Road

Clarence Avenue & South Access Road

FIGURE 2621-1-1

DELINEATION LIGHTING PRIORITY RANKING POINTS

The purpose of this rating is to priority rank intersections for intersection delineation lighting. Points are assigned as follows:

	<u>Points</u>	<u>Maximum Points</u>
1. Highway Classification		
Arterial (major or minor)	5	3 Points
Collector	3	3 Points
Local	1	
2. AADT on Through Highway		
Points = 0.01 * AADT		25
(Through highway intersection leg with highest AADT)	0.01 x 1584 = 16	16 Points
	0.01 x 1275 = 13	13 Points
3. AADT on Intersecting Roadway		
Points = 0.05 * AADT		
(AADT on intersecting leg to be lit)	0.05 x 382 = 19	19 Points
	0.05 x 382 = 19	19 Points
4. Average Annual Number of Accidents		
Average annual number of night accidents last 3 years * 10	1/3 x 10 = 3	30
	1/3 x 10 = 3	3 Points
		3 Points
		Sub-Total; 41 Points
		Sub-Total; 38 Points

Section:

PARTIAL OR AREA LIGHTING

Subject:

INTERSECTION DELINEATION

FIGURE 2621-1-1
Continued

	<u>Points</u>	<u>Maximum Points</u>
5. Geometric Features		
5.1 Through Highway		
5.1.1 Channelized intersection treatment	5	
5.1.2 Divided Highway	5	
5.1.3 Intersection on horizontal curve	2	
5.1.4 Intersection off curve but within 100 m of curve (ST or TS)	1	
5.1.5 Intersection road surface visible:		
i) less than 180 m	2	
ii) less than 370 m	1	
5.1.6 Obstructed Sight Triangle in advance of intersection:		0 Points
i) one sight triangle obstructed	2	0 Points
ii) both sight triangles obstructed	3	
5.1.7 Intersection angle less than 70 or more than 110 degrees	2	
5.2 Intersecting Roadway		
5.2.1 Intersection road surface visible from less than 180 m	2	
5.2.2 Horizontal curve ending less than 60 m from the intersection	1	0 Points
5.2.3 Channelized intersection or divided roadway	5	0 Points
5.2.4 Signed Hospital access route	5	

Sub-Total; 0 Points

Sub-Total; 0 Points

Section:

PARTIAL OR AREA LIGHTING

Subject:

INTERSECTION DELINEATION

FIGURE 2621-1-1
Continued

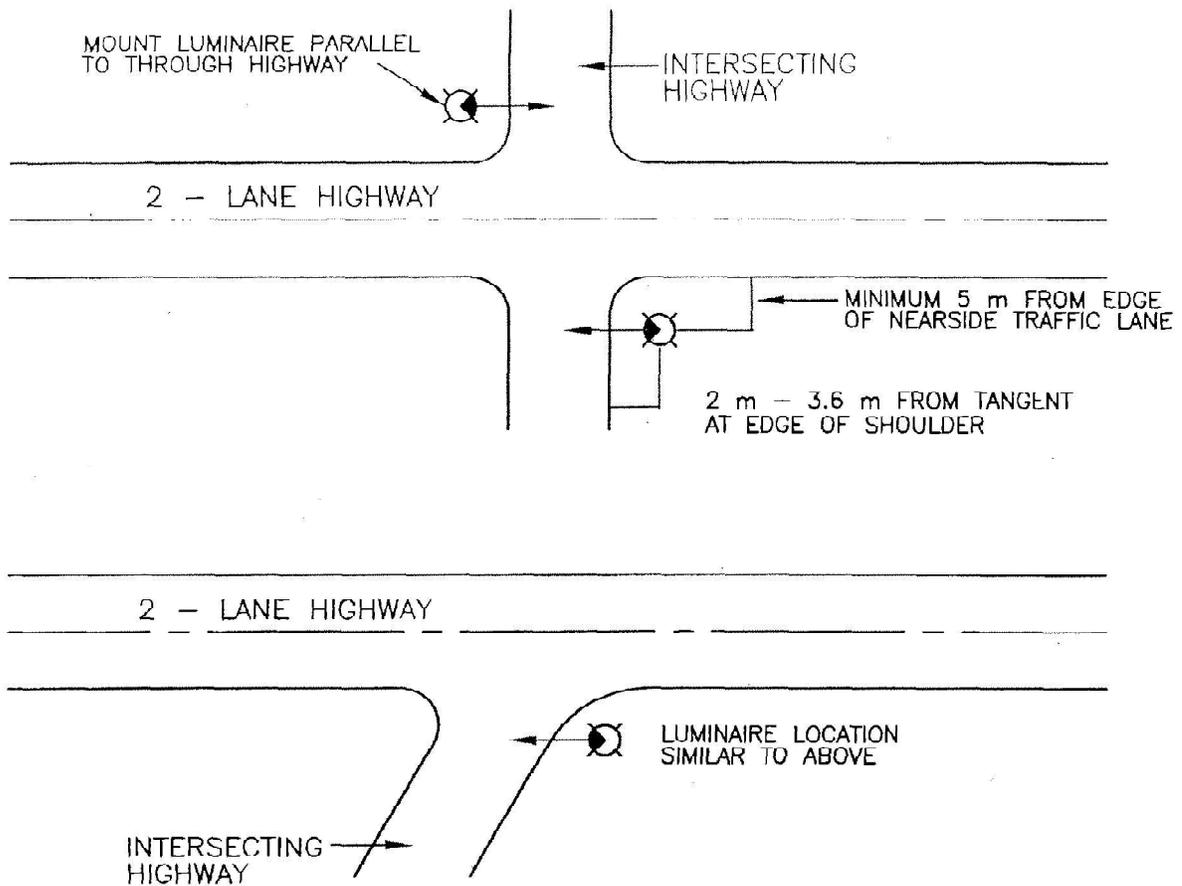
	<u>Points</u>	<u>Maximum Points</u>
6. Environmental Factors		
Either		
6.1 Rural development with lighting : (within 150 m of intersecting leg)		
i) in four quadrants	8	0 Point
ii) in three quadrants	6	
iii) in two quadrants	4	
iv) in one quadrant	1	
or		
6.2 Urban built up area:		
i) highway commercial	8	4 Points
ii) residential	4	
iii) industrial with lighting	3	4 Points

Total Ranking Points: 45 Points

Total Ranking Points: 42 Points

NOTES:

1. Delineation lighting is not provided if there is already an equivalent urban street light within 25 m of the intersection.
2. High speed exit/entrance roadways partial lighting should be given higher priority than at grade intersections with 60 points or less.
3. To qualify for intersection delineation lighting candidates, other than provincial highways or designated community access roads, shall incur an intersecting roadway traffic volume \geq 150 AADT or 250 SADT for seasonal recreational roads.
4. Height of eye for road surface visibility should be 1.15 m.



Notes:

1. High Pressure Sodium Vapour Luminaire, photocell switch (150 HPS or equivalent).
2. 10.7 m high, 2.4 m davit steel pole, M.H. (road surface to luminaire) not less than 9.0 m.
3. Use approved type slip-joint or frangible base.
4. Underground wiring from nearest line pole to base of light pole.
5. Flange of slip-joint must not protrude more than 10 cm above ground.
6. Check traffic sign(s) and relocate if necessary to suit lighting.
7. At 4-leg intersections where one leg of the intersection is not a highway, a light should be installed where the road AADT is 150 or higher.



Saskatchewan
Highways and
Transportation

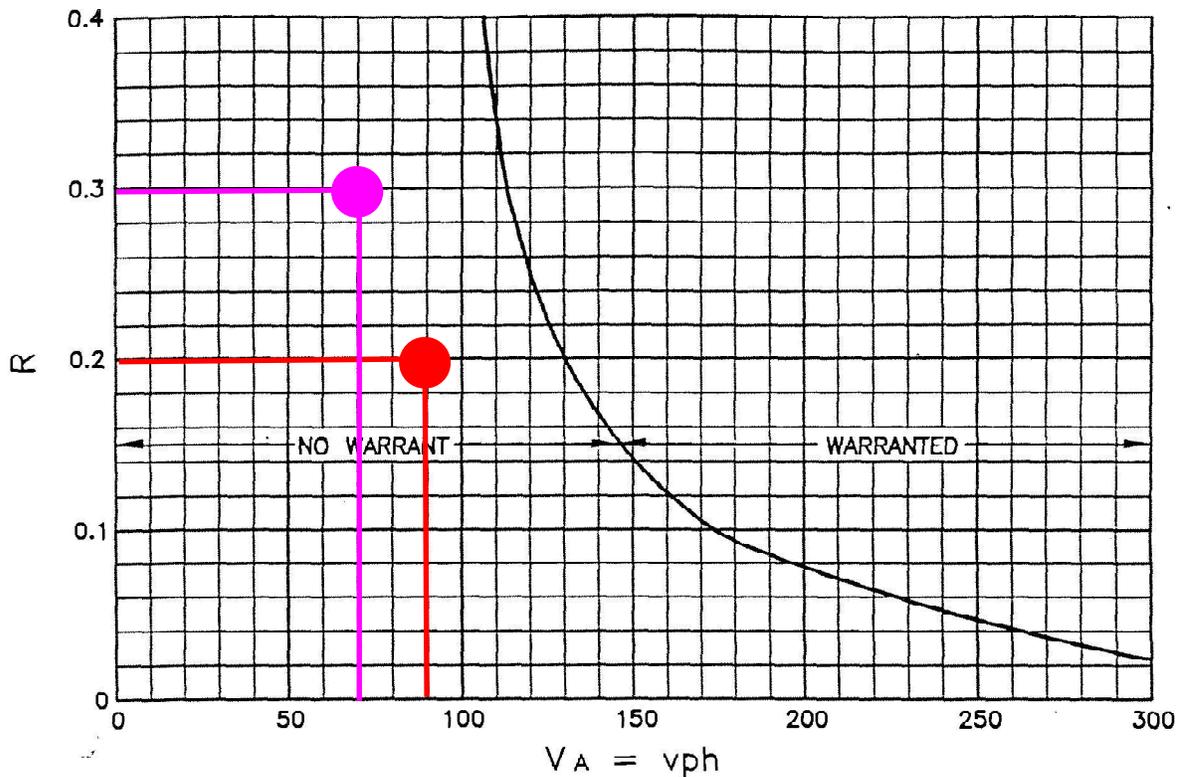
DELINEATION LIGHTING AT RURAL HIGHWAY INTERSECTIONS 2 LANE HIGHWAY

RECOMMENDED BY:	<i>[Signature]</i>	SENIOR DESIGN ENGINEER ENGINEERING SERVICES BR.	DATE	02-05-21	STANDARD PLAN NO	2621-1-1
APPROVED BY:	<i>[Signature]</i>	EXECUTIVE DIRECTOR ENGINEERING SERVICES BR.	DATE	02-06-05	SHEET	1 of 1

ACAD DWG: 2621-1-1.DWG LAST REV DATE: 01/11/20

Appendix D

Warrant for Intersection Treatment



Warrants are based on Design Hourly Volumes

VA = Advancing Volume, includes Volume Right and Volume Left unless exclusive left turn lane.

VR = Right Turn Volume, vph.

$$R = VR/VA$$

Warrants: NON FLARED INTERSECTION – Provide 3.7 m turning lane.

FLARED INTERSECTION – Lengthen deceleration lane to meet the right turn lane standard.

Clarence Avenue & North Access Road

Clarence Avenue & South Access Road

VA = (17+72) = 89 vehicles per hour

VR = 17 vehicles per hour

R = VR/VA = 0.2

VA = (17+50) = 67 vehicles per hour

VR = 17 vehicles per hour

R = VR/VA = 0.3

Not Warranted

Not Warranted



Saskatchewan
Highways and
Transportation

WARRANTS FOR RIGHT TURN LANES RURAL HIGHWAYS

RECOMMENDED BY:	<i>[Signature]</i>	DIRECTOR TECH. STDS. & POLICIES	DATE	95.12.24	STANDARD PLAN NO	20614
APPROVED BY:	<i>[Signature]</i>	ASSIST. DEPUTY MINISTER OPERATIONS DIVISION	DATE	95-02-28	SHEET	1 of 2

NOTES:

1. Right turn lanes are warranted at the following locations:
 - intersections with other Provincial Highways.
 - Industrial Access Roads.
 - Provincial Campgrounds and Picnic Sites.
2. Use corrected peak hourly volumes (vph) projected to the 10th year after the proposed construction date. Refer to correction factors under DM 502-3 for further information.
3. Normally 0.6 m shoulder will be provided on turning lane.
4. 1.5 m shoulder may be provided on divided highways and at intersections where truck volumes are higher than normal, for example, at scale sites and access to industrial sites generating heavy truck volumes.
5. Length of the turning lane will be related to highway design speed and turning speed. See Standard Plan No. 20618.
6. For 4 lane highways, the advancing volume should be based on 50% of the total directional volume (vph) or 25% of the total volume (where directional split is not a factor), with no further reduction for left turn vehicles.



Saskatchewan
Highways and
Transportation

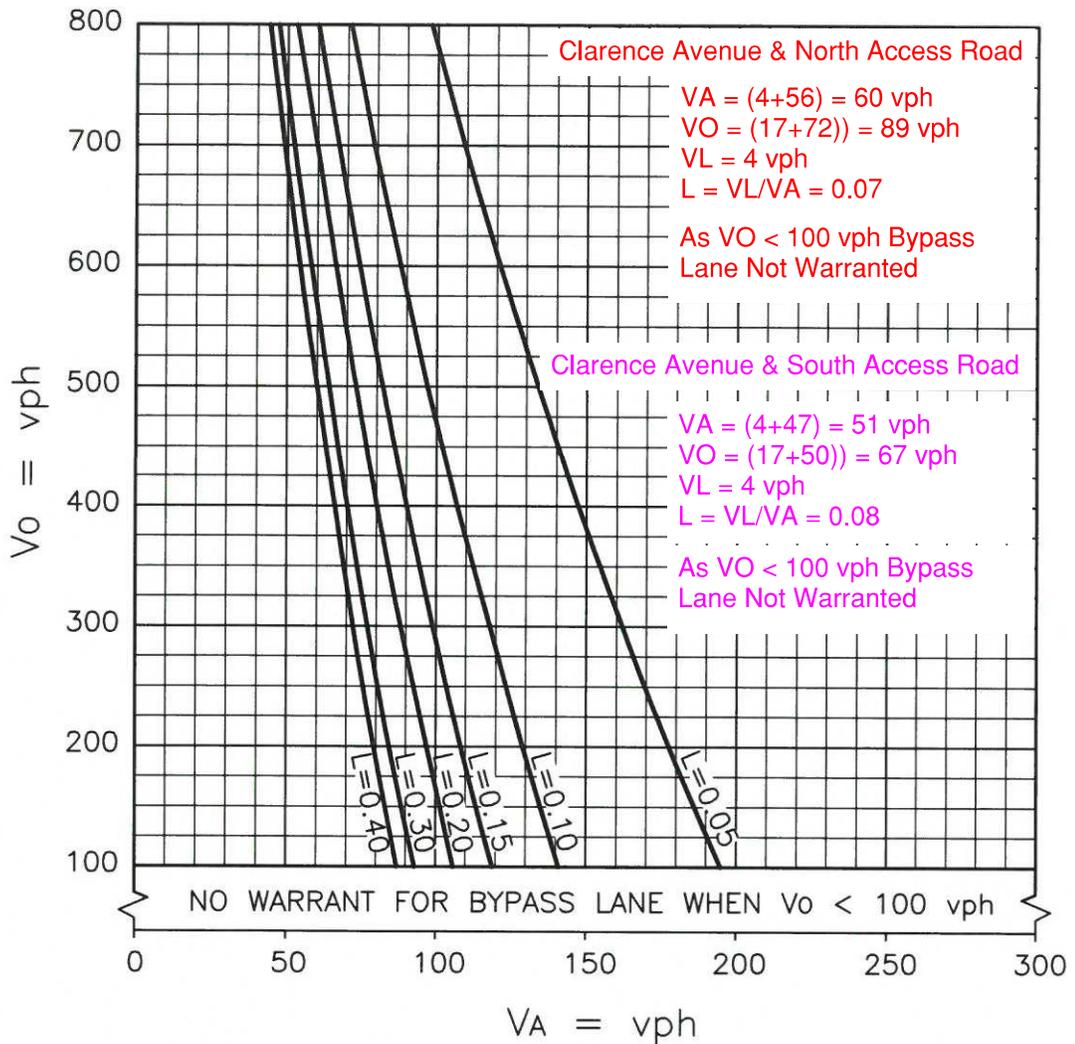
WARRANTS FOR RIGHT TURN LANES
RURAL HIGHWAYS

RECOMMENDED BY:		DIRECTOR TECH. STDS. & POLICIES	DATE	95-02-24	STANDARD PLAN NO	20614
APPROVED BY:		ASSIST. DEPUTY MINISTER OPERATIONS DIVISION	DATE	95-02-28	SHEET	2 of 2

LAST REV DATE: FEB.14,1995

1-2

ACAD DWG



VA = Advancing volume, includes volume left and volume right unless exclusive right turn lane.

VO = Opposing volume, includes volume left, and volume right unless separated right turning roadway (ramp).

VL = Left turn volume.

$$L = VL / VA$$

NOTES:

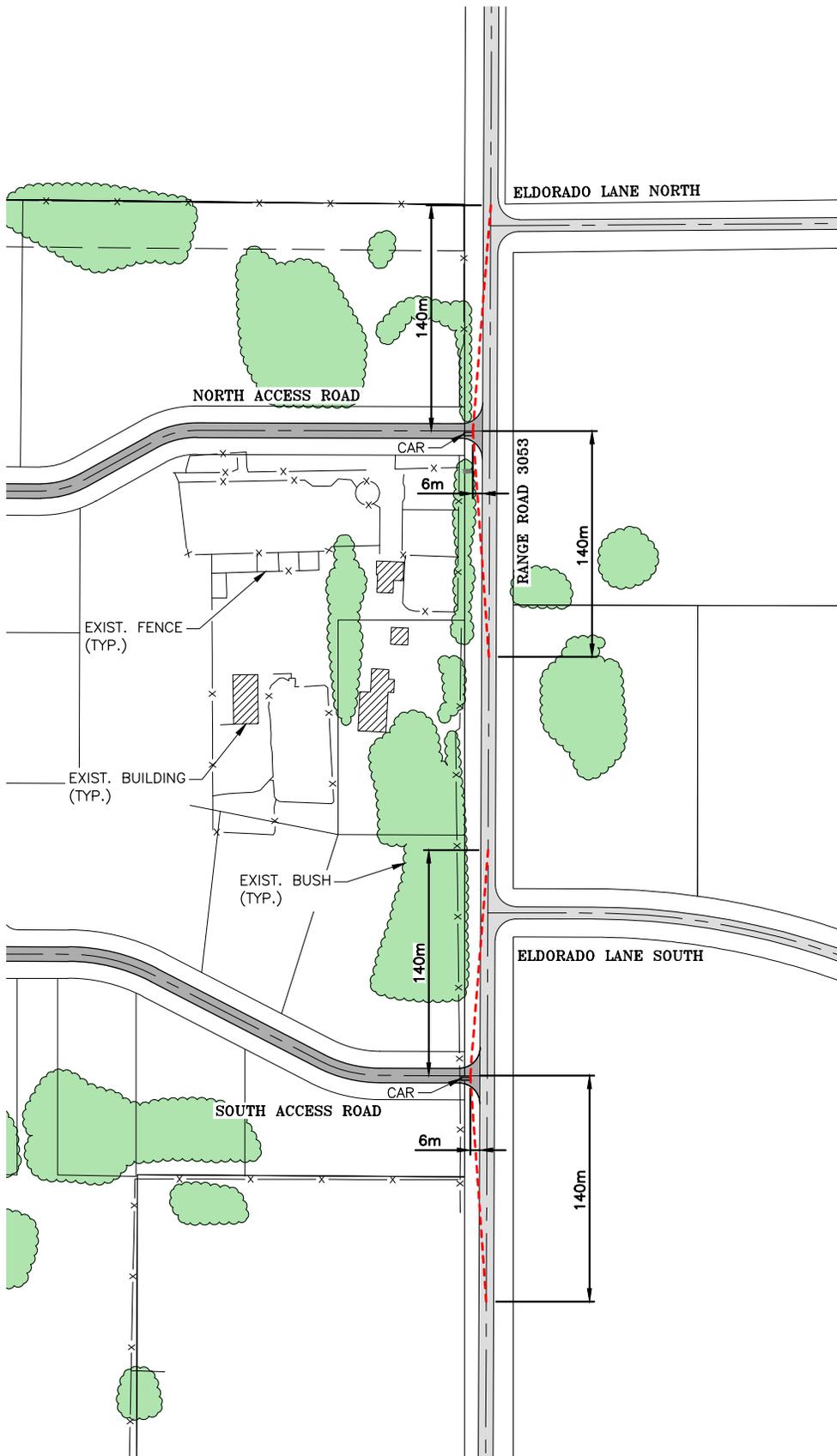
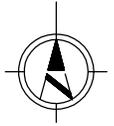
1. Use corrected peak hourly volumes (vph) projected to the 10th year after the proposed construction date. Refer to correction factors under SKS 2.3.1-C for further information.
2. No warrant for a bypass lane is plotted point falls to left of applicable "L" line, or if $L < 0.05$.
3. If a bypass lane is not warranted, check flared intersection treatment warrants, Standard Plan 20613.
4. For additional information please refer to SKS 2.2.2-B, SKS 2.3.1-F, SKS 2.3.5-C & SKS 2.3.8-B.

		WARRANTS FOR BYPASS LANE INTERSECTIONS 2 LANE RURAL HIGHWAYS			
RECOMMENDED BY		DIRECTOR DESIGN & TRAFFIC ENG	DATE	2016-03-21	STANDARD PLAN NO 20612
APPROVED BY		EXECUTIVE DIRECTOR TECHNICAL STANDARDS BRANCH	DATE	May 5/16	SHEET 1 OF 1

ACAD DWG: SKS20612
LAST REV DATE: 16/01/27

Appendix E

Intersection Sight Distance Requirements



N:\Larry Grozell - 653\003 - TIA - Ravenswood Development\Drawings\653-003.dwg erin 17/04/19 - 1:05 P

CATTERALL & WRIGHT
CONSULTING ENGINEERS

1221 - 8th Street East
SASKATOON SK S7H 0S5

Tel: (306) 343-7280, Fax: (306) 956-3199



OWNER/CLIENT

LARRY GROZELL

LOCATION

RM OF CORMAN PARK

PROJECT

**RAVENSWOOD
TRAFFIC IMPACT
ASSESSMENT**

SHEET TITLE

**SIGHT DISTANCE FOR
ENTERING VEHICLES**

DATE	REVISION

SCALE VERIFICATION

WHEN DRAWING IS PLOTTED FULL SIZE
THIS LINE IS 30mm IN LENGTH.

SCALE	NTS	DESIGNED	SNH
DRAWN	ERL	CHECKED	SNH
DATE	19/03/18	SHEET	1 of 1
DRAWING NUMBER	APPENDIX E1		



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CATTERALL & WRIGHT
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OWNER/CLIENT
LARRY GROZELL

LOCATION
RM OF CORMAN PARK

PROJECT
**RAVENSWOOD
TRAFFIC IMPACT
ASSESSMENT**

SHEET TITLE
**SIGHT TRIANGLE
AT INTERSECTIONS**

DATE	REVISION

SCALE VERIFICATION

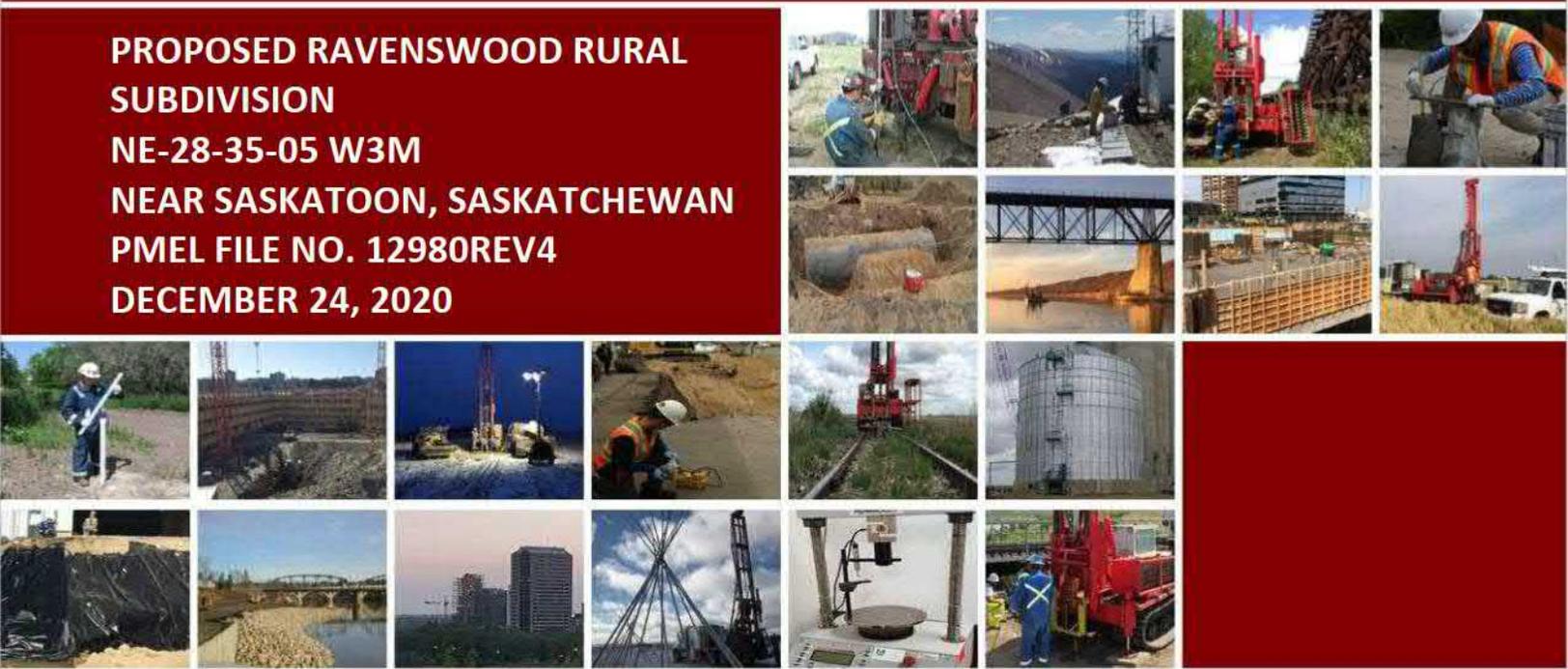
 WHEN DRAWING IS PLOTTED FULL SIZE
 THIS LINE IS 30mm IN LENGTH.

SCALE	NTS	DESIGNED	SNH
DRAWN	ERL	CHECKED	SNH
DATE	19/03/18	SHEET	1 of 1
DRAWING NUMBER	APPENDIX E2		

Appendix C: Hydrogeological Report and Correspondence

HYDROGEOLOGICAL INVESTIGATION

**PROPOSED RAVENSWOOD RURAL
SUBDIVISION
NE-28-35-05 W3M
NEAR SASKATOON, SASKATCHEWAN
PMEL FILE NO. 12980REV4
DECEMBER 24, 2020**



**PREPARED FOR:
Mr. Larry Grozell**

ATTENTION: Mr. Larry Grozell

PRIVILEGED AND CONFIDENTIAL

PROJECT: Hydrogeological Investigation
Proposed Ravenswood Rural Subdivision
NE-28-35-05 W3M
Near Saskatoon, Saskatchewan
PMEL File No. 12980REV4
December 24, 2020

LEGAL DESCRIPTION: *The northeast quarter of Section 28, Township 35, Range 05, West of the 3rd Meridian (NE1/4-28-35-05-W3M) located within the Rural Municipality (RM) of Corman Park No. 344, Saskatchewan.*

PREPARED FOR: Mr. Larry Grozell
51 Wood Meadows Lane
R.M. Corman Park No. 344
Near Saskatoon, Saskatchewan
S7T 1C7

ATTENTION: Mr. Larry Grozell
PHONE NUMBER: 306.230.3667
EMAIL: grozell55@gmail.com

DISTRIBUTION: Larry Grozell – One Copy
P. Machibroda Engineering Ltd. – One Copy

EXECUTIVE SUMMARY

The following report presents the results of a hydrogeological investigation conducted by P. Machibroda Engineering Ltd. (PMEL) for the proposed Ravenswood rural subdivision (i.e., site) to be constructed on the property legally described as:

- *The northeast quarter of Section 28, Township 35, Range 05, West of the 3rd Meridian (NE 28-35-05 W3M) located within the Rural Municipality (RM) of Corman Park No. 344, Saskatchewan.*

This report was completed to assist with the application for the proposed Ravenswood residential subdivision. It is reported that the proposed subdivision is proposing the use of onsite waste treatment systems (OWTS) to manage and treat sewage generated at the site. Potable water is to be supplied via a piped distribution network.

The objectives of this investigation were to: 1) Provide further assessment as to the suitability of the site for OWTS; and 2) Address additional comments provided by the SHA as part of the proposed Ravenswood subdivision application.

Field work, including: drilling of test holes; soil sampling; installation of monitoring wells (piezometers); and surveying of test hole locations and elevations was performed from April 26 to 28, 2017. Groundwater monitoring; hydraulic conductivity (bail response) testing; and/or groundwater sampling were performed at the site between May 5 and June 7, 2017.

A separate investigation was conducted at the site by Imagine Contracting Inc. (Imagine) on August 16, 2020 to provide further assessment of the feasibility of the use of OWTS for the proposed Ravenswood subdivision. Eight (8) test pits were excavated across the site as part of this supplemental investigation and multiple soil samples were submitted for laboratory analysis from each test pit to assist with the detailed soils assessment.

SUMMARY OF RESULTS

OWTS SUITABILITY

Based on the results of this assessment and information provided in the by Imagine Wastewater Management Evaluation report, there is sufficient physical evidence illustrating that each lot has adequate area, soil consistency, and vertical separation (vadose zone) to accommodate the use of OWTS for management/treatment of sanitary waste generated at the site. However, based on the results of the cumulative nitrate assessment, conducted as part of this hydrogeological investigation, advanced package treatment systems (e.g., treatment plant coupled with a standard soil treatment system) will be required to ensure that the effluent quality entering the receiving environment will not adversely impact downstream groundwater users and/or the environment.

The following advanced package treatment system types/specifications will be required based on lot location within the proposed Ravenswood subdivision:

- **Lots where the OWTS would be constructed within 220 m of the property boundary:** an advanced package treatment system meeting or exceeding NSF-40, NSF245, and NSF-350 standards (Bio-Microbics BioBarrier-N MBR or equivalent) with an average effluent nitrate concentration of less than or equal to 9 mg/L.
- **Lots where the OWTS would be constructed greater than 220 m from the property boundary:** an advanced package treatment system meeting or exceeding NSF-40 and NSF-245 standards (e.g., Ecoflo Coco Filter ECDn Model or equivalent) with an average effluent nitrate concentration of less than or equal to 18.9 mg/L

The results of the cumulative nitrate assessment illustrated that if advanced package treatment systems are utilized that can reduce the average effluent nitrate concentrations to less than approximately 9 and 18.9 mg/L for OWTS constructed within 220 m and greater than 220 m from the property boundary, respectively, the simulated average nitrate concentration across the site is expected to range from 4.3 to 5.4 mg/L. It is recommended that the required advanced treatment system type be specified for each lot in the purchase agreement.

SOIL TREATMENT SYSTEM/OWTS TYPES

The results of the field investigation, soil classification, and a detailed site assessment conducted by Imagine Contracting Inc. revealed that the following types of soil treatment systems/OWTS types are suitable based on the soil conditions and hydrogeological conditions at the site:

- holding tanks
- pressurized treatment field
- pressurized raised treatment field
- pressurized type II mound
- advanced enviro-septic field
- advanced enviro septic mound

In accordance with the GOS (2018) guidance the following OWTS would not be suitable OWTS at the site:

- Lagoons are not acceptable as all the lots are smaller than 4 hectares.
- Jets and Type 1 mounds are not acceptable as the proposed subdivision is high density and is considered a sensitive area.

The type of soil treatment system selected for any individual lot will be based on the soil and hydrogeological conditions encountered at the location where the system is to be installed.

Based on the results of this assessment there is adequate area (including reserve area) with suitable soil and hydrogeological conditions for the construction of an OWTS on each of the proposed lots. Therefore, specific locations for OWTS placement, or reserve areas, were not specified as part of this investigation. This is preferable as it provides the future landowner with some degree of design and architectural flexibility.

In accordance with Government of Saskatchewan regulations and/or bylaws a detailed soils assessment will be necessary for each individual lot where an OWTS system will be installed. The detailed soils assessment will be conducted where the OWTS is proposed and will need to be completed prior to obtaining a final building permit.

SOIL CONSISTENCY

Based on the results of this assessment and the assessment conducted by Imagine, the soils at the site were classified as predominantly loam, sandy loam, or silty loam and would be suitable for one or more of the soil treatment systems specified above. Soil samples collected from only two of the test holes (17-6 and 17-7) and one of test pit (20-1) were classified as silty clay loam or silty clay which are considered suitable for an OWTS.

Test hole 17-7 and test pit 20-1 are located in a low-lying area on the same lot (Lot 2 Block 2) approximately 50 m apart. Lot 2 is a relatively large lot with an area greater than 3 acres (1.2 hectares). Soil samples collected from a second test pit (20-2) excavated at a higher elevation on the same lot were classified as primarily sandy loam and would be suitable for one or more the specified soil treatment systems. Test pit 20-3 was excavated approximately 100 m from test hole 20-6 to determine if there were soils suitable for an OWTS in this area. The soil samples collected from test pit 20-3 were classified primarily as sandy loam and would be also be suitable for one or more of the specified soil treatment systems. As such there are sufficient areas across the site where the soil consistency is suitable for the use of an OWTS.

VERTICAL SEPARATION DISTANCE (VADOSE ZONE)

The groundwater depth in the monitoring wells at the site was measured three times between May 5, 2017 and July 20, 2020. The groundwater depth in the shallow soils ranged from 1.5 mbg to 5.8 mbg. The minimum value of 1.5 mbg was measured at only a single monitoring well (17-7) and only during the June 5, 2017 monitoring event. The depth to the groundwater table at this monitoring well had decreased to 1.9 mbg during the July 20, 2020 monitoring event. Except for this monitoring well the groundwater depth in the remaining wells, during every monitoring event, exceeded 2.0 mbg with an average groundwater depth of 4.1 mbg. Monitoring Well 17-7 is located in a natural depression along the east side of the property, which is part of the natural surface water drainage course at the site. There is adequate space at higher elevation, on the same lot where monitoring well 17-7 is located.

Most of the calculated vadose zone depths, that would be required to achieve the recommended pathogen removal rate (60 day retention time) based on the measured hydraulic conductivity values, were less than the minimum vadose zone depth (1.5 m) required by the GOS (2012). The calculated vadose zone depths were determined using the field measured hydraulic conductivity values, which are typically more representative of the horizontal hydraulic conductivity. The vertical hydraulic conductivity is typically one (1) to two (2) orders of magnitude lower and therefore, the expected effluent infiltration rate would be slower and less vadose zone depth would be required to achieve the recommended retention time and associated pathogen removal rate.

Therefore, the depth to the uppermost groundwater table at the site is expected to be sufficiently deep to provide adequate unsaturated soil (vadose zone) below the soil treatment systems. In addition, since each OWTS will require some level of advanced treatment the OWTS effluent is classified as secondary treated effluent. As such, the required vertical separation can be reduced from 1.5 to 0.9 m below the infiltration surface.

In the Imagine assessment report it was also concluded, based on the results of their site assessment, that there was sufficient vertical separation (vadose zone) to support the use of OWTS at the site on all the proposed lots.

DRAINAGE CONSIDERATIONS

As part of the drainage and stormwater management design for the site, overland flow will follow natural drainage courses, swales, and/or roadways to constructed stormwater ponds within each catchment area.

The proposed subdivision layout was designed to optimize natural low-lying areas for common storage as a means of mimicking the natural drainage system and reducing substantial alteration of the landscape. The stormwater ponds were designed with the assumption that all natural depressions situated within private properties could be potentially filled in by the owner during lot development thus eliminating these as potential storage areas. Since the major natural depressions across the site were selected for the construction of the stormwater ponds and the site is expected to utilize natural drainage courses where possible, it is expected that overland flow will continue to migrate towards these stormwater catchment ponds post development.

As part of the drainage and stormwater management design process, minimum building elevations were determined for each proposed lot based upon their elevation relative to the high-water level of each of the ponds plus an additional 0.5 m of freeboard as an additional factors of safety. The AE (2020) report confirmed that each proposed lot has sufficient area above the minimum building elevation to accommodate housing construction. It is recommended and typical that the OWTS for each home is situated nearby the residence within the area deemed to be suitable for housing construction based upon the application of the minimum building elevation.

SETBACKS AND RESERVE AREA

Based on the current development plan there is to be adequate space on each lot for the construction of an OWTS (including reserve area) whilst maintaining the required setback distances to potential site infrastructure (e.g., basement/building, walkways, etc.), property boundaries, and water courses. There will be not be any potable groundwater sources located on the site.

For illustrative purposes, the available reserve area for the smallest lot on the proposed subdivision was estimated. This calculation took into consideration the required setback distances from the property boundaries where an OWTS is prohibited and the area occupied by a typical home, outbuilding, driveway, and the OWTS itself.

- The smallest lot (Lot 23 Block 1) within the proposed subdivision is approximately 0.52 hectares (1.28 acres) or 5,180 m² and has an approximate width of 51 m and a length of 102 m.
- Applying setback distances of 8, 10, and 3 m for the front, back, and side yards, respectively the area occupied by the setback is approximately 1,420 m². For this calculation it is assumed that an OWTS cannot be constructed within these areas. As per the GOS (2018) guidance document the required setback from the property boundary is 3 m for a package treatment system. As such the applied setback area is conservative and should be sufficient to account for other site infrastructure (e.g., building, walk/driveway, etc.).
- A developed area of 1,300 m² was used to represent the area occupied by a typical home (400 m²), outbuilding (300 m²), and driveway (600 m²) as per the assumptions used in the WSP Drainage and Stormwater Management Report.
- The OWTS was assumed to be approximately 300 m² (10 x 30 m).

Reserve Area = Lot size – setback area – developed area – OWTS area

$$Reserve Area = 5,180m^2 - 1,410m^2 - 1,300m^2 - 300m^2$$

$$Reserve Area = 2,160m^2$$

The calculated reserve area for the smallest lot is more than sufficient to support the construction of a replacement OWTS. As such each lot within the proposed subdivision will have more than adequate reserve area for the construction of a replacement OWTS.

TOPOGRAPHIC CONSTRAINTS

From field observations and a review of information provided in the Drainage and Stormwater Management Report and the Wastewater Management Evaluation Report there are no topographic features (e.g., cuts, banks, slopes, landscaping, etc.) that would make any lot unsuitable for the construction of an OWTS. As the site is naturally rolling and is not intended to have any significant cuts, slopes, or banks there does not appear to be any slope stability concerns related to the construction of an OWTS anywhere on the site.

The drainage and overland

INDICATIONS OF WET/POOR SOIL CONDITIONS

Based on observations made during the field investigation and as indicated in the Imagine Assessment Report, the only location containing vegetation indicative of wet or poor soil conditions (maple and birch trees) was along the east side of the property proximate monitoring well 17-7, which has already been identified as an unsuitable location for an OWTS. There is adequate space at higher elevation on the same lot.

There were no other indicators (e.g., surface precipitates, desiccation, etc.) of wet or poor soil conditions present at the site.

RECOMMENDATIONS

The following recommendations are provided based on the results of this assessment:

- The use of onsite wastewater treatment systems (OWTS) are a suitable alternative to manage sanitary sewage generated at the site.
- Two (2) types of advanced package treatment systems will be required at the site to ensure protection of downgradient groundwater users and/or the environment:
 - **Lots where the OWTS would be constructed within 220 m of the property boundary:** an advanced package treatment system meeting or exceeding NSF-40, NSF245, and NSF-350 standards (Bio-Microbics BioBarrier-N MBR or equivalent) with an average effluent nitrate concentration of less than or equal to 9 mg/L.
 - **Lots where the OWTS would be constructed greater than 220 m from the property boundary:** an advanced package treatment system meeting or exceeding NSF-40 and NSF-245 standards (e.g., Ecoflo Coco Filter ECDn Model or equivalent) with an average effluent nitrate concentration of less than or equal to 18.9 mg/L
- One or more of the following soil treatment systems/OWTS types were determined to be suitable based on the soil and hydrogeological conditions at the site:
 - holding tanks
 - pressurized treatment field
 - pressurized raised treatment field
 - pressurized type II mound
 - advanced enviro-septic field
 - advanced enviro septic mound

In accordance with the GOS (2018) guidance the following OWTS would not be suitable OWTS at the site:

- Lagoons are not acceptable as all the lots are smaller than 4 hectares.
- Jets and Type 1 mounds are not acceptable as the proposed subdivision is high density and is considered a sensitive area.

Prior to receiving approval of the building permit, a detailed soils assessment will be required for each individual lot to confirm the soil and groundwater conditions for selection and design of an appropriate soil treatment system. The detailed soils assessment and system installation should be conducted by a certified septic system contractor or qualified professional. As outlined by the GOS (2018), details regarding system operation and maintenance must be supplied to the homeowner by the permit applicant.

- System maintenance should be conducted by a certified septic system contractor and conducted at the frequency recommend by the system manufacturer.

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1 INTRODUCTION

The following report presents the results of a hydrogeological investigation conducted by P. Machibroda Engineering Ltd. (PMEL) for the proposed Ravenswood rural subdivision (i.e., site) to be constructed on the property legally described as:

- *The northeast quarter of Section 28, Township 35, Range 05, West of the 3rd Meridian (NE 28-35-05 W3M) located within the Rural Municipality (RM) of Corman Park No. 344, Saskatchewan.*

This report was completed to assist with the application for the proposed Ravenswood residential subdivision. It is reported that the proposed subdivision is proposing the use of onsite waste treatment systems (OWTS) to manage and treat sewage generated at the site. Potable water is to be supplied via a piped distribution network.

This is the third submission of the hydrogeological investigation for the proposed subdivision. The first submission was completed in April 2017 (PMEL, 2017a). Field work, including: drilling of test holes; soil sampling; installation of monitoring wells; and surveying of test hole locations and elevations was performed from April 26 to 28, 2017. Groundwater monitoring; hydraulic conductivity (bail response) testing; and groundwater sampling were performed at the site on April 29 or June 5, 2017.

The second submission was completed in April 2020 (PMEL, 2020) and incorporated a revised nitrate assessment and other report revisions to address comments provided by the Saskatchewan Health Authority (SHA) as part of their technical review. No additional fieldwork was completed as part of the second submission.

This submission includes further revision to the nitrate assessment (package treatment systems) as well additional information to address comments provided by the SHA. Groundwater monitoring was completed by PMEL on July 20, 2020 to assess/confirm the depth to the groundwater table at the site. An additional field investigation was completed by Imagine Contracting Inc. (Imagine) on August 16, 2020 to further characterize the soils and groundwater conditions at site as they pertained to the suitability of OWTS.

1.1 OBJECTIVES

The objectives of this investigation were to: 1) Provide further assessment as to the suitability of the site for OWTS; and 2) Address additional comments provided by the SHA as part of the proposed Ravenswood subdivision application.

The Government of Saskatchewan (GOS, 2012) risk-based framework for subdivision OWTS assessment was utilized as a preliminary evaluation tool to determine the type of assessment (e.g., desktop and/or field study, etc.) and the level of assessment (Level 1, Level 2, cumulative nitrate assessment) that would be required as part of the hydrogeological investigation for the proposed subdivision. The steps and outcome of this preliminary evaluation are provided in Section 2 of this report.

1.2 SCOPE OF WORK

The scope of work for the hydrogeological investigation was completed in general accordance with the following guidance documents:

- Government of Saskatchewan - Guidance document for developments and subdivision where onsite wastewater treatment systems are proposed (GOS, 2012).
- Government of Saskatchewan - Saskatchewan Onsite Wastewater Disposal Guide (GOS 2018).

The scope of work for this investigation included a desktop study, multiple field investigations, an OWTS feasibility assessment, and preparation of a summary report. The general scope of work that was conducted for each component of this investigation is outlined below.

Desktop Study

The following information was reviewed as part of the desktop study component of this investigation:

- Information provided by the client regarding the proposed subdivision.
- Applicable regulations and guidelines provided by the RM of Corman Park No. 344, GOS, SHA, or any other pertinent information.
- Regional geological and hydrogeological information for the site and surrounding area.
- Available information regarding groundwater use (private or municipal wells), surface water use, and other wastewater treatment systems (private or communal systems) in the vicinity of the site.
- Available third-party subdivision applications in the vicinity of the site.
- Any other relevant background information that is applicable to this hydrogeological investigation or the proposed subdivision application.

Field Investigation

- Drilled multiple test holes for the purpose of characterizing the geological and hydrogeological conditions at the site.
- Collected representative soil samples from the test holes for soil classification and index testing.
- Installed monitoring wells in each of the test holes for the purposes of groundwater monitoring and sampling.
- Measured the depth to the groundwater table in each of the monitoring wells at the site on multiple occasions.
- Conducted field hydraulic conductivity testing in select monitoring wells at the site to characterize the bulk hydraulic conductivity of the soils to determine:

- The types of OWTS that are applicable based on the hydrogeological conditions at site; and
- The flow and transport properties required for the nitrate assessment.
- Collected representative groundwater samples from each monitoring well at the site for laboratory analysis of select constituents that are indicative of water quality impacts resulting from typical OWTS. These samples were considered to represent background concentrations of these indicator parameters.

An additional field investigation was conducted by Imagine to further characterize the soils and groundwater conditions at the site. The scope of work for this separate assessment is documented in the Imagine Wastewater Management Evaluation Report, provided in Appendix A. This report will be referred to as the Imagine Assessment Report for the remainder of this document.

Assessment and Reporting

- Evaluated the overall suitability of the site regarding the use of OWTS to manage sanitary septic waste generate at the site based on the soils and hydrogeological conditions.
- Completed a cumulative nitrate assessment, using the information obtained from the desktop study and field investigations, to evaluate potential nitrate migration from OTWS to nearby receptors (e.g., water well, surface water body, etc.).
- Prepared a report compiling the results of the desktop study, field investigations (conducted by PMEL and others), and the site OWTS suitability assessment results.
- Provided recommendations regarding the overall site suitability for the use OWTS, OWTS systems types, and general design and construction considerations.

2 SUBDIVISION ASSESSMENT SCREENING

2.1 PROPOSED SUBDIVISION

The proposed subdivision is located on NE-28-35-05 W3M along the west side of Range Road 3053 (Clarence Avenue South). Once complete the proposed Ravenswood subdivision would consist of 44 residential lots, a senior care facility and housing centre, a long-term care centre, and a community centre. The layout of the proposed subdivision is shown on the site Plan, Drawing No. 12980-1. Pertinent details of the proposed Ravenswood subdivision, that pertain to the hydrogeological investigation, are summarized in Table I.

It is understood that the proposed residential subdivision, which has an area of approximately 59 hectares (146.6 acres), will be subdivided into 47 lots. As per GOS (2012), a subdivision is considered a high density area if:

- It contains 40 existing or proposed residential units or more on a quarter section; or
- The average land size associated with each or potential residential units is less than 1 hectare (2.5 acres).

As the proposed subdivision will consist of 47 lots, the proposed subdivision is considered a high density area.

TABLE I: SUMMARY OF SUBDIVISION DETAILS

Item	Notes
Subdivision Location	Portion of NE-28-35-5 W3M
Subdivision Size	146.6 acres (59.3 hectares) - includes equivalent ag holding (10.2 acres [4.1 hectares])
Number of Proposed Lots	47 lots
Current Landuse	Community Care Centre and Agricultural land
Surrounding Landuse	Residential Subdivision (low to high density), agricultural land
Average Lot Size	2.9 acres (1.18 hectares)
Minimum Lot Size	1.28 acres (0.52 hectares)
Maximum Lot Size	6.72 acres (2.72 hectares)

2.2 ASSESSMENT INCLUSION SCREENING

In accordance with GOS (2012) and as discussed in the Imagine Assessment Report (Appendix A), the site falls under Scenario A and a hydrogeological assessment is required based on the following:

- The average lot size within the proposed subdivision (not including reserve area) will be less than 4 hectares (9.9 acres).
- After development is complete there will be more than nine (9) residential lots on the quarter section where the proposed development will be located. In addition, the Edgemont Estates residential subdivision, which will be located on the adjacent quarter section to the north of the site, has been proposed with an overall density of approximately 1.3 lots per acre with a total of 99 residential lots.
- The proposed development does not meet any of the exemption criteria including:
 - The proposed subdivision will contain more than 16 residential lots on a quarter section;
 - The minimum size of the proposed lots will be less than one (1) hectare (2.5 acres);
 - The proposed subdivision is less than 1.6 km from other medium or high density developments; and
 - The site is underlain by a surficial aquifer and as such is classified as a sensitive area (to be discussed in Sections 3.3.4 and 4.2.7) and not hydrogeologically isolated from potential potable groundwater resources.

2.3 RISK BASED FRAMEWORK ASSESSMENT SCREENING

The GOS (2012) risk-based framework was used to assist in determining the level of hydrogeological assessment required for the proposed subdivision. The response and justification for each step of the risk-based assessment framework is outlined in Table II. The relevant report sections are also outlined in Table II.

Based on the results of the screening process, it was determined that a Level II Assessment would be required. It was also recommended that a cumulative nitrate assessment be conducted based on the estimated probability of an OWTS system intercepting a potential downgradient water well and that the site is considered to be located in a sensitive area.

TABLE II: SUMMARY OF RISK BASED FRAMEWORK DECISION PROCESS AND JUSTIFICATION

Item	Response/Next Step	Justification	Report Section
Step 1 - Screen for inclusion criteria	Yes/Step 2	Proposed subdivision falls into Scenario A	2.2
Step 2 - Desktop review and field program	Yes/Step 3	Desktop review and field program was conducted for the site.	4 and 5
Step 3 - Isolate from supply aquifer	No/Step 4	Based on the information reviewed, the site is underlain by a large surficial aquifer and therefore is not hydrogeologically isolated from a potable groundwater resource.	3.3.4 and 4.2.7
Step 4 - Sufficient (vadose zone) retention time	Yes/Step 5	There appears to be an area of each lot where there would be sufficient vadose zone retention time. In addition, advanced package treatment systems will be utilized at the site, which also improve the quality of OWTS effluent and reduce the required vertical separation distance (vadose zone).	7.3
Step 5 - Prepare assessment report	Yes/Step 6	Based on the proposed number of lots (47) the site is classified as high density and a Level 2 Assessment is required.	2.1
Step 6 - >90% chance of intersecting a plume	Yes/Step 6a	The probability of an OWTS plume intersecting a potable groundwater well revealed that the probability of this occurring ranged from approximate 80 to 85%. A cumulative nitrate assessment was completed for the site to be conservative.	6.2
Step 6a - Complete a Cumulative Nitrate Assessment	Yes/Step 7a	A cumulative nitrate assessment was completed.	6.5
Step 7a - Predict nitrate concentrations in downgradient wells	Yes/Step 7b	In the previous hydrogeological investigation (PMEL, 2020), the predicted nitrate concentration was determined to be approximately 13 mg/L at the property boundary if traditional OWTS would be constructed on each lot. This assessment was redone assuming that advanced package treatment systems would be installed on each lot. Nitrate concentrations at the property boundary were determined to be less than potable drinking water limits.	6.5.7 and 6.5.8
Step 7b - Determine if nitrate concentrations >10 mg/L in downgradient wells	No/Seek Subdivision Approval	Advanced package treatment systems would be required for each lot and the average nitrate concentration across the site was less than 10 mg/L.	6.5.7 and 6.5.8

3 DESKTOP REVIEW – SITE CHARACTERIZATION

3.1 CURRENT SITE SETTING

The site is currently being utilized as farmland (cultivated and/or pasture). The care centre, that will be part of the proposed subdivision, already exists along the east side of the same quarter section as the proposed subdivision. There are several outbuildings and animal corrals associated with the existing care centre. An existing acreage is located in the southeast corner of the quarter section.

3.2 SURROUNDING LAND USE

Surrounding land use in the vicinity of the site includes predominantly residential development (acreages), cultivated/pastureland, and farms/farmyards. The land use within 1.6 km of the proposed subdivision is summarized in Table III.

TABLE III: SUMMARY OF LAND USE ON QUARTER SECTIONS IMMEDIATELY ADJACENT TO PROPOSED SUBDIVISION

Direction	Land Use	Distance From Proposed Subdivision Property Boundary (m)
North	Edgemont Estates (Phase I Approved) - High density residential subdivision Grasswood North and South - Medium density residential subdivisions	Adjacent 0.8 to >1.6 km
Northeast	Cultivated agricultural land with farmyard in northwest corner Cultivated agricultural land and individual farmyards	Adjacent 0.8 to >1.6 km
East	Casa Rio Estates - Low density residential subdivision Cultivated agricultural land and individual farmyards Grasswood Estates - Medium density residential subdivision	Adjacent 0.8 to 1.6 km >1.6 km
Southeast	Casa Rio Estates - Low density residential subdivision Cultivated agricultural land and individual farmyards	Adjacent 0.8 to >1.6 km
South	Casa Rio Estates - Low density residential subdivision	Adjacent to > 1.6 km
Southwest	Cultivated agricultural land with farmyard in southeast corner Cultivated agricultural land and individual farmyards	Adjacent 0.8 to >1.6 km
West	Wood Meadows - Low density residential subdivision Crossmount - High Density Residential Subdivision	Adjacent 0.8 to >1.6 km
Northwest	Cultivated agricultural land with farmyard in northwest corner Cultivated agricultural land and individual farmyards	Adjacent 0.8 to >1.6 km

3.3 REGIONAL SETTING

3.3.1 TOPOGRAPHY AND DRAINAGE

A review of satellite imagery (Google, 2020) revealed the following:

- Regionally the ground surface ranges from flat to gently undulating with a gentle regional downward slope towards the South Saskatchewan River.
- The average regional downward ground surface slope, towards the South Saskatchewan River, is on the order of approximately 0.005 m/m (0.5%).

- Ground surface elevations range from approximately 513 metres above sea level (masl), east of the site, to approximately 500 masl along the top of the Saskatchewan River Valley. The elevation of the South Saskatchewan River is approximately 477 masl.
- The maximum topographic relief appears to be in the order of approximately 36 m over a distance of approximately 6.1 km.
- The South Saskatchewan River, which is the nearest major surface water resource to the site, is located over 3 km to the west.

3.3.2 PHYSIOGRAPHY

A review of published physiography information (Acton et al., 1960) revealed the following:

1. The site lies in the physiographic region known as the Saskatchewan Rivers Plain.
2. This region is characterized as gently undulating to rolling glacial lacustrine-alluvial (glacial lake) plains, aeolian plains (dunes) and till plains.

3.3.3 GEOLOGY

A review of published physiography information (MDH, 2011, Christiansen, 1967) revealed the following:

1. The surficial deposits above the bedrock surface are characterized as variable deposits of gravel, sand, silt, and clay deposited by glacial and/or subsequent erosional processes. These deposits are formally named the Surficial Stratified Deposits Formation and are associated with the Saskatoon Group.
2. Regionally, the Surficial Stratified Deposits consists of approximately 10 m of silt, sand, and gravel underlain by approximately 32 m of sand, silt, and clay.
3. The Surficial Stratified Deposits are underlain by approximately 90 m of glacial till associated with the Battleford Formation of the Saskatoon Group.
4. The uppermost bedrock deposit in the vicinity of the site is comprised of several members of the Bearpaw formation with a combined thickness of approximately 90 m. The uppermost member of the Bearpaw Formation consists of approximately 5 to 10 m of noncalcareous silty clay shale.
5. The Bearpaw Formation is underlain by bedrock deposits associated with the Judith River Formation followed by the Lea Park Formation, which marks the base of exploration in the region.

3.3.4 HYDROGEOLOGY

An examination of hydrogeological data (MDH, 2011 and Christiansen, 1967) for this region revealed the following observations:

1. Important groundwater resources in the region are reported to be associated with variable surficial, intratill, and/or intertill deposits of coarse-grained sediments (silt, sand, and gravel).

2. The site overlies a large surficial aquifer which is up to approximately 40 m thick in the vicinity of the site.
3. There does not appear to be any intertill and/or intratill aquifers directly underlying the site. However, there appear to be several intertill or intratill aquifers within approximately 1.5 km of the site as summarized below.
 - a. A large Battleford Aquifer is located, at its nearest point, over 1 km to the southwest of the site. The surface of this aquifer is located at a depth of approximately 33 metres below grade (mbg).
 - b. An Upper Floral Aquifer is located, at its nearest point, approximately 1 km to the southwest of the site. The surface of this aquifer is located approximately 40 mbg.
 - c. A lower Dundurn Formation Aquifer is located at its closest point, approximately 1.5 km northeast of the site. The surface of this aquifer is approximately 130 mbg.
4. No Lower Floral Formation, Warman Formation, or Upper Dundurn Formation Aquifers appear to be present within 1.5 km of the site.
5. The base of groundwater exploration, or the depth which it is considered to be uneconomic to explore for groundwater because the cost of wells is too high or the water is too mineralized, is considered to be the bedrock surface at the base of the drift.

3.4 GROUNDWATER WELLS

3.4.1 WATER WELL RECORDS

A search of the Saskatchewan Water Security Agency (WSA) Groundwater Well Database (WSA, 2020) was conducted for a radius of approximately 1.6 km from the site boundaries. A summary of the well records is presented in Table IV while copies of the well records have been retained in our files.

Review of the water well search summarized in Table IV revealed the following:

1. Two registered groundwater wells are located on the same quarter section as the site. One (1) of these wells had a diameter of 38 mm and was completed at a depth of 8.2 mbg. The other well, which had a diameter of 1.1 m, was completed at a depth of 15.5 mbg. The predominant soil stratigraphy listed on the water record for these water wells was sand intermixed with variable deposits of silt and clay.
2. There were a total of 152 groundwater water wells registered for domestic use for water withdrawal (139 wells) and/or as water test holes (13 wells) within a 1.6 km radius of the site.
3. The majority of the registered groundwater wells were large diameter (diameters exceeding 760 mm) and completed at depths of less than 25 mbg and appear to be installed in the upper surficial sand aquifer.
4. The groundwater levels, for wells completed shallower than 30 mbg, were reported on the water well records to range from approximately 1.8 to 11.6 mbg.

5. There are no registered municipal withdrawal wells located within 1.6 km of the site.

It is possible that the water well record search includes water wells that are located more than 1.6 km from the site. This is because the search includes all wells that are assigned to a quarter section that is completely or partially within the specified search radius. A field verification survey was not conducted to confirm the exact location of these water wells and/or if there are additional water wells not registered in the WSA database.

3.4.2 WATER WELL INVENTORY

A field inventory of water wells within 1.0 km of the proposed subdivision was not completed as part of this investigation. Although, a field inventory is required as part of a Level 2 hydrogeological assessment, it was determined not to be necessary as detailed information regarding water well users in the vicinity of the site was provided to PMEL.

PMEL reviewed information provided by the RM of Corman Park No. 344 (Michael Whitehead, Pers. Comm., 2020) to determine potable water sources utilized by the properties adjacent to and/or downgradient of the site. In addition, PMEL was also provided with drawings showing the size and location of the potable water distribution lines to the northwest of the site (e.g., Parklands Road). A review of this information revealed the following:

1. The Existing Wood Meadows subdivision located to the west of the site is connected to the water distribution system servicing Casa Rio Estates and does not obtain its potable water source from the aquifer in the vicinity of the site.
2. The proposed Edgemont Estates subdivision is to be connected to the Dundurn Rural Water Utility.
3. The properties located along Parklands Road, downgradient of the site, are all connected to the Grasswood Water Distribution Line.
4. It is also reported that the other properties along Swityk Lane, Prairie Lane, and those along the west side of Clarence Avenue (between Grasswood Road and the site), are also connected to potable water distribution systems.
5. The only property that is believed to use a groundwater well as a potential potable water source is the property located at the southwest intersection of Grasswood Road and Clarence Avenue. This property is located greater than 800 m cross-gradient from the site.

3.5 SURFACE WATER USERS

There did not appear to be any surface water users proximate the site.

TABLE IV: SUMMARY OF REGISTERED GROUNDWATER WELLS

WWDR #	Land Location	Depth		Diameter		Pumping Rate (litres/minute)	Water Use	Well Use
		(metres)	(feet)	(mm)	(inches)			
099160	-28-035 -05 -W3	15.5	51	1067	42.0	7	Domestic	Withdrawal
238033	NE-28-035 -05 -W3	10.7	35	224	8.8	1	Other	Withdrawal
043816	NE-28-035 -05 -W3	8.2	27	38	1.5	0	Domestic	Withdrawal
229858	NW-28-035 -05 -W3	18.9	62	1067	42.0	20	Domestic	Withdrawal
236268	NW-28-035 -05 -W3	13.7	45	152	6.0	0	Domestic	Water Test Hole
125010	NW-28-035 -05 -W3	54.9	180	127	5.0	10	Domestic	Withdrawal
236269	NW-28-035 -05 -W3	16.8	55	152	6.0	0	Domestic	Water Test Hole
209528	NW-28-035 -05 -W3	11.6	38	1067	42.0	15	Domestic	Withdrawal
086179	NW-28-035 -05 -W3	12.8	42	1118	44.0	0	Domestic	Withdrawal
088794	NW-28-035 -05 -W3	11.6	38	1118	44.0	6	Domestic	Withdrawal
213802	NW-28-035 -05 -W3	16.5	54	1067	42.0	6	Domestic	Withdrawal
209534	NW-28-035 -05 -W3	16.5	54	1067	42.0	5	Domestic	Withdrawal
241192	SW-28-035 -05 -W3	25.9	85	130	5.1	5	Domestic	Withdrawal
104464	SW-28-035 -05 -W3	16.8	55	1067	42.0	9	Domestic	Withdrawal
223506	SW-28-035 -05 -W3	15.2	50	0	0.0	0	Domestic	Withdrawal
106622	SW-28-035 -05 -W3	14.6	48	1067	42.0	8	Domestic	Withdrawal
100727	SW-28-035 -05 -W3	16.5	54	1118	44.0	0	Domestic	Withdrawal
104465	SW-28-035 -05 -W3	14.6	48	1067	42.0	8	Domestic	Withdrawal
106020	SW-28-035 -05 -W3	18.3	60	1067	42.0	7	Domestic	Withdrawal
104463	SW-28-035 -05 -W3	15.2	50	1067	42.0	9	Domestic	Withdrawal
108670	SE-28-035 -05 -W3	18.9	62	1067	42.0	9	Domestic	Withdrawal
104829	SE-28-035 -05 -W3	17.7	58	1067	42.0	8	Domestic	Withdrawal
118596	SE-28-035 -05 -W3	20.4	67	1067	42.0	7	Domestic	Withdrawal
105760	SE-28-035 -05 -W3	18.3	60	1067	42.0	5	Domestic	Withdrawal
063058	SE-28-035 -05 -W3	12.5	41	1321	52.0	6	Domestic	Withdrawal
103041	SE-28-035 -05 -W3	19.8	65	1067	42.0	20	Domestic	Withdrawal
108330	SE-28-035 -05 -W3	19.2	63	1067	42.0	6	Domestic	Withdrawal

TABLE IV: SUMMARY OF REGISTERED GROUNDWATER WELLS (CONTINUED)

WWDR #	Land Location	Depth		Diameter		Pumping Rate (litres/minute)	Water Use	Well Use
		(metres)	(feet)	(mm)	(inches)			
099278	-33-035 -05 -W3	27.7	91	1067	42.0	7	Domestic	Withdrawal
056423	-33-035 -05 -W3	13.7	45	1067	42.0	6	Domestic	Withdrawal
045317	SW-33-035 -05 -W3	7.6	25	38	1.5	0	Domestic	Withdrawal
057215	SW-33-035 -05 -W3	15.2	50	1067	42.0	7	Domestic	Withdrawal
104121	SE-33-035 -05 -W3	14.6	48	1067	42.0	0	Domestic	Withdrawal
225555	SE-33-035 -05 -W3	5.2	17	152	6.0	0	Research	Water Test Hole
055468	SE-33-035 -05 -W3	14.0	46	762	30.0	0	Domestic	Withdrawal
126585	NE-33-035 -05 -W3	12.2	40	914	36.0	6	Domestic	Withdrawal
031915	NE-33-035 -05 -W3	8.2	27	51	2.0	4	Domestic	Withdrawal
062408	NE-33-035 -05 -W3	15.8	52	1016	40.0	0	Domestic	Withdrawal
239769	NE-33-035 -05 -W3	15.2	50	1524	60.0	0		Water Test Hole
101916	NE-33-035 -05 -W3	12.2	40	1067	42.0	6	Domestic	Withdrawal
043819	NE-33-035 -05 -W3	6.7	22	38	1.5	0	Domestic	Withdrawal
091778	NE-33-035 -05 -W3	10.7	35	1219	48.0	4	Domestic	Withdrawal
239770	NE-33-035 -05 -W3	12.2	40	152	6.0	0		Water Test Hole
103289	NE-33-035 -05 -W3	19.2	63	1067	42.0	3	Domestic	Withdrawal
066369	NE-33-035 -05 -W3	10.7	35	914	36.0	0	Domestic	Withdrawal
239768	NE-33-035 -05 -W3	16.8	55	152	6.0	0	Domestic	Water Test Hole
047555	NE-33-035 -05 -W3	8.2	27	38	1.5	0	Domestic	Withdrawal
031914	NE-33-035 -05 -W3	10.1	33	914	36.0	0	Domestic	Withdrawal
056426	NE-33-035 -05 -W3	12.8	42	1118	44.0	8	Domestic	Withdrawal
094227	NE-33-035 -05 -W3	9.1	30	914	36.0	5	Domestic	Withdrawal
077248	NE-33-035 -05 -W3	12.2	40	1219	48.0	12	Domestic	Withdrawal
109247	NE-33-035 -05 -W3	14.6	48	1067	42.0	6	Domestic	Withdrawal
031919	NW-33-035 -05 -W3	7.0	23	914	36.0	5	Domestic	Withdrawal
031916	NW-33-035 -05 -W3	14.3	47	914	36.0	0	Domestic	Withdrawal
100728	NW-33-035 -05 -W3	14.6	48	1118	44.0	0	Domestic	Withdrawal

TABLE IV: SUMMARY OF REGISTERED GROUNDWATER WELLS (CONTINUED)

WWDR #	Land Location	Depth		Diameter		Pumping Rate (litres/minute)	Water Use	Well Use
		(metres)	(feet)	(mm)	(inches)			
031917	NW-33-035 -05 -W3	9.1	30	914	36.0	5	Domestic	Withdrawal
062406	NW-33-035 -05 -W3	15.8	52	1016	40.0	0	Domestic	Withdrawal
102539	NW-33-035 -05 -W3	16.8	55	1067	42.0	4	Domestic	Withdrawal
080262	NW-33-035 -05 -W3	15.2	50	0	0.0	0	Domestic	Withdrawal
091777	NW-33-035 -05 -W3	11.6	38	914	36.0	2	Domestic	Withdrawal
009541	NW-33-035 -05 -W3	9.8	32	914	36.0	0	Domestic	Withdrawal
081458	NW-33-035 -05 -W3	15.2	50	1067	42.0	0	Domestic	Withdrawal
094228	NW-33-035 -05 -W3	18.3	60	1067	42.0	9	Domestic	Withdrawal
031918	NW-33-035 -05 -W3	8.2	27	660	26.0	0	Domestic	Withdrawal
109362	NW-33-035 -05 -W3	17.7	58	1067	42.0	12	Domestic	Withdrawal
083606	-34-035 -05 -W3	8.2	27	965	38.0	0	Domestic	Withdrawal
233937	NW-34-035 -05 -W3	16.2	53	1067	42.0	4	Domestic	Withdrawal
108331	SE-34-035 -05 -W3	19.2	63	1067	42.0	20	Domestic	Withdrawal
110464	SE-34-035 -05 -W3	14.6	48	1067	42.0	6	Domestic	Withdrawal
120156	SE-34-035 -05 -W3	18.3	60	1067	42.0	25	Domestic	Withdrawal
085610	SW-34-035 -05 -W3	15.8	52	914	36.0	2	Domestic	Withdrawal
031920	SW-34-035 -05 -W3	11.0	36	914	36.0	0	Domestic	Withdrawal
045913	SW-34-035 -05 -W3	8.2	27	914	36.0	0	Domestic	Withdrawal
081450	SW-34-035 -05 -W3	23.2	76	1067	42.0	0	Domestic	Withdrawal
105761	SE-32-035 -05 -W3	9.1	30	914	36.0	5	Domestic	Withdrawal
239762	SE-32-035 -05 -W3	15.2	50	1067	42.0	25	Domestic	Withdrawal
031913	SE-32-035 -05 -W3	6.1	20	1219	48.0	0	Domestic	Withdrawal
098784	-29-035 -05 -W3	9.8	32	914	36.0	3	Domestic	Withdrawal
090930	-29-035 -05 -W3	15.5	51	1118	44.0	15	Domestic	Withdrawal
234048	SE-29-035 -05 -W3	18.3	60	127	5.0	0		Water Test Hole
031903	SE-29-035 -05 -W3	29.0	95	102	4.0	0	Domestic	Withdrawal
234049	SE-29-035 -05 -W3	15.2	50	152	6.0	0		Water Test Hole

TABLE IV: SUMMARY OF REGISTERED GROUNDWATER WELLS (CONTINUED)

WWDR #	Land Location	Depth		Diameter		Pumping Rate (litres/minute)	Water Use	Well Use
		(metres)	(feet)	(mm)	(inches)			
234001	SE-29-035 -05 -W3	16.8	55	152	6.0	0		Water Test Hole
234050	SE-29-035 -05 -W3	15.2	50	152	6.0	0		Water Test Hole
102937	NE-21-035 -05 -W3	14.6	48	1118	44.0	6	Domestic	Withdrawal
106621	NE-21-035 -05 -W3	14.6	48	1067	42.0	4	Domestic	Withdrawal
105361	NE-21-035 -05 -W3	14.6	48	1067	42.0	0	Domestic	Withdrawal
105756	NE-21-035 -05 -W3	14.6	48	1067	42.0	8	Domestic	Withdrawal
105362	NE-21-035 -05 -W3	20.7	68	1067	42.0	0	Domestic	Withdrawal
105912	NE-21-035 -05 -W3	14.6	48	1067	42.0	6	Domestic	Withdrawal
104828	NE-21-035 -05 -W3	14.6	48	1067	42.0	8	Domestic	Withdrawal
108326	NE-21-035 -05 -W3	19.8	65	1067	42.0	15	Domestic	Withdrawal
105363	NE-21-035 -05 -W3	14.6	48	1067	42.0	6	Domestic	Withdrawal
104459	NW-21-035 -05 -W3	14.6	48	1067	42.0	8	Domestic	Withdrawal
103894	NW-21-035 -05 -W3	21.3	70	1067	42.0	8	Domestic	Withdrawal
104456	NW-21-035 -05 -W3	14.9	49	1067	42.0	10	Domestic	Withdrawal
104457	NW-21-035 -05 -W3	14.6	48	1067	42.0	6	Domestic	Withdrawal
104466	NW-21-035 -05 -W3	19.8	65	1067	42.0	12	Domestic	Withdrawal
104455	NW-21-035 -05 -W3	14.6	48	1067	42.0	5	Domestic	Withdrawal
213827	NW-21-035 -05 -W3	18.3	60	1067	42.0	6	Domestic	Withdrawal
101915	NW-21-035 -05 -W3	21.9	72	1118	44.0	0	Domestic	Withdrawal
106706	NW-21-035 -05 -W3	14.6	48	1067	42.0	7	Domestic	Withdrawal
104458	NW-21-035 -05 -W3	14.9	49	1067	42.0	7	Domestic	Withdrawal
105365	NW-22-035 -05 -W3	14.6	48	1067	42.0	8	Domestic	Withdrawal
031898	NW-22-035 -05 -W3	11.9	39	914	36.0	0	Domestic	Withdrawal
108003	NW-22-035 -05 -W3	18.3	60	1067	42.0	20	Domestic	Withdrawal
102938	NW-22-035 -05 -W3	15.2	50	1067	42.0	5	Domestic	Withdrawal
105588	NW-22-035 -05 -W3	18.6	61	1067	42.0	10	Domestic	Withdrawal
106924	NW-22-035 -05 -W3	19.5	64	1067	42.0	12	Domestic	Withdrawal

TABLE IV: SUMMARY OF REGISTERED GROUNDWATER WELLS (CONTINUED)

WWDR #	Land Location	Depth		Diameter		Pumping Rate (litres/minute)	Water Use	Well Use
		(metres)	(feet)	(mm)	(inches)			
240931	NW-22-035 -05 -W3	15.8	52	1067	42.0	15	Domestic	Withdrawal
111077	NW-22-035 -05 -W3	18.9	62	1067	42.0	12	Domestic	Withdrawal
107869	NW-22-035 -05 -W3	16.8	55	1067	42.0	10	Domestic	Withdrawal
105757	NW-22-035 -05 -W3	14.6	48	1067	42.0	0	Domestic	Withdrawal
107052	NW-22-035 -05 -W3	20.1	66	1067	42.0	15	Domestic	Withdrawal
031897	NW-22-035 -05 -W3	9.8	32	914	36.0	0	Domestic	Water Test Hole
107870	NW-22-035 -05 -W3	14.6	48	1067	42.0	12	Domestic	Withdrawal
106557	NW-22-035 -05 -W3	16.5	54	1067	42.0	10	Domestic	Withdrawal
105364	NW-22-035 -05 -W3	17.7	58	1067	42.0	6	Domestic	Withdrawal
105587	NW-22-035 -05 -W3	14.9	49	1067	42.0	7	Domestic	Withdrawal
112074	NW-27-035 -05 -W3	21.3	70	1067	42.0	10	Domestic	Withdrawal
096883	NW-27-035 -05 -W3	17.1	56	1067	42.0	3	Domestic	Withdrawal
107871	NW-27-035 -05 -W3	21.9	72	1067	42.0	8	Domestic	Withdrawal
107323	NW-27-035 -05 -W3	18.6	61	1067	42.0	10	Domestic	Withdrawal
106562	NW-27-035 -05 -W3	14.9	49	1067	42.0	5	Domestic	Withdrawal
109361	NW-27-035 -05 -W3	18.3	60	1067	42.0	12	Domestic	Withdrawal
106563	NW-27-035 -05 -W3	14.6	48	1067	42.0	5	Domestic	Withdrawal
107055	NW-27-035 -05 -W3	22.6	74	1067	42.0	10	Domestic	Withdrawal
107872	NW-27-035 -05 -W3	18.9	62	1067	42.0	10	Domestic	Withdrawal
107056	NW-27-035 -05 -W3	26.8	88	1067	42.0	5	Domestic	Withdrawal
112626	NW-27-035 -05 -W3	18.3	60	1067	42.0	0	Domestic	Withdrawal
109500	NW-27-035 -05 -W3	24.4	80	1067	42.0	6	Domestic	Withdrawal
106564	NW-27-035 -05 -W3	14.6	48	1067	42.0	8	Domestic	Withdrawal
219195	NW-27-035 -05 -W3	19.8	65	1067	42.0	15	Domestic	Withdrawal
110609	NW-27-035 -05 -W3	18.3	60	1067	42.0	7	Domestic	Withdrawal
107054	NW-27-035 -05 -W3	20.1	66	1067	42.0	5	Domestic	Withdrawal
111714	NW-27-035 -05 -W3	18.3	60	1067	42.0	1	Domestic	Withdrawal

TABLE IV: SUMMARY OF REGISTERED GROUNDWATER WELLS (CONTINUED)

WWDR #	Land Location	Depth		Diameter		Pumping Rate (litres/minute)	Water Use	Well Use
		(metres)	(feet)	(mm)	(inches)			
108669	NW-27-035 -05 -W3	21.3	70	1067	42.0	20	Domestic	Withdrawal
103288	NE-27-035 -05 -W3	17.7	58	1067	42.0	0	Domestic	Withdrawal
104461	NE-27-035 -05 -W3	18.3	60	1067	42.0	10	Domestic	Withdrawal
102245	SE-27-035 -05 -W3	19.5	64	1067	42.0	17	Domestic	Withdrawal
105590	SE-27-035 -05 -W3	14.6	48	1067	42.0	6	Domestic	Withdrawal
104462	SE-27-035 -05 -W3	16.8	55	1067	42.0	12	Domestic	Withdrawal
105589	SE-27-035 -05 -W3	14.6	48	1067	42.0	8	Domestic	Withdrawal
235849	SW-27-035 -05 -W3	13.1	43	130	5.1	0	Domestic	Water Test Hole
106019	SW-27-035 -05 -W3	14.6	48	1067	42.0	30	Domestic	Withdrawal
105366	SW-27-035 -05 -W3	16.5	54	1067	42.0	12	Domestic	Withdrawal
107874	SW-27-035 -05 -W3	14.6	48	1067	42.0	9	Domestic	Withdrawal
235850	SW-27-035 -05 -W3	36.0	118	130	5.1	5	Domestic	Withdrawal
105367	SW-27-035 -05 -W3	14.6	48	1067	42.0	8	Domestic	Withdrawal
111079	SW-27-035 -05 -W3	20.1	66	1067	42.0	5	Domestic	Withdrawal
106561	SW-27-035 -05 -W3	18.0	59	1067	42.0	7	Domestic	Withdrawal
088029	SW-27-035 -05 -W3	16.8	55	1118	44.0	4	Domestic	Withdrawal
107873	SW-27-035 -05 -W3	18.9	62	1067	42.0	10	Domestic	Withdrawal
235848	SW-27-035 -05 -W3	35.4	116	130	5.1	0	Domestic	Water Test Hole
105759	SW-27-035 -05 -W3	14.6	48	1067	42.0	6	Domestic	Withdrawal

3.6 OWTS DEVELOPMENT

An inventory of OWTS within 1 km of the proposed developments is required as part of a Level 2 assessment. A field inventory of OWTS surrounding the proposed developments was not conducted as part of the field investigation.

A desktop review of the OWTS utilized on the surrounding subdivisions, within 1 km of the site, was conducted by Imagine and the results are summarized in Table V. Further details are provided in the Imagine Assessment Report (Appendix A).

TABLE V: SUMMARY OF OWTS DEVELOPMENT ON SUBDIVISIONS WITHIN 1 KM OF THE PROPOSED DEVELOPMENT

Direction	Subdivision/Property	Type of OWTS System
Onsite	Existing Care Home proximate east side of site	Advanced Treatment System (Advanced Enviro-Septic System)
North	Edgemont Estates (Phase I Approved) - High density residential subdivision	Advanced Treatment System (Biomicrobics BioBarrier) that meets or exceeds NSF-40, NSF-245, and NSF-350
	Grasswood North and South	OWTS - All lots require site and soil assessment to determine suitable OWTS
East	Casa Rio Estates - Low density residential subdivision	Advanced Treatment System (MicroFAST) that meets or exceeds NSF-40
	Grasswood Estates	Advanced Treatment System (Advanced Enviro-Septic System) that meets or exceeds NSF-40
South East	Casa Rio Estates - Low density residential subdivision	Advanced Treatment System (MicroFAST) that meets or exceeds NSF-40
South	Casa Rio Estates - Low density residential subdivision	Advanced Treatment System (MicroFAST) that meets or exceeds NSF-40
West	Wood Meadows - Low density residential subdivision	OWTS - All lots require site and soil assessment to determine suitable OWTS

3.7 THIRD PARTY REPORTS

Publicly available third-party reports and/or general information in the region, relevant to the current investigation, was review as part of this assessment. This included the comprehensive development review (CDR) report for Edgemont Park Estates (Edgemont Estates), which is located in the quarter section (SE-33-35-5 W3M) immediately north of the proposed Ravenswood subdivision. The CDR report for the Edgemont Estates subdivision has not been appended to this report. However, relevant information was included where applicable.

The following investigations, appended to the Edgemont Estates CDR report, are specifically applicable to this investigation:

- **Imagine Contracting (2017)** – Septic System Feasibility Report for Prairie Lane Estates SE1/4-33-35-05-W3M, RM of Corman Park No. 344 Saskatchewan. June 10, 2017.
- **SNC Lavalin (2017)** - Geotechnical Investigation Proposed Residential Subdivision SE1/4-33-35-05-W3M South of Saskatoon, Saskatchewan. Prepared for Bullee Consulting Ltd. File No. 646273. April 24, 2017.
- **SNC Lavalin (2017)** – Final – Cumulative Nitrate Impact Assessment Desktop Study. Proposed Residential Subdivision SE1/4-33-35-05-W3M South of Saskatoon, Saskatchewan. Prepared for Bullee Consulting Ltd. File No. 648746. March 16, 2018.

3.8 LOCAL SETTING

Information regarding the local setting, compiled from a review of the available third party reports and/or documents that have not been appended to this report, is summarized below. Further discussion of the local site setting, obtained during this and supplement investigations, is provided in Section 4.2.

3.8.1 TOPOGRAPHY AND DRAINAGE

A topographic survey of the site was conducted in 2016 (Catterall & Wright, 2019) using an unmanned aerial vehicle (UAV; drone) as part of the original Drainage & Storm Water Management Report for the site (Catterall & Wright, 2019). The topographic survey information was utilized in the revised Drainage & Stormwater Management Report prepared by WSP Canada Inc. (WSP, 2020). Further adjustments to the values and assumptions used in the WSP (2020) drainage and stormwater management design were provided by AE (2020). The AE (2020) technical memorandum and the WSP (2020) drainage report provided are Appendix B. The WSP (2020) report includes figures illustrating the predevelopment topographic contours for the site along with the pre and post development drainage patterns.

The ground surface at the site is flat to gently rolling with ground slope ranging from less than 1% to 6% (WSP, 2020). Approximately 20 to 40 percent of the site is vegetated with trees.

WSP noted that the site is relatively free draining and that pre-development drainage is towards localized natural depressions where the surface water infiltrates into the sandy soil. Based on a review of aerial photographs and photographs taken following a 1:25 year storm event in 2017, it was noted that almost all the localized depressions are normally dry. The only depression that had standing water between the period from 2002 to 2017 was the slough located in the northeast corner of the site. Field observations made by PMEL confirmed that the only standing water body present at the site was the slough located in the northeast corner of the site and a surface water body located (offsite) along the northeast corner of the site.

The WSP (2020) report also included documentation (photographs and clipping of news article) of a 1:25 year storm event that occurred in the vicinity of the site. Approximately 49 mm of precipitation was recorded during the 1:25 year storm event that occurred on July 11, 2017.

Photographs taken within 24 hours of the storm event showed that all the depressions on the site were dry except for a small puddle located in catchment area D4, which disappeared later that day (WSP, 2020).

Similar findings were noted in the CDR for the Edgemont Estates proposed subdivision, which is in the quarter section immediately to the north of the site. The Edgemont Estates property was also noted to be relatively free draining with little to no standing water. This appears to confirm observations that the soils in the area are relatively free draining with relatively high infiltration rates.

3.8.2 GEOLOGY AND SOIL CONDITIONS

Ten boreholes were drilled as part of a geotechnical investigation for the Edgemont Estates subdivision located to the north of the site. The general soil profile noted for Edgemont Estates consisted of topsoil overlying silt and/or sand or sequences of silt/sand underlain by clay extending to at least 15.2 mbg, which was the maximum depth drilled during the geotechnical investigation. In some boreholes the sand extended to 5.7 mbg, which was the maximum depth of these boreholes.

Soil classification and/or index testing revealed the following information about the soils across the Edgemont Estates property:

- Silt deposits typically ranged from soft to stiff, non- to low plastic, and were moist.
- Sand deposits were fine-grained and typically ranged from loose to compact and were moist.
- Clay deposits typically ranged from firm to stiff, were highly plastic, and were moist.
- Silt and sand deposits below the water table were saturated.

Five (5) test pits were excavated across the Edgemont Estates subdivision to classify the soil properties as part of the septic feasibility study. The soils were noted as generally falling within the sand loam and sandy clay loam categories with moderate structure. Soil conditions within test pits at higher elevations were found to be adequate for OWTS to a depth of approximately 2.7 mbg, whereas the vertical separation in the test pits at lower elevations varied between 0.5 and 1.5 mbg.

The observed soil profile is generally consistent with what was observed during field investigations conducted for the proposed Ravenswood subdivision (discussed further in Section 4.2.1).

3.8.3 HYDROGEOLOGY

Seven monitoring wells were installed during the geotechnical investigation conducted for Edgemont Estates subdivision and were completed at depths ranging from 4.1 to 13.1 mbgs. The depth to the groundwater table ranged from approximately 1.74 to 3.67 mbg on April 17, 2017. The corresponding groundwater elevations ranged from approximately 500.4 to 500.8 masl. Based on the measured groundwater levels, the hydraulic gradient ranged from 0.0007 to 0.001.

No field hydraulic conductivity tests were conducted as part of the geotechnical investigation or cumulative nitrate assessment for the proposed Edgemont Estates subdivision.

3.8.4 OWTS FEASIBILITY

This report indicated that there was adequate space on all the proposed lots for OWTS. However, due to the small size of the lots and high density of the subdivision, the placement of each system would have to be considered during the early planning stages to ensure that all setback distances could be achieved. Due to size and spacing of the lots, only select systems were recommended for use as part of the proposed subdivision.

4 FIELD INVESTIGATION

4.1 METHODOLOGY

4.1.1 TEST HOLE DRILLING

From April 26 to 28, 2017 a total of 13 test holes, located as shown on Drawing No. 12980-1, were dry drilled using PMEL's owned and operated truck-mounted, continuous flight, solid stem auger drill rig. The test holes were 150 mm in diameter and extended to depths ranging from approximately 6 to 18 mbg. Test hole drill logs were compiled during test drilling to record the soil stratification, the groundwater conditions, and any other relevant observations (e.g., the position of unstable sloughing soils, depths at which cobblestones and/or boulders were encountered, staining, etc.).

In addition, a total of three (3) piezocone penetration tests (CPTu) were conducted during the field investigation as part of a geotechnical investigation conducted at the site (PMEL, 2017). The CPTu test locations have been shown on the site Plan, Drawing No. 12980-1, while the interpretation of the of the CPTu tests is presented in the geotechnical report. Standard penetration tests (N-index), utilizing a safety hammer with automatic trip, were performed during test drilling.

Disturbed samples of auger cuttings were collected during test drilling and sealed in plastic bags to minimize moisture loss. Select soil samples were taken to our laboratory for grain size distribution analysis. Soils samples were classified in general accordance with the Canadian Soil Classification System. The results of the grain size distribution analysis are provided in Appendix C.

4.1.2 MONITORING WELL INSTALLATION

Monitoring wells (i.e., piezometers), were installed in Test Hole Nos. 17-2 to 17-7, 17-9 to 17-12, and 17-12A. The purpose of the monitoring wells was to allow for monitoring of groundwater levels, collection of groundwater samples, and to conduct hydraulic conductivity tests (e.g., bail response).

Each monitoring well consisted of a 50 mm diameter, Schedule 40, PVC machine slotted screen with a solid riser pipe.

Unless sloughing occurred, the annular spaces around the slotted screens were filled with silica sand. In areas of sloughing soil, the sand was allowed to collapse adjacent to the screen and if required, additional sand was added to allow the sand pack to extend above the screen. The remaining borehole annulus above the sand pack/slough interval was backfilled to groundwater surface with bentonite to isolate the well screen and prevent surface water flow into the well.

4.1.3 TEST HOLE/MONITORING WELL SURVEY

The test holes/monitoring well locations were surveyed following the drilling investigation using a Trimble Geoexplorer 6000 Global Positioning System (GPS) and are presented on the test hole Logs, Drawing Nos. 12980-2 to 14. The ground surface and monitoring well elevations, surveyed using a rod and level and, are also presented on the test hole logs.

4.1.4 GROUNDWATER MONITORING

The groundwater levels were measured in each monitoring wells at the site on May 5, 2017, approximately one week after installation. The groundwater levels were measured again on June 5, 2017 to allow for additional time for the groundwater levels to reach equilibrium conditions and again on July 20, 2020 to determine if there had been any significant changes in the water level since the previous measurements in 2017.

The groundwater levels were measured using a Solinst electric water level meter. To prevent cross contamination the water level tape was cleaned between each monitoring well using a solution of diluted detergent and distilled water.

4.1.5 HYDRAULIC CONDUCTIVITY TESTING

Field hydraulic conductivity tests (i.e., bail response) were performed on June 5 and 6, 2017 in select monitoring wells at the site (17-2 to 17-7, 17-9 to 17-12, and 17-12A) to determine the bulk saturated hydraulic conductivity of the in-situ soil. Each test consisted of removing a known volume of water to produce a change in the hydraulic head within the monitoring wells. The water levels within the monitoring wells were then allowed to recover and the response was measured using a combination pressure transducer and data logger.

The computer software program Aqutesolv was used to determine the bulk hydraulic conductivity values from the measured pressure response using the Bouwer and Rice (1976) analytical method. The hydraulic conductivity test data and results are provided in Appendix D.

4.1.6 GROUNDWATER MONITORING AND SAMPLING

On June 6, 2017, following monitoring, each groundwater monitoring was purged dry, or the equivalent of at least three well volumes was removed from each well, using a dedicated disposable bailer to induce groundwater recharge. Following purging, groundwater samples were collected, using dedicated disposable bailers, from each monitoring well. An attempt was made to allow enough time for the well to recover to approximately 50% of the original (static) water level prior to sampling. The collected groundwater samples were placed in the appropriate laboratory supplied containers with laboratory specified preservatives and stored on ice in a cooler.

To prevent cross contamination, all groundwater samples were collected, using the same dedicated disposable bailer used to purge each well and new nitrile gloves were worn at each new monitoring well/sample location.

The collected samples were submitted to ALS Canada Ltd. (ALS) in Saskatoon, Saskatchewan for laboratory analysis of routine indicator parameters (pH; conductivity; total dissolved solids [TDS]; major ions; nitrate as nitrogen [nitrate]; nitrite as nitrogen [nitrite]; hardness; and alkalinity). Standard Chain of Custody procedures were used to track sample handling. Copies of the laboratory Certificate of Analysis Reports are provided in Appendix E.

A blind duplicate sample was also collected from monitoring well 17-10 to assess sampling procedures, to verify the precision of the laboratory results, and to provide general quality assurance/quality control (QA/QC) of the laboratory analysis.

4.1.7 WASTEWATER MANAGEMENT EVALUATION

A separate investigation was conducted at the site by Imagine on August 16, 2020 to provide further assessment of the feasibility of the use of OWTS for the proposed Ravenswood subdivision. Eight (8) test pits were excavated by the client as part of this investigation. A detailed soil assessment was conducted by Imagine on each test pit to identify the relevant soil conditions (e.g., depth and thickness of each soil horizon, moisture conditions, root depths, evidence of historical water level fluctuations, etc.) necessary to evaluate the suitability and general design (i.e., vadose zone retention times, system selection, etc.) of OWTS's.

Multiple soil samples were collected from each test pit for laboratory analysis to determine the grain size distribution, soil texture, and soil structure of each soil horizon.

The investigation also included an assessment of the overall site (e.g., vegetation assessment, etc.) to identify any areas that would not be suitable for the use of OWTS's.

A copy of the Imagine Assessment Report has been appended in Appendix A. Information from Imagine Assessment Report has been included in the relevant sections of this report.

4.2 RESULTS

4.2.1 GENERAL SOIL PROFILE

Detailed descriptions of the soil stratigraphy at the site are presented on the test hole logs, Drawing Nos. 12980-2 to 14. Stratigraphic sections showing an interpretation of the soil profile are presented on Drawing Nos. 12980-15 and 16. The location of the stratigraphic sections is shown on Drawing No. 12980-1.

The general soil profile consisted of up to approximately 300 mm of topsoil overlying variable deposits of sand, silt, and clay extending to depths of at least 18 mbg, the maximum depth drilled at the site by PMEL. The soils encountered at the site were comprised of predominantly sand and silt with intermittent clay layers typically in the order of 1 to 2 m thick. The clay did not appear to be continuous across the site and was encountered at depths ranging from 1.6 to 10 mbg.

Thicker clay units were identified in three (3) of the test holes drilled at the site:

- In Test Hole 17-7 a clay unit was encountered at a depth of approximately 1.7 mbg extending to 7.5 mbg, which was the maximum depth drilled at this location.
- In Test Hole 17-10 an approximately 4.2 m thick layer of clay was encountered at a depth of approximately 1.9 mbg. This clay unit was underlain by sand.
- In Test Hole 17-12 a thin clay layer (0.4 m thick) was encountered at a depth of approximately 4.7 mbg followed by sand and then clay extending from approximately 7 to 18.2 mbg, which was the maximum depth drilled at this location and at the site.

The test holes (17-7, 17-10, and 17-12) with significant clay units are located in the southeast portion of the site and as discussed below should not affect the suitability of OWTS in these areas of the site.

- Test Hole 17-7 is in the south portion of Lot 2 proximate Municipal Utility 4. The eastern half of this lot was noted by WSP and Imagine as a low lying area at the site. The ground surface elevation on the western half of this lot is approximately 1.5 to 2.0 m higher.
- Test Hole 17-10 is located in the northwest corner of Lot 10 to the south of a low-lying area. The ground surface elevation along the eastern portion of this lot is approximately 1.5 to 2.0 m higher.
- The clay units encountered in test hole 17-12 were at depths of 4.7 and 18.2 mbg.

4.2.2 HYDROGEOLOGICAL CONDITIONS

The depth to groundwater in the monitoring wells at the site was measured on May 5 and June 5, 2017 and again on July 20, 2020. A summary of the groundwater levels recorded has been presented in Table VI.

Review of the results presented in Table VI and field observations revealed the following:

1. Not all the monitoring wells appeared to have reached equilibrium conditions on May 5, 2017, which was approximately one (1) week after installation and have therefore been excluded from further discussion.
2. The depth to groundwater on June 5, 2017 ranged from approximately 1.5 to 5 mbg with average and median values of 3.7 and 3.8 mbg, respectively.
3. The depth to groundwater on July 20, 2020 ranged from approximately 1.9 to 5.8 mbg with average and median values of 4.0 and 4.2 mbg, respectively.
4. The apparent direction of groundwater flow on June 5, 2017 and July 20, 2020 was consistently towards the northwest at average gradients of 0.002 to 0.005, respectively. The inferred groundwater surface elevation contours, excluding deeper monitoring well 17-12, and the apparent groundwater flow directions for June 5, 2017 and July 20, 2020 are shown on Drawing Nos. 12980-17 and 12980-18, respectively.

5. Based on the groundwater surface elevations at the monitoring well nest comprised of 17-12 and 17-12A, for the measurements collected on June 5, 2017 and July 20, 2020, the vertical gradient varied between a downward vertical gradient of 0.01 and flat (determined using midpoint of the well screens). The presence of a downward hydraulic gradient on June 5, 2017 and a flat gradient on July 20, 2020 suggests that this monitoring well is located in a localized area of intermittent groundwater recharge and the groundwater at the site is flowing downward from the ground surface towards the water table.
6. The groundwater conditions (e.g., depth to groundwater, horizontal and vertical hydraulic gradients) at the site were generally consistent between the measurements collected on July 5, 2017 and July 20, 2020.
7. Groundwater seepage and sloughing conditions were encountered during test drilling. The depths at which groundwater seepage and/or sloughing conditions were encountered are shown on the test hole logs (Drawing Nos. 12980-2 to 14).

Elevated groundwater levels are possible during and/or following spring snowmelt or periods of precipitation. However, the groundwater depths at the site were generally consistent between the measurements collected on June 5, 2017 and July 20, 2020 and appear to be representative of general groundwater conditions at the site.

From a review of the topographic contours, provided in the WSP report, a number of the monitoring wells are proximate natural ground surface depressions at the site. Therefore, it would be expected that the depth to the groundwater table would be shallower in these areas and should be deeper in areas of higher elevation.

TABLE VI: SUMMARY OF GROUNDWATER MONITORING DATA

Test Hole Number	Elevation (masl)		Depth to Groundwater (mbg)			Groundwater Elevation (masl)		
	Monitoring Well Rim	Ground Surface	5-May-17	5-Jun-17	20-Jul-20	5-May-17	5-Jun-17	20-Jul-20
17-2	504.50	503.50	2.03	1.98	2.55	501.47	501.52	500.95
17-3	506.50	505.40	3.92	3.83	4.37	501.48	501.57	501.03
17-4	505.70	504.50	3.06	3.01	3.57	501.44	501.49	500.93
17-5	509.10	508.00	Dry	Dry	Dry	< 502.0	< 502.0	< 502.0
17-6	507.30	506.30	5.02	5.00	5.80	501.28	501.30	500.50
17-7	504.80	503.80	5.30	1.51	1.94	498.50	502.29	501.86
17-9	507.20	506.20	3.80	5.02	3.93	502.40	501.18	502.27
17-10	507.80	506.80	4.83	4.78	5.30	501.97	502.02	501.50
17-11	506.60	505.60	3.85	3.84	4.10	501.75	501.76	501.50
17-12	508.20	507.10	3.98	4.06	4.43	503.12	503.04	502.67
17-12A	508.20	507.00	6.60	3.86	4.28	500.40	503.14	502.72

masl denotes metres above sea level
 mbg denotes metres below grade

4.2.3 SOIL CLASSIFICATION AND INDEX TESTS

The soil classification and index tests consisted of a visual classification of the soil, water contents, unit weights, Atterberg limits, and grain size distribution analysis. The results of the soil classification and index tests, conducted on representative samples of soil recovered from this site, have been plotted on the test hole logs (Drawing Nos. 12980-2 to 14) alongside the corresponding depths at which the samples were recovered. A total of nine (9) soil samples were recovered from the test holes drilled across the site at depths ranging from approximately 0.5 to 2.0 mbg.

The results of the grain size distribution analyses, described using the Canadian System of Soil Classification, have been presented in Appendix C and summarized in Table VII.

A review of the results presented in Table VII revealed the following:

1. In general, the surficial soils (i.e., upper 2.0 m) at the site were classified as loam, sandy loam, or silty loam.
2. Soil samples collected from two of the test holes were classified as silty clay loam (17-6) and silty clay (17-7). The soils samples that were classified as silty clay loam and silty clay were collected at depths of approximately 1.5 to 1.9 and 2.0 mbg, respectively, and were the deepest soil samples analyzed at the site.

TABLE VII: SUMMARY OF CANADIAN SYSTEM OF SOIL CLASSIFICATION

Test Hole Number	Depth (metres)	Grain Size Distribution Analysis (percent)			Canadian System of Soil Classification Nomenclature
		Sand	Silt	Clay	
17-2	1.0	71	16	13	Sandy Loam
17-4	1.0	40	35	25	Loam
17-5	0.5	65	21	14	Sandy Loam
17-6	1.5 to 1.9	19	45	36	Silty Clay Loam
17-7	2.0	2	51	47	Silty Clay
17-8	1.0	73	16	11	Sandy Loam
17-9	0.5	26	49	25	Silt Loam
17-10	0.5	50	36	14	Loam
17-12	1.0	73	19	8	Sandy Loam

4.2.4 HYDRAULIC CONDUCTIVITY

The results of hydraulic conductivity tests, calculated using the Bouwer and Rice (1976) method, are summarized in Table VIII, while detailed reports are presented in Appendix D.

Review of the results presented in Table VIII revealed the following range of hydraulic conductivities for the soils at the site:

- **Predominantly sand soils:** approximately 2×10^{-7} to 2×10^{-6} m/s;

- **Predominantly silt soils:** approximately 2×10^{-7} to 8×10^{-8} m/s; and
- **Predominantly clay soils:** 9×10^{-10} to 3×10^{-8} m/s.

The field hydraulic conductivity tests predominantly measure the horizontal component of the hydraulic conductivity. The vertical hydraulic conductivity values are typically 1 to 2 orders of magnitude lower than the horizontal hydraulic conductivity.

TABLE VIII: SUMMARY OF HYDRAULIC CONDUCTIVITY TEST RESULTS AND REQUIRED VADOSE ZONE DEPTH

Test Hole Number	Effective Screen Length (m)	Hydraulic Conductivity (m/s)	Hydraulic Conductivity (m/day)	Required Vadose Zone Depth (m)	Soil Type
17-2	3.5 to 5.5	2×10^{-6}	0.173	10.4	Sand/Silt/Sand & Silt
17-3	3.5 to 5.5	4×10^{-7}	0.035	2.1	Sand
17-4	5.0 to 6.0	8×10^{-8}	0.007	0.4	Sand & Silt
17-6	4.5 to 5.5	2×10^{-7}	0.017	1.0	Silt/Sand
17-7	4.0 to 6.0	9×10^{-9}	0.001	0.05	Clay
17-10	4.0 to 6.0	3×10^{-8}	0.003	0.2	Clay/Sand
17-11	3.0 to 5.0	7×10^{-7}	0.060	3.6	Sand/Clay
17-12	13.0 to 15.0	9×10^{-10}	0.0001	0.005	Clay
17-12A	4.0 to 6.0	6×10^{-7}	0.05	3.1	Sand/Clay

¹ Not Measured

Effective screen length refers to the total length/area of the sand pack/screened interval that is assumed to be providing groundwater recharge.

The required vadose zone depth is calculated assuming that 60 days of retention time within the vadose zone is required to achieve at least a 3-log (i.e., 99%) removal of pathogens from the OWTS effluent.

4.2.5 LABORATORY CHEMICAL ANALYSIS – GROUNDWATER

The results of the laboratory chemical analysis for major ions and routine parameters are summarized in Table IX along with the Saskatchewan Ministry of Environment (SKMoE) Saskatchewan Environmental Quality Standards (SKMoE, 2020) for the protection of the groundwater pathway for coarse-grained soils, for comparison purposes (Section 6.5.5). Detailed analytical results can be found in the laboratory Certificate of Analysis (COA) report, provided in Appendix E, which also includes a listing of the laboratory analytical methods and a summary of the laboratory quality assurance/quality control (QA/QC) results.

Review of the results presented in Table IX revealed the following:

1. The concentration of total dissolved solids (TDS) was elevated in all the samples analyzed and exceeded the referenced endpoints in the groundwater samples recovered from monitoring wells 17-2, 17-6, 17-7, and 17-10.
2. Sulphate, at a concentration (1,070 mg/L) exceeding the referenced endpoint (500 mg/L) was measured in the groundwater sample recovered from monitoring well 17-7.
3. The concentrations of the remaining constituents were below the referenced endpoints in all the samples analyzed.

TABLE IX: RESULTS OF LABORATORY CHEMICAL ANALYSIS

Test Hole No.		17-2	17-3	17-4	17-6	17-7	17-10	17-11	17-12	17-12A	SKMoE (2020)	
Sample No.		17-1	17-2	17-3	17-5	17-6	17-8	17-16	17-9	17-10	17-10A	Potable Water
Date Sampled		6-Jun-17	6-Jun-17	6-Jun-17	6-Jun-17	6-Jun-17	6-Jun-17		6-Jun-17	6-Jun-17	6-Jun-17	Coarse-Grained Soil
Parameter	Units											Endpoints
Conductivity	uS/cm	859	810	645	1090	2400	923	930	830	774	783	No Endpoint
pH	pH	7.75	7.81	7.73	7.67	7.4	7.61	7.71	7.62	7.69	7.74	6.5 to 8.5
Alkalinity, Total (as CaCO ₃)	mg/L	387	369	325	389	421	383	383	413	369	375	No Endpoint
Bicarbonate (HCO ₃)	mg/L	472	450	396	475	514	468	468	504	450	457	No Endpoint
Carbonate (CO ₃)	mg/L	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	No Endpoint
Chloride (Cl)	mg/L	5	9.7	5.6	20	20.1	8.6	9.4	6	5.7	7.1	250
Hardness (as CaCO ₃)	mg/L	437	415	277	547	1300	450	436	423	393	385	No Endpoint
Hydroxide (OH)	mg/L	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	No Endpoint
Nitrate+Nitrite-N	mg/L	2.79	4.22	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	No Endpoint
Nitrate-N	mg/L	2.76	4.14	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	10
Nitrite-N	mg/L	<0.050	0.075	<0.050	0.067	<0.050	<0.050	0.064	<0.050	<0.050	<0.050	1
TDS (Calculated)	mg/L	539	491	372	699	1930	579	573	493	464	467	500
Calcium (Ca) Dissolved	mg/L	117	84.2	61.8	130	331	120	116	116	114	111	No Endpoint
Magnesium (Mg) Dissolved	mg/L	35.1	49.7	29.7	54	116	36.6	35.6	32.5	26.2	26.3	No Endpoint
Potassium (K) Dissolved	mg/L	4.4	2.6	5	6	10.7	5.1	5.3	4.5	5.3	5.3	No Endpoint
Sodium (Na) Dissolved	mg/L	26	24.1	36.3	32.2	126	35.1	34.5	20.4	20.8	20.7	200
Sulfur (as SO ₄) Dissolved	mg/L	107	80.8	38.5	223	1070	144	142	65.7	70.7	71.5	500

Notes:

-SKMoE Saskatchewan Environmental Quality Standards (SKMoE, 2020). <<https://envrbrportal.crm.saskatchewan.ca/segg-search/>> [Accessed April 27, 2020].

-Sample No. 17-16 is a field blind duplicate of Sample No. 17-8. Both samples were recovered from Test Hole No. 17-10.

█ Concentration exceeds referenced endpoint.

4. The measured nitrate concentrations at the site ranged from below the laboratory detection limit (<0.5 mg/L;) to 4.22 mg/L (17-3). The nitrate concentrations of the majority of the samples analyzed (7 of 9 samples) were below the laboratory detection limits.
5. In general, the groundwater chemistry was similar between all the monitoring wells at the site except for the sample collected from monitoring well 17-7. Monitoring well 17-7 had elevated concentrations of conductivity, sulfate, TDS, calcium, magnesium, potassium, sodium, sulphate, and hardness relative to the other monitoring wells at the, which is typical of water associated with a localized discharge zone. Monitoring well 17-7 is located in a low-lying area along the east side of the property.
6. The remaining groundwater was relatively fresh and typical of shallow calcium-bicarbonate groundwater.

4.2.6 HYDRAULIC RETENTION TIME

In accordance with GOS (2012) guidance a minimum retention time of 60 days within the vadose zone is required to achieve a 3-log (i.e., 99.9%) removal of pathogens from the OWTS effluent. The GOS (2012) recommends that a minimum vadose zone depth of 1.5 m for primary treated effluent and 0.9 m for secondary treated effluent.

The required vadose zone depth, from the bottom of the infiltrative surfaces (i.e., bottom of dispersal trench, etc.) to the surface of the water table and/or restrictive layer, for each type of soil was estimated using the hydraulic conductivity values measured at the site (Table VIII). The required vadose zone depth for the soil samples collected at the site is provided in Table VIII.

A review of the results presented in Table VIII revealed the following:

1. The required vadose zone depths for the soils at the site range from 0.005 to 10.4 m based on the range of hydraulic conductivity values.
2. The majority of the calculated required vadose zone depths (5 of 9 calculated values) were less than the minimum separation distance of 1.5 m and would provide sufficient vadose zone retention time to effectively remove pathogens from OTWS effluent.
3. The areas where the required vadose zone depth exceeded the minimum recommended values were areas with a higher content of sand.

The field hydraulic conductivity values are representative of the subsurface soils immediately adjacent to the monitoring well screen, which were completed at depths ranging from 3.0 to 15.0 mbg. However, it is believed that these hydraulic conductivity values would be representative of similar soil types at shallower depths at the site.

As discussed above, groundwater recharge during field hydraulic conductivity tests is typically due to horizontal groundwater flow towards the monitoring well and as such the resulting hydraulic conductivity values are generally considered to represent the horizontal hydraulic conductivity. The vertical hydraulic conductivity is typically one (1) to two (2) orders of magnitude lower than the horizontal hydraulic conductivity. As such, the required vadose zone depths calculated using the measured hydraulic conductivity values are considered to be conservative.

4.2.7 SITE SENSITIVITY

In accordance with GOS (2018) guidance a site is considered sensitive if one or more of the following conditions exist:

1. The subdivision, containing the parcel/lot, is less than 1.0 km from the boundary of any municipality (e.g., city, town, village, organized hamlet or approved subdivision containing at least two parcel/lots) that utilizes groundwater source(s) for drinking water purposes.
2. The presence of coarse soils over an unconfined aquifer, that is of sufficient quality and quantity to be used as a drinking water source. The presence of high levels of aesthetic constituents should not be used to determine drinking water suitability.
3. The presence of subsurface water (seasonal or permanent), which is less than 1.5 m below the natural ground surface elevation.
4. Historical concerns with well water quality (in particular nitrate) believed to be due to human activities.

Based on the results of the desktop study and field investigation the site is considered to be located in a sensitive area due to the following conditions:

1. The site is located within 1.0 km, upgradient, of an approved subdivision (Grasswood North that is or could potentially utilize a groundwater well for drinking water purposes; and
2. The site is underlain by a saturated sand unit containing groundwater of apparent sufficient quality and quantity to represent an unconfined surficial aquifer.

5 CONCEPTUAL HYDROGEOLOGICAL MODEL

5.1 HYDROGEOLOGICAL SETTING

Based on a review of regional information and observations from field investigations conducted at the site, the site overlies a large surficial aquifer that includes stratified sand, silt, and clay deposits. For this assessment the geology of the shallow surficial soils has been simplified into a single and continuous sand aquifer.

All the water in the surficial aquifer originates as precipitation which has infiltrated downward from the ground surface to the water table, which forms the surface of the uppermost surficial aquifer. Recharge occurs seasonally, mainly during intensive or long duration rainstorms. Groundwater entering the surficial aquifer will migrate downward, recharging underlying aquifers, or laterally in a generally northwest direction towards the South Saskatchewan River, which is the inferred regional groundwater flow direction. In some areas of the site localized flow may occur towards topographic depressions.

5.2 SUBSTANCES OF POTENTIAL CONCERN

Many contaminants present in the OWTS effluent are removed during the primary treatment that occurs within the septic tank (e.g., settling, microbial digestion).

The primary substances of potential concern (SOPCs) leaving the septic tank and entering the soil treatment system are pathogenic organisms and different forms of nitrogen containing compounds

(e.g., ammonia, nitrite, nitrate). Household waste is typically composed of organic nitrogen that is converted to ammonia under anaerobic conditions (e.g., septic tank). As the effluent leaves the septic tank and is discharged through the soil treatment system it is biochemically transformed into nitrate through aerobic processes. It is typically assumed that no further chemical transformation occurs once the effluent is discharged from the soil treatment system as site conditions (e.g., mass of organics, anaerobic conditions) are not typically favourable for denitrification to occur (e.g., conversion to nitrogen gas). As such, the composition of nitrogen within the effluent exiting the soil treatment system and entering the groundwater is assumed to be in the form of nitrate.

The minimum vertical separation values outlined in the GOS (2012) guidance document and recommend in most wastewater treatment design manuals, are calculated to ensure almost complete removal of organics and pathogenic organisms. If insufficient vertical separation is provided the pathogens will enter the groundwater and are difficult to remove. As each system must be designed to provide sufficient vertical separation, it is assumed for assessment purposes that the pathogens will be effectively removed within the vadose zone.

For this assessment it is assumed that the primary SOPC within the OWTS effluent was nitrate. It is well understood that nitrate is relatively inert and does not degrade readily in the environment. As such nitrate is generally considered a useful indicator of the migration potential of other SOPCs within the OWTS effluent.

5.3 OWTS EFFLUENT FATE AND TRANSPORT

A conceptual model of an OWTS effluent plume is presented in Figure 1. Effluent released from an OWTS is expected to travel vertically through the vadose (unsaturated) zone under the influence of gravity. Vertical flow through the vadose zone is assumed to be primarily restricted to the area underneath the soil adsorption soil treatment system.

Once the effluent reaches the groundwater surface, it is expected to move horizontally in the direction of groundwater flow due to the lateral force applied by the aquifer's hydraulic gradient. Since flow in most aquifers is generally considered to be laminar under most conditions, it is assumed there is minimal mixing between the effluent plume and the surrounding groundwater. As such, a long narrow nitrate plume, which remains near the surface of the aquifer and extends in the direction of groundwater flow, is expected to develop at the site.

Based on groundwater monitoring, conducted on June 5, 2017 and July 20, 2020, the overall apparent direction of groundwater flow is towards the northwest at an average gradient ranging from 0.002 to 0.005. As such, nitrate plumes developing at the site are expected to move towards the northwest. In some areas of site groundwater flow may be towards localized ground surface depressions.

It is well understood that nitrate is relatively inert and does not degrade readily in the environment. Reductions in nitrate concentrations occur as a result of dilution due to mixing of the nitrate with groundwater and precipitation recharge.

The final nitrate concentration will depend on the recharge rates (groundwater and precipitation) and background nitrate concentration in these recharge sources.

In accordance with GOS (2012) dilution due to mixing of groundwater can only be considered in cases where the upgradient lands have been fully developed for a considerable period of time. The upgradient lands adjacent to the site are occupied by Casa Rio Estates. Based on a review of satellite imagery (Google, 2020) Casa Rio Estates was developed prior to 2002. From a comparison of satellite images from 2002 and 2020 the level of development has remained relatively consistent. Although, it is not anticipated that there will be further development within Casa Rio Estates, it is understood that only approved OWTS systems meeting or exceeding the NSF-40 standard can be constructed within this development and therefore, typical OWTS operation would not be expected to significantly alter the background nitrate concentration at the site.

The land use upgradient of Casa Rio Estates is primarily cultivated agricultural land developed more than 40 years ago. It is generally understood that the nitrogen load from grain agriculture can be much larger than from conventional OWTS's and as such if the land is converted to a residential development it would likely not alter the background nitrate concentrations at the site.

The upgradient lands are considered to be fully developed and therefore, dilution via groundwater recharge was assumed to be applicable at the site.

5.4 RECEPTORS

The SKMoE (2020) Saskatchewan Environmental Quality Standards (SEQS) provides referenced criteria for assessment of nitrate concentrations for the protection of the groundwater and surface water pathways. As the nitrate plume moves away from the OWTS, it is possible that it will be intercepted by wells (if any) or a surface water body located downgradient (northwest) of the proposed subdivision.

The proposed Ravenswood subdivision will be comprised of predominantly single-family residential homes but will also include a senior centre, care home, and community centre. In accordance with the RM of Corman Park No. 344 bylaws new multiparcel residential developments require potable water to be supplied via a piped distribution network. As such there will be no new potable water wells installed at the site and therefore, there will not be the possibility of a nitrate plume intercepting a potable water well on the site.

Currently the site is bordered to the west by Wood Meadows subdivision (NW-28-35-05-W3M) and Edgemont Estates is proposed to be built immediately to the north of the site and will occupy SE-33-35-5 W3M in the future.

As discussed previously Wood Meadows and the proposed Edgemont Estates subdivisions obtain potable water via a piped distribution network. SW-33-35-5-W3M is currently being utilized for agricultural purposes and has a single development (farmhouse/sod house) located in its northwest corner. It is possible that groundwater wells could be utilized as a potable water source. The three (3) quarter sections listed above are located downgradient of the site.

Based on a review of satellite imagery (Google, 2020) the closest surface water body is a slough located in the northeast corner of the site and is cross gradient (northeast) to the apparent direction of groundwater flow (northwest). There is also a surface water body located (offsite) to the east and cross gradient of the site. There are no surface water bodies located immediately downgradient of the site. There is an apparent intermittent surface water body located in the northwest corner of SW-33-35-5-W3M, which is approximately 750 m from the site.

As part of the drainage and stormwater management plan for the proposed subdivision it has been proposed that both natural depressions and manmade stormwater collection ponds will be constructed at the site. However, with the exception of the surface water body located in the northeast corner of the site, it is reported that the site is relatively free draining and these collection ponds will typically be dry and as such will not support freshwater aquatic life.

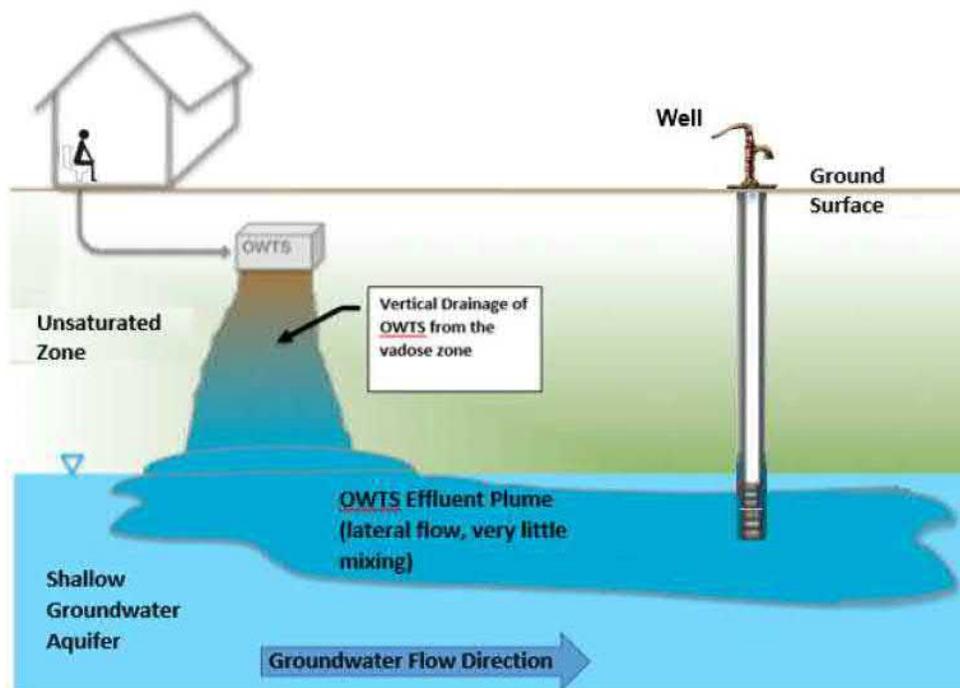


FIGURE 1: CONCEPTUAL SITE MODEL OF EFFLUENT RELEASE FROM TYPICAL OWTS

6 SITE IMPACT ASSESSMENT

The OWTS assessment included an evaluation of the potential for groundwater mounding as a result of OWTS effluent released at the site and the fate and transport of nitrate contained within the OWTS effluent.

6.1 PREVIOUS NITRATE ASSESSMENTS

Previous nitrate modelling results (PMEL, 2017, 2020), evaluated as part of the initial hydrogeological submissions, revealed that if standard OWTS systems are utilized at the site (assumed raw effluent nitrate concentrations of 40 mg/L) the resulting nitrate concentration in groundwater would exceed 10 mg/L (i.e., referenced endpoints) at the downgradient property boundary.

To ensure protection of groundwater resources, for future downgradient users and the environment, advanced package treatment systems will be utilized at the site. The nitrate assessment was conducted to determine the required effluent quality (maximum nitrate concentrations) for OWTS constructed at the site to minimize potential adverse impacts to human and/or environmental receptors. The results of the nitrate assessment would be used in conjunction with other site-specific information (e.g., soil and groundwater conditions, etc.) to specify suitable OWTS for the site.

6.2 LEVEL OF CURRENT NITRATE ASSESSMENT

In accordance with GOS (2012) guidance a preliminary nitrate assessment is required as part of all Level 1 and 2 assessments. A cumulative nitrate assessment is only necessary where the probability of a water well intercepting an OWTS effluent plume is greater than 90%.

The probability of a water well intercepting an OWTS effluent plume is contingent on:

1. The presence of existing water wells or the potential for new water wells to be installed within 1 km downgradient of the site in the apparent groundwater flow direction; and
2. The percentage of the total flow area exiting the site that is occupied by OWTS effluent plume(s).

6.2.1 WATER WELLS

The RM of Corman Park No. 344 bylaws stipulate in their Zoning Bylaws, that all new multi-parcel residential subdivision developments must be serviced by a centralized potable waterline and prohibits the installation of potable groundwater wells for multi-parcel residential developments. Therefore, all new subdivisions to be constructed downgradient of the site (e.g., Edgemont Estates) cannot install a water well as a potable water source. It is understood that Wood Meadows subdivision is connected to the potable water distribution line that services Casa Rio Estates. The proposed subdivision will also be connected to the same potable water distribution system used by Wood Meadows. It is understood that Edgemont Estates is proposing to be connected to the Dundurn Rural Water Utility.

The only water wells that could be potentially intercepted by an OWTS would be those groundwater wells that existed prior to the implementation of the new Zoning Bylaws or new water wells installed for a single-family residential development. The nearest existing or future water well downgradient of the site, would be a water well associated with the single-family residential property located in SW-33-35-5-W3M (Melenchuk) or the residential properties located along Parklands Road (NW-33-35-5-W3M).

6.2.2 PERCENTAGE OF AREA OCCUPIED BY OWTS PLUMES

Another prerequisite to a theoretical OWTS nitrate plume intersecting a downgradient water well, is the width of the plume(s) relative to the overall flow width. To calculate this, potential OWTS's were superimposed onto a plan of the proposed subdivision. It was assumed that each system would have an average width of 25 m and that the groundwater nitrate plume(s), exiting each OWTS, would travel generally parallel to the overall groundwater flow direction.

It is well understood that a groundwater nitrate plume will maintain a nearly consistent width as it travels through the shallow groundwater zone with minimal lateral dispersion (will widen by approximately 5° on both sides) in most geological settings (MDEQ, 2015).

To be conservative, the OWTS were arranged on each proposed lot such that the OWTS effluent plumes migrated parallel to each other, maximizing the width of the combined nitrate plume travelling across the site. The probability of the nitrate plume intersecting a well was then determined by comparison of the total flow width occupied by all the nitrate plumes to the total maximum available flow width perpendicular to the groundwater flow direction. Using this approach, it was determined that the probability of the groundwater nitrate plume intersecting a downgradient water well would be between 80 and 88%. Although, this approach does not consider widening of the effluent plumes as they migrate from an OWTS, this should be negated by the fact that the theoretical OWTS locations were purposely misaligned to obtain a maximum combined plume width relative to the total flow width.

6.2.3 SUMMARY

It was recommended that a cumulative nitrate assessment be conducted for the property based on the following:

1. There is the potential for an existing or future water well to be constructed within 1.0 km downgradient of the site; and
2. The combined width of the OWTS effluent plumes would occupy between 80 to 88% of the total available flow width, approaching the 90% probability threshold of a potable water well intercepting an OWTS plume.

The site is also classified as a sensitive area due to its proximity to other approved subdivisions that could utilize potable groundwater and the presence of a surficial aquifer underlying the site.

6.3 NITRATE ASSESSMENT MODEL

The purpose of the cumulative nitrate assessment was to evaluate the combined effect of the nitrate from all the onsite OWTS and other potential sources of nitrate proximate the proposed subdivision (e.g., fertilizer application, intensive livestock operations, lagoons, landfills, etc.). A predictive based assessment, using the Wehrman (1983) mass balance nitrate dilution model, was conducted to evaluate the cumulative effects of nitrate on potential receptors.

As discussed previously, there does not appear to be any surface water bodies near and downgradient of the proposed subdivision.

The closest surface water body, located in the northeast corner of the site, appears to be cross gradient to the overall groundwater flow direction. Therefore, the SKMoE referenced endpoints for protection of the potable groundwater pathway (10 mg/L) were used for assessment purposes.

6.4 CUMULATIVE NITRATE CONCEPTUAL MODEL

As discussed previously (Section 5.3) OWTS effluent released at the site is expected to migrate vertically downward until it reaches the groundwater surface and then will travel horizontally along the top of the groundwater table in the overall direction of groundwater flow.

Based on the information reviewed as part of this assessment the surficial aquifer underlying the site is also present below the adjacent properties and the geological and hydrogeologic properties are similar.

Once the nitrate enters the shallow surficial aquifer underlying the site it may be diluted by recharge from precipitation infiltrating across the surface of the site and groundwater entering from upgradient of the site. The infiltrating precipitation and groundwater recharge are potential sources of nitrate.

As the regional groundwater flow direction is expected to be towards the South Saskatchewan River (west to northwest direction) groundwater recharge entering the site would be primarily from the east and southeast of the site. The concentrations of nitrate in the groundwater to the east and southeast would be affected by the associated land use in these areas and potential upgradient sources. It is assumed the nitrate laden groundwater recharge from the upgradient properties will provide a constant source of nitrate and will be fully mixed when it enters the site.

The properties directly to the east and southeast of the site are currently occupied by Casa Rio Estates subdivision. This subdivision utilizes OWTS for management of its septic waste, which would provide a source of nitrate to the underlying groundwater. The properties upgradient of Casa Rio Estates (more than 800 m from the site) consist of cultivated agricultural land followed by Grasswood Estates subdivision, which also utilizes OWTS. The fertilizer applied to the surface of the cultivated agricultural land will most likely contain nitrogen, which will leach into the underlying groundwater with infiltrating precipitation. There does not appear to be any other major sources of nitrate (e.g., municipal sewage lagoons, landfills, etc.) located near the site.

Groundwater samples of the upgradient groundwater were not collected as part of this investigation. As the site of the proposed subdivision has historically been used for cultivated agriculture, is occupied by a care home with an OWTS and livestock, and is adjacent to other subdivisions utilizing OWTS, it was assumed that the maximum measured nitrate concentrations from groundwater samples collected on site as part of this investigation would be representative of the upgradient groundwater. The maximum nitrate concentrations in samples collected from the site were from monitoring wells downgradient of the existing care home, which includes an OWTS and a small livestock operation.

6.5 NITRATE DILUTION MODEL AND MODEL INPUTS

The Wehrman (1983) mass balance nitrate dilution model was selected to conduct the cumulative nitrate assessment for the proposed subdivision. The Wehrman (1983) nitrate dilution model takes into consideration the cumulative addition of nitrate from the entire subdivision (e.g., the combined nitrate from individual OWTS) and dilution across the entire subdivision (e.g., groundwater recharge and precipitation).

Sources of nitrate considered in the Wehrman (1983) mass balance model include: nitrate within the OWTS effluent, background groundwater, and precipitation. The model considers the magnitude of the hydraulic gradient but does not consider the groundwater flow direction.

The Wehrman (1983) model assumes that the average nitrate concentration in groundwater leaving the site, C_o , is the sum of all nitrate sources in the system divided by the total volume of water in the system.

$$C_o = \frac{M_b + M_i + M_s - M_p}{(V_b + V_i + V_s - V_p)}$$

Where:

M_b = the mass of nitrate of groundwater recharge entering the site (mg/day)

M_i = the mass of nitrate in precipitation entering the site (mg/day)

M_s = the total mass of nitrate in the wastewater effluent from all the OWTS (mg/day)

M_p = the mass of nitrate removed from the system due to pumping from water wells (mg/day)

V_b = the volume of groundwater recharge across the width of the site, perpendicular to the groundwater flow direction, across the depth of the mixing zone (L/day)

V_i = the volume of groundwater recharge due to precipitation occurring across the entire surface area of the site (L/day)

V_s = the total volume of wastewater being added to the system from all the OWTS (L/day)

V_p = the volume of groundwater being removed from the system due to pumping from water wells (L/day)

An explanation of each term and the values used in the Wehrman (1983) mass balance nitrate dilution model are summarized below. Example calculations for select scenarios that illustrate the overall outcome of the nitrate assessment model results are provided in Appendix E.

6.5.1 GROUNDWATER RECHARGE

The mass of nitrate in the background groundwater recharge was calculated as follows:

$$M_b = V_b C_b$$

$$V_b = KiA(86,400,000)$$

$$A = W_p D_A$$

Where:

C_b = the concentration of nitrate in groundwater recharge entering the site (mg/L)

K = the hydraulic conductivity of the aquifer (m/s)

i = the lateral hydraulic gradient of the aquifer (m/m)

A = the cross-sectional area through which groundwater recharge is occurring (m²)

W_p = the width of the site perpendicular to the groundwater flow direction (m)

D_A = the assumed depth of the aquifer where mixing takes place (m)

86,400,000 is multiplier to convert from m³/s to L/day

Groundwater nitrate Concentrations

As discussed in Section 5.3, groundwater recharge originates from the properties upgradient of the site and the nitrate concentration of the groundwater recharge was assumed to be equal to the maximum nitrate concentration measured at the site.

The maximum nitrate concentrations measured in groundwater samples collected at the site were 2.76 and 4.14 mg/L in the groundwater samples recovered from monitoring wells 17-2 and 17-3, respectively.

The nitrate concentrations in the remaining groundwater samples analyzed from the site were below the laboratory reportable detection limit of 0.5 mg/L. All the monitoring wells at the site are screened across the uppermost groundwater zone and should intersect groundwater nitrate plumes migrating across the site, which tend to remain close to the groundwater surface. To account for a potential increase in development in the area in the future, concentrations of nitrate in the groundwater recharge were varied between 4.14 and 8.25 mg/L, which is approximately double the current maximum measured value at the site.

Groundwater Recharge and Flow Area

Based on the results of the groundwater monitoring on June 5, 2017 and July 20, 2020 the near surface groundwater at the site flows towards the northwest at an average gradient ranging from 0.002 to 0.005, respectively. These values are similar to the regional ground surface slope and the range of values (SNC, 2018) noted for the proposed Edgemont Estates subdivision. The hydraulic conductivity (K) values calculated for the site range from 9×10^{-10} to 2×10^{-6} m/s.

The width of the site perpendicular to the direction of groundwater flow was determined to be approximately 1,100 m. The depth of the uppermost shallow aquifer (mixing depth) below the site was assigned a maximum value of 4.6 m as per guidance provided by WDoH (2017).

6.5.2 PRECIPITATION RECHARGE

The mass of nitrate in the precipitation recharge was calculated as follows:

$$M_i = V_i C_i$$

$$V_i = A_i R_i (1,000)$$

Where:

C_i = the nitrate concentration in precipitation recharge (mg/L)

A_i = the surface area contributing to precipitation recharge (m^2)

R_i = the amount of rainfall infiltrating and recharging the underlying groundwater zone (m/day)

1,000 is a multiplier to convert from m^3 to L

Precipitation Nitrate Concentrations

A nitrate concentration of 1 mg/L was assumed for precipitation based on information provided in Wehrman (1983). This value is considered to be conservative based on a review of literature reported values and/or the default values provided by other analytical methods (WDoH, 2017).

Precipitation Recharge and Infiltration Surface

The total area of the proposed subdivision is approximately 59 hectares (146.6 acres). The proposed drainage and stormwater management plan is to utilize existing natural depressions and/or manmade stormwater collection ponds for temporary containment of overland flow within each catchment area. It is understood that this water will not be directed offsite with the intent that it will infiltrate into the soils underlying the site. It is assumed that all rainwater collected from the eavestroughs would eventually be released and enter the groundwater zone minus any losses due to evapotranspiration. Therefore, the total area of the site was considered to provide precipitation recharge.

The total annual precipitation was assumed based on the average annual precipitation for Saskatoon, Saskatchewan (354 mm/year; Environment Canada, 2020).

It was assumed that only 15% of the total annual precipitation (53 mm/year) infiltrates into the groundwater zone due to evapotranspiration and runoff, which is close to the default infiltration rate for coarse grained soils (60 mm/year) suggested by AEP (2019) and default values provided by Wehrman (1983) and WDoH (2017).

6.5.3 WASTEWATER EFFLUENT

The mass of nitrate in the OWTS effluent was calculated as follows:

$$M_S = V_S C_S$$

$$V_S = PHQ_P A$$

Where:

C_S = the nitrate concentration in wastewater effluent from the OWTS (mg/L)

P = the number of people per household

H = the lot density

Q_P = the average per capita wastewater volume (L/day)

Wastewater Effluent Concentration

A range of nitrate concentrations were used (6 to 40 mg/L) to represent the wastewater effluent based on the types of advanced treatment systems that would potentially be specified for the site based on compatibility with site specific conditions (e.g., soil and groundwater conditions).

Wastewater Volumes

As shown on Drawing No. 12980-1, the proposed subdivision will have 47 lots each with their own OWTS. This will include 44 single family residential homes, a care home (existing), a senior citizen's centre, and a community centre.

Information provided in the GOS (2018) guidance document was used to determine the occupancy and expected sewage volume for each type of lot:

- **Single family residential home:** A value of 2 persons per bedroom are assumed for a 2-bedroom home and a value of 1.5 persons per bedroom for a 3-bedroom home. For this assessment it was assumed that each home would contain at least 3 bedrooms resulting in 4.5 persons per lot.
- **Care Home:** It is understood that the existing care home and associated OWTS has already been approved for a maximum capacity of 18 people.
- **Senior Citizens Centre:** It is understood that the proposed senior citizens centre will consist of 30 – one (1) bedroom residential units. This would result in 2 persons per unit for a total of 60 people.

- **Community Centre:** The expected facility type for the community centre was an assembly hall. For this assessment it was assumed that the maximum occupancy would be approximately 100 people, which would be sufficient seating for approximately half of the individuals residing within the single-family home (44 homes x 4.5 persons/home).

For the single-family residential homes, care centre, and the senior citizens centre the average per capita expected sewage volume provided in the GOS (2018) guidance document was used. Information provided by the GOS (2013) indicates it is acceptable to use the average per capita sewage volume when calculating the expected OWTS effluent volumes as part of a nitrate assessment. Similarly, other studies have shown that the use of the average per capita sewage volume, rather than the peak per capita wastewater volume, provides representative estimates of the nitrate loading from an OWTS (MEQ, 2009) as the peak per capita sewage volume is not typically sustained on a long-term basis. An average per capita wastewater volume of 227 litres/person/day was used in this assessment.

For the community centre the expected per capita expected sewage volume for an assembly hall of 10 L/per seat/day, as provided in Annex 1 of the GOS (2018) guidance document, was used.

6.5.4 WATER WELL PUMPING

As per the RM of Corman Park No. 344 bylaws, the installation of a groundwater well for potable water use is prohibited. The installation of many non-potable groundwater wells is not anticipated and as such, groundwater removal due to pumping was not considered in this assessment.

6.5.5 ASSESSMENT CRITERIA

As the proposed subdivision will be connected to a potable water distribution system, the groundwater below the site will not be used as a potable water source. The existing Wood Meadows subdivision (west of the site) and the proposed Edgemont Estates subdivision (north of the site) are and/or will be connected to a potable water distribution system, respectively. As these subdivisions do not utilize groundwater as a potable water source they should not be adversely impacted as a result of elevated nitrate concentrations in groundwater migrating from the proposed subdivision. As discussed above, the property located to the northwest of the site is being leased as farmland and the house in the northwest corner of this property was abandoned in 1990 and has been vacant since this time. If this property is redeveloped with a single-family home it is possible that a groundwater well could technically be installed on this property.

Site observations and a review of satellite imagery (Google, 2020) reveal that there are no apparent surface water bodies located immediately downgradient of the site. The closest surface water body is a slough located in the northeast corner of the site and is cross gradient to the apparent direction of groundwater flow. There is another surface water body located to the east and cross-gradient of the site. There is an apparent intermittent surface water body located in the northwest corner of SW-33-35-5 W3M, which is approximately 750 m northwest of the site.

In consideration of the above, the SKMoE (2020) referenced endpoint for protection of the potable groundwater pathway (10 mg/L) was utilized for assessment purposes.

6.5.6 SENSITIVITY ANALYSIS

A sensitivity analysis was completed for each analytical model to evaluate the effects of the range of site measured parameters and hydrogeological conditions on the estimated nitrate concentration and groundwater mounding height. The measured minimum and maximum hydraulic conductivity values (9×10^{-10} and 2×10^{-6} m/s), hydraulic gradient values (0.002 to 0.005 m/m), background nitrate concentration (4.14 to 8.25 mg/L), specific yield (0.1 to 0.2), and OWTS effluent nitrate concentrations (6 to 40 mg/L), were used in various combinations within the models. The median and mean effluent nitrate concentrations of 6 and 9 mg/L reported for the Bio-Microbics BioBarrier-N MBR package treatment system, were assigned for the advanced treatment systems that would be constructed adjacent to the property boundary. The median and mean effluent nitrate concentrations of 15.6 and 18.9 mg/L, reported for the Ecoflo Coco Filter ECDn Model package treatment system were assigned for the advanced treatment systems that would be constructed within the interior of the property.

Select parameters were not included in the sensitivity analysis as the assigned value was assumed to be conservative and representative of site conditions (background precipitation nitrate concentration), the reasoning has been well documented (sewage effluent volume), and or the values were fixed (total parcel size).

The results of the sensitivity analysis revealed that the simulated nitrate concentrations were not sensitive to the range of hydraulic conductivity and hydraulic gradients values used in the model as the volume of groundwater recharge was insignificant in comparison to the volume of OWTS effluent or precipitation. Since the volume of groundwater recharge is insignificant in comparison to the volume of OWTS effluent or precipitation, for the range of measured input values, the simulated nitrate concentration was also insensitive to changes in the background nitrate concentration.

Similarly, the simulated groundwater mounding height was relatively insensitive to changes in the groundwater recharge rate (vertical hydraulic conductivity). This is likely due to the fact even where a restrictive horizontal soil is encountered there is sufficient horizontal hydraulic conductivity that effluent would be able to flow laterally away the OWTS resulting in minimal groundwater mounding.

6.5.7 RESULTING NITRATE CONCENTRATION

The resulting nitrate concentration, predicted using the Wehrman (1983) mass balance nitrate dilution model, was simulated to be 9.2 mg/L. This would be the average concentration of nitrate in groundwater at the boundary of the site and is below the SKMoE (2020) referenced endpoint for protection of the potable groundwater pathway (10 mg/L). This value was computed assuming that all systems at the site had effluent nitrate concentrations of approximately 20 mg/L.

However, based on assessment of individual lots, adjacent to the property boundary (Section 6.5.8), it was determined that systems constructed adjacent to the property boundary would require further reduction in effluent quality to protect downgradient groundwater users and/or the environment. The cumulative nitrate assessment was redone using two different types of advanced treatment systems. For the OWTS systems constructed adjacent to the property boundary the effluent nitrate concentrations were varied from 6 to 9 mg/L, which represent the median and mean values reported for the Bio-Microbics BioBarrier-N MBR advanced packaged treatment system. For OWTS systems constructed at some distance from the property boundary the effluent nitrate concentrations were varied from 15.6 to 18.9 mg/L, which represent the median and mean values reported for the Ecoflo Coco Filter ECDn Model package treatment system. The distance to the property boundary was determined using an iterative approach (Section 6.5.8).

The simulated average nitrate concentrations across the property using this approach was determined to range from 4.3 to 5.4 mg/L.

6.5.8 LATERAL NITRATE MIGRATION

The Washington State Department of Health (WDoH, 2017) nitrate dilution model was used to assess potential impacts resulting from theoretical nitrate plumes emanating from individual OWTS systems located on the site.

The WDoH (2017) model also utilizes a mass balance approach but assumes that groundwater recharge only occurs over the area directly below the OWTS. Similarly, the model assumes that precipitation recharge only occurs over an area as wide as the OWTS.

For the model, it was assumed that the nitrate concentration of groundwater recharge below any of the properties located along the property boundary would be equal to the average nitrate concentration determined from a cumulative nitrate assessment of all the properties located within the interior of the subdivision. The simulated cumulative nitrate concentration for all the properties located in the interior of the subdivision ranged from 7 to 8.2 mg/L. To be conservative a nitrate concentration of 8.25 mg/L, which is equal to twice the maximum measured nitrate concentration in groundwater at the site (4.14 mg/L), was also applied to account for potential future residential development in the area.

For this assessment it was assumed that the area of the soil treatment system would be approximately 30 m wide by 10 m long. The remaining parameters applied in the WDoH (2017) model were the same as those used in the Wehrman (1983) model as described above.

An iterative modeling approach was used to determine the distance at which the systems with the higher nitrate concentration range (15.6 to 18.9 mg/L) could be constructed that would not be expected to result in an exceedance of the referenced endpoints at the property boundary for the site. It was determined that at a distance of approximately 220 m from the property boundary an OWTS that released effluent containing nitrate concentrations as high as 18.9 mg/L would not result in a nitrate concentration at the site boundary exceeding 10 mg/L.

In other words, a setback distance of at least 220 m is required for the use of an OWTS that is capable of reducing the average effluent nitrate concentrations to below 18.9 mg/L. All OWTS constructed closer than this setback distance must be capable of reducing the average effluent nitrate concentration to less than 9 mg/L.

Example calculations for select scenarios of the WDoH (2017) model results are presented in Appendix F.

6.6 GROUNDWATER MOUNDING

An assessment of groundwater mounding was completed using the USGS (2010) Microsoft Excel worksheet that is based on the analytical solution developed by Hantush (1967). The analytical solution requires knowledge of select site and system parameters (e.g., vertical and horizontal hydraulic conductivity, system size, hydrogeological conditions, etc.). The applicable site measured parameters and hydrogeological conditions were varied in the analytical solution to evaluate the potential range of groundwater mounding that may be experienced. Various combinations of the minimum (clay), maximum (sand), and geometric mean hydraulic conductivity values were input for the recharge rate and horizontal hydraulic conductivity in the analytical solution.

In accordance with USGS (2010) guidance, the measured hydraulic conductivity values used for the recharge rate were divided in half as a factor of safety. Specific yields of 0.1 and 0.2 were assumed for the clay and sand materials, respectively (Sanders, 1998). The septic field was assumed to be approximately 30 long by 10 m wide and the peak daily sewage volume (340 L/person/day x 4.5 persons = 1,530 L/day) was applied to the soil treatment system to be conservative.

The simulated groundwater mounding below the OWTS, for the scenarios analyzed, ranged from 0.039 to 0.84 m with average and median values of 0.042 and 0.045 m, respectively. The relatively small mounding height appears to be reasonable based on the predominant soil types (sand) and is similar to the average mounding values estimated by SNC (2017) for the proposed Edgemont Estates subdivision.

6.7 GROUNDWATER MONITORING

The use of advanced packaged treatment systems as specified in this report, should provide adequate protection of downgradient groundwater users and/or the environment. As such it should not be necessary to monitor groundwater quality downgradient of the site.

7 OWTS FEASIBILITY

Based on the results of this assessment and information provided in the by Imagine Wastewater Management Evaluation report (Appendix A), there is sufficient physical evidence illustrating that each lot has adequate area, soil consistency, and vertical separation (vadose zone) to accommodate the use of OWTS for management/treatment of sanitary waste generated at the site.

However, based on the results of the cumulative nitrate assessment, conducted as part of this hydrogeological investigation, advanced package treatment systems (e.g., treatment plant coupled with a standard soil treatment system) will be required to ensure that the effluent quality entering the receiving environment will not adversely impact downstream groundwater users and/or the environment.

It was determined that if advanced package treatment systems, that could reduce the effluent nitrate concentrations to less than 20 mg/L, were used on each lot, the aggregate nitrate concentration released by all the lots in the subdivision would be less than 10 mg/L. However, additional assessment revealed that the nitrate plume emanating from a system with an effluent nitrate concentration of 20 mg/L would require approximately 220 m to be diluted below 10 mg/L. As such the maximum effluent nitrate concentration released from an OWTS within 220 m of a property boundary must be less than 10 mg/L. If two (2) different advanced treatment systems are utilized (i.e., effluent nitrate concentration of less than 20 mg/L for distance > 220 m from boundary and effluent nitrate concentration less than 10 mg/L for distance < 200 m from property boundary), the resulting average nitrate concentration across the is expected to range from 4.3 to 5.4 mg/L.

The following advanced package treatment system types/specifications will be required based on lot location within the proposed Ravenswood subdivision:

- **Lots where the OWTS would be constructed within 220 m of the property boundary:** an advanced package treatment system meeting or exceeding NSF-40, NSF245, and NSF-350 standards (Bio-Microbics BioBarrier-N MBR or equivalent) with an average effluent nitrate concentration of less than or equal to 9 mg/L.
- **Lots where the OWTS would be constructed greater than 220 m from the property boundary:** an advanced package treatment system meeting or exceeding NSF-40 and NSF-245 standards (e.g., Ecoflo Coco Filter ECDn Model or equivalent) with an average effluent nitrate concentration of less than or equal to 18.9 mg/L.

7.1 SOIL TREATMENT SYSTEM/OWTS TYPES AND LOCATIONS

The results of the field investigation, soil classification, and a detailed site assessment conducted by Imagine (Appendix A) revealed that the following types of soil treatment systems/OWTS types would be well suited based on the soil conditions and hydrogeological conditions at the site:

- holding tanks
- pressurized treatment field
- pressurized raised treatment field
- pressurized type II mound
- advanced enviro-septic field
- advanced enviro septic mound

In accordance with the GOS (2018) guidance the following OWTS would not be suitable OWTS at the site:

- Lagoons are not acceptable as all the lots are smaller than 4 hectares.
- Jets and Type 1 mounds are not acceptable as the proposed subdivision is high density and is considered a sensitive area.

The type of soil treatment system selected for any individual lot will be based on the soil and hydrogeological conditions encountered at the location where the system is to be installed.

Based on the results of this assessment there is more than adequate area (including reserve area) with suitable soil and hydrogeological conditions for the construction of an OWTS on each of the proposed lots. Therefore, specific locations for OWTS placement, or reserve areas, were not specified as part of this investigation. This is preferable as it provides the future landowner with some degree of design and architectural flexibility.

In accordance with Government of Saskatchewan regulations and/or bylaws a detailed soils assessment will be necessary for each individual lot where an OWTS system will be installed. The detailed soils assessment will be conducted where the OWTS is proposed and will need to be completed prior to obtaining a final building permit.

7.2 SOIL CONSISTENCY

Based on the results of this assessment, the soils at the site were classified as predominantly loam, sandy loam, or silty loam and would be suitable for one or more of the soil treatment systems specified above. Soil samples collected from only two of the test holes (17-6 and 17-7) and one of test pit (20-1) were classified as silty clay loam or silty clay which are considered suitable for an OWTS.

Test hole 17-7 and test pit 20-1 are located in a low-lying area on the same lot (Lot 2 Block 2) approximately 50 m apart. Lot 2 is a relatively large lot with an area greater than 3 acres (1.2 hectares). Soil samples collected from a second test pit (20-2) excavated at a higher elevation on the same lot were classified as primarily sandy loam and would be suitable for one or more of the specified soil treatment systems. Test pit 20-3 was excavated approximately 100 m from test hole 20-6 to determine if there were soils suitable for an OWTS in this area. The soil samples collected from test pit 20-3 were classified primarily as sandy loam and would be also be suitable for one or more of the specified soil treatment systems. As such there are sufficient areas across the site where the soil consistency is suitable for the use of an OWTS.

7.3 VERTICAL SEPARATION DISTANCE (VADOSE ZONE)

The GOS (2012) recommends that a minimum vadose zone, from the bottom of the infiltrative surfaces (i.e., bottom of dispersal trench) to the surface of the water table or restrictive layer be a depth of 1.5 m for primary effluent and 0.9 m for secondary treated effluent.

The groundwater depth in the monitoring wells at the site was measured three times between May 5, 2017 and July 20, 2020.

The groundwater depth in the shallow soils ranged from 1.5 mbg to 5.8 mbg. The minimum value of 1.5 mbg was measured at only a single monitoring well (17-7) and only during the June 5, 2017 monitoring event. The depth to the groundwater table at this monitoring well had decreased to 1.9 mbg during the July 20, 2020 monitoring event. Except for this monitoring well the groundwater depth in the remaining wells, during every monitoring event, exceeded 2.0 mbg with an average groundwater depth of 4.1 mbg. Monitoring Well 17-7 is located in a natural depression along the east side of the property, which is part of the natural surface water drainage course at the site. There is adequate space at higher elevation on the same lot where monitoring well 17-7 is located with presumably a greater depth to the groundwater table.

Most of the calculated vadose zone depths, that would be required to achieve the recommended pathogen removal rate (60 day retention time) based on the measured hydraulic conductivity values, were less than the minimum vadose zone depth (1.5 m) required by the GOS (2012). The calculated vadose zone depths were determined using the field measured hydraulic conductivity values, which are typically more representative of the horizontal hydraulic conductivity. The vertical hydraulic conductivity is typically one (1) to two (2) orders of magnitude lower and therefore, the expected effluent infiltration rate would be slower and less vadose zone depth would be required to achieve the recommended retention time and associated pathogen removal rate.

Therefore, the depth to the uppermost groundwater table at the site is expected to be sufficiently deep to provide adequate unsaturated soil (vadose zone) below the soil treatment systems. In addition, since each OWTS will require some level of advanced treatment the OWTS effluent is classified as secondary treated effluent. As such, the required vertical separation can be reduced from 1.5 to 0.9 m below the infiltration surface.

In the Imagine assessment report it was also concluded, based on the results of their site assessment, that there was sufficient vertical separation (vadose zone) to support the use of OWTS at the site on all the proposed lots.

7.4 DRAINAGE CONSIDERATIONS

A revised Drainage and Stormwater Management Report was completed by WSP for the proposed Ravenswood subdivision. Further adjustments to the values and assumptions used in the WSP (2020) drainage and stormwater management design were provided by AE (2020). The AE (2020) technical memorandum and the WSP (2020) report are provided in Appendix B.

WSP evaluated the existing site topography to determine predevelopment drainage patterns across the site. This information was used to assist with the design of a surface drainage and stormwater management system that maximized use of natural drainage patterns and depressions within each catchment area. The drainage and stormwater management system was designed to contain a 1:100 year storm event. The outcome of the drainage and stormwater system designs was the use of natural depressions that would be enlarged (size and depth) for use as stormwater ponds. The size and the depth of the stormwater ponds were designed to contain the expected water volume during the 1:100 year storm event from the associated catchment areas.

These stormwater ponds would be designated as Municipal Utilities. As public land, development in these areas would be prohibited.

The proposed subdivision layout was designed to optimize natural low-lying areas for common storage as a means of mimicking the natural drainage system and reducing substantial alteration of the landscape. The stormwater ponds were designed with the assumption that all natural depressions situated within private properties could be potentially filled in by the owner during lot development thus eliminating these as potential storage areas. Since the major natural depressions across the site were selected for the construction of the stormwater ponds and the site is expected to utilize natural drainage courses where possible, it is expected that overland flow will continue to migrate towards these stormwater catchment ponds post development.

As part of the drainage and stormwater management design process, minimum building elevations were determined for each proposed lot based upon their elevation relative to the high-water level of each of the ponds plus an additional 0.5 m of freeboard as an additional factors of safety. The AE (2020) report confirmed that each proposed lot has sufficient area above the minimum building elevation to accommodate housing construction. It is recommended and typical that the OWTS for each home is situated nearby the residence within the area deemed to be suitable for housing construction based upon the application of the minimum building elevation.

7.5 SETBACKS AND RESERVE AREA

Based on the current development plan there is adequate space on each lot for the construction of an OWTS (including reserve area) whilst maintaining the required setback distances to potential site infrastructure (e.g., basement/building, walkways, etc.), property boundaries, and water courses. There will be not be any potable groundwater sources located on the site.

For illustrative purposes, the available reserve area for the smallest lot on the proposed subdivision was estimated. This calculation takes into consideration the required setback distances from the property boundaries where an OWTS is prohibited and the area occupied by a typical home, outbuilding, driveway, and the OWTS itself.

- The smallest lot (Lot 23 Block 1) within the proposed subdivision is approximately 0.52 hectares (1.28 acres) or 5,180 m² and has an approximate width of 51 m and a length of 102 m.
- Applying setback distances of 8, 10, and 3 m for the front, back, and side yards, respectively the area occupied by the setback is approximately 1,420 m². For this calculation it is assumed that an OWTS cannot be constructed within these areas. As per the GOS (2018) guidance document the required setback from the property boundary is 3 m for a package treatment system. As such the applied setback area is conservative and should be sufficient to account for other site infrastructure (e.g., building, walk/driveway, etc.).

- A developed area of 1,300 m² was used to represent the area occupied by a typical home (400 m²), outbuilding (300 m²), and driveway (600 m²) as per the assumptions used in the WSP Drainage and Stormwater Management Report.
- The OWTS was assumed to be approximately 300 m² (10 x 30 m).

$$\text{Reserve Area} = \text{Lot size} - \text{setback area} - \text{developed area} - \text{OWTS area}$$

$$\text{Reserve Area} = 5,180\text{m}^2 - 1,410\text{m}^2 - 1,300\text{m}^2 - 300\text{m}^2$$

$$\text{Reserve Area} = 2,160\text{m}^2$$

The calculated reserve area for the smallest lot is more than sufficient to support the construction of a replacement OWTS. As such each lot within the proposed subdivision will have more than adequate reserve area for the construction of a replacement OWTS.

7.6 TOPOGRAPHIC CONSTRAINTS

From field observations and a review of information provided in the drainage and stormwater management (Appendix B) and the wastewater management evaluation (Appendix A) reports there are no topographic features (e.g., cuts, banks, slopes, landscaping, etc.) that would make any lot unsuitable for the construction of an OWTS. As the site is naturally rolling and is not intended to have any significant cuts, slopes, or banks there does not appear to be any slope stability concerns related to the construction of an OWTS anywhere on the site.

However, no OWTS systems should be built within any natural surface water drainage pathways and/or in close proximity to natural or manmade stormwater catchment ponds.

7.7 INDICATIONS OF WET/POOR SOIL CONDITIONS

Based on observations made during the field investigation and as indicated in the Imagine Assessment Report, there appeared to be minimal vegetation at the site that was indicative of wet or poor soil conditions. The only location containing vegetation indicative of wet or poor soil conditions (maple and birch trees) was along the east side of the property proximate monitoring well 17-7, which has already been identified as an unsuitable location for an OWTS. There is adequate space at higher elevation on the same lot.

There were no other indicators (e.g., surface precipitates, desiccation, etc.) of wet or poor soil conditions present at the site.

8 RECOMMENDATIONS

The following recommendations are provided based on the results of this assessment:

- The use of onsite wastewater treatment systems (OWTS) are well suited to manage sanitary sewage generated at the site.
- Two (2) types of advanced package treatment systems will be required at the site to ensure protection of downgradient groundwater users and/or the environment:

- **Lots where the OWTS would be constructed within 220 m of the property boundary:** an advanced package treatment system meeting or exceeding NSF-40, NSF245, and NSF-350 standards (Bio-Microbics BioBarrier-N MBR or equivalent) with an average effluent nitrate concentration of less than or equal to 9 mg/L.
- **Lots where the OWTS would be constructed greater than 220 m from the property boundary:** an advanced package treatment system meeting or exceeding NSF-40 and NSF-245 standards (e.g., Ecoflo Coco Filter ECDn Model or equivalent) with an average effluent nitrate concentration of less than or equal to 18.9 mg/L

It is recommended that the type of advanced treatment system required for each lot be specified in each purchase agreement.

- One or more of the following soil treatment systems/OWTS types were determined to be suitable based on the soil and hydrogeological conditions at the site:
 - holding tanks
 - pressurized treatment field
 - pressurized raised treatment field
 - pressurized type II mound
 - advanced enviro-septic field
 - advanced enviro septic mound

In accordance with the GOS (2018) guidance the following OWTS would not be suitable OWTS at the site:

- Lagoons are not acceptable as all the lots are smaller than 4 hectares.
- Jets and Type 1 mounds are not acceptable as the proposed subdivision is high density and is considered a sensitive area.

Prior to receiving approval of the building permit, a detailed soils assessment will be required for each individual lot to confirm the soil and groundwater conditions for selection and design of an appropriate soil treatment system. The detailed soils assessment and system installation should be conducted by a certified septic system contractor or qualified professional. As outlined by the GOS (2018), details regarding system operation and maintenance must be supplied to the homeowner by the permit applicant.

- System maintenance should be conducted by a certified septic system contractor and conducted at the frequency recommend by the system manufacturer.

9 LIMITATIONS

The hydrogeological investigation has been completed as authorized. Thirteen, 150 mm diameter test holes were dry drilled using our continuous flight auger drill rig. Field drill logs were compiled for the test holes during test drilling which, we believe, were representative of the subsurface conditions at the test hole locations at the time of test drilling.

Variations in the subsurface conditions from that shown on the drill logs at locations other than the exact Test Hole locations should be anticipated. If conditions should differ from those reported here, then we should be notified immediately in order that we may examine the conditions in the field and reassess our recommendations in the light of any new findings.

No identifiable evidence (e.g., odours, visual observations, etc.) of environmentally sensitive materials was detected during the actual time of the field test drilling program. If, on the basis of any knowledge, other than that formally communicated to us, there is reason to suspect that environmentally sensitive materials may exist, then additional test holes should be drilled and samples recovered for chemical analysis.

The subsurface investigation necessitated the drilling of deep test holes. The test holes were backfilled at the completion of test drilling. Please be advised that some settlement of the backfill materials will occur which may leave a depression or an open hole. It is the responsibility of the client to inspect the site and backfill, as required, to ensure that the ground surface at each Test Hole location is maintained level with the existing grade.

This report has been prepared for the exclusive use of Mr. Larry Grozell and his agents for specific application to the proposed Rural Subdivision to be constructed within NE-28-35-5-W3M near Saskatoon, Saskatchewan. It has been prepared in accordance with generally accepted geotechnical engineering practices and no other warranty, express or implied, is made.

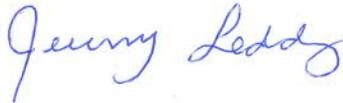
Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, is the responsibility of such Third Party. Governing Agencies such as municipal, provincial or federal agencies having jurisdiction with respect to this development and/or construction of the facilities described herein have full jurisdiction with respect to the described development. Any other unspecified subsequent development would be considered Third Party and would, therefore, require prior review by PMEL. PMEL accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

The acceptance of responsibility for the design/construction recommendations presented in this report is contingent on adequate and/or full time inspection (as required, based on site conditions at the time of construction) by a representative of the Geoenvironmental Consultant. PMEL will not accept any responsibility on this project for any unsatisfactory performance if adequate and/or full time inspection is not performed by a representative of PMEL.

If this report has been transmitted electronically, it has been secured with personal passwords to lock the document. Due to the possibility of digital modification, only originally signed reports and those reports sent directly by PMEL can be relied upon without fault.

We trust that this report fulfills your requirements for this project. Should you require additional information, please contact us.

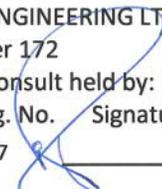
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Jeremy Ledding, P.Eng., M.Sc.



Ray Machibroda, P. Eng., M.Sc.

Association of Professional Engineers & Geoscientists of Saskatchewan CERTIFICATE OF AUTHORIZATION P. MACHIBRODA ENGINEERING LTD. Number 172 Permission to Consult held by: Discipline Sk. Reg. No. Signature Geoenvironmental 6687 		
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DRAWINGS



NOTE:

1. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.
2. THIS DRAWING WAS COMPILED FROM GOOGLE EARTH PRO ©2017, IMAGE ©2017 DIGITALGLOBE, (IMAGERY DATE: 8/23/15).
3. THIS DRAWING WAS COMPILED FROM APPROXIMATE LOCATES OF TEST PITS PROVIDED BY IMAGINE CONTRACTING INC.

LEGEND



-PMEL TEST HOLE



-PMEL TEST HOLE (MONITORING WELL INSTALLED)



-PMEL PIEZOCONE PENETRATION TEST (PMEL REPORT No. 12983)



CONSULTING
GEOENVIRONMENTAL
GEOTECHNICAL
ENGINEERS

**P. MACHIBRODA
ENGINEERING LTD.**

806 - 48th STREET EAST
SASKATOON, SK
S7K 3Y4

DRAWING TITLE:

SITE PLAN - TEST HOLE AND PIEZOCONE LOCATIONS

PROJECT:

PROPOSED RURAL SUBDIVISION
NE-28-35-5-W3M, NEAR SASKATOON, SK

APPROVED BY:

JL

DRAWN BY:

TP

DRAWING NUMBER:

12980-1

DATE:

DECEMBER, 2020

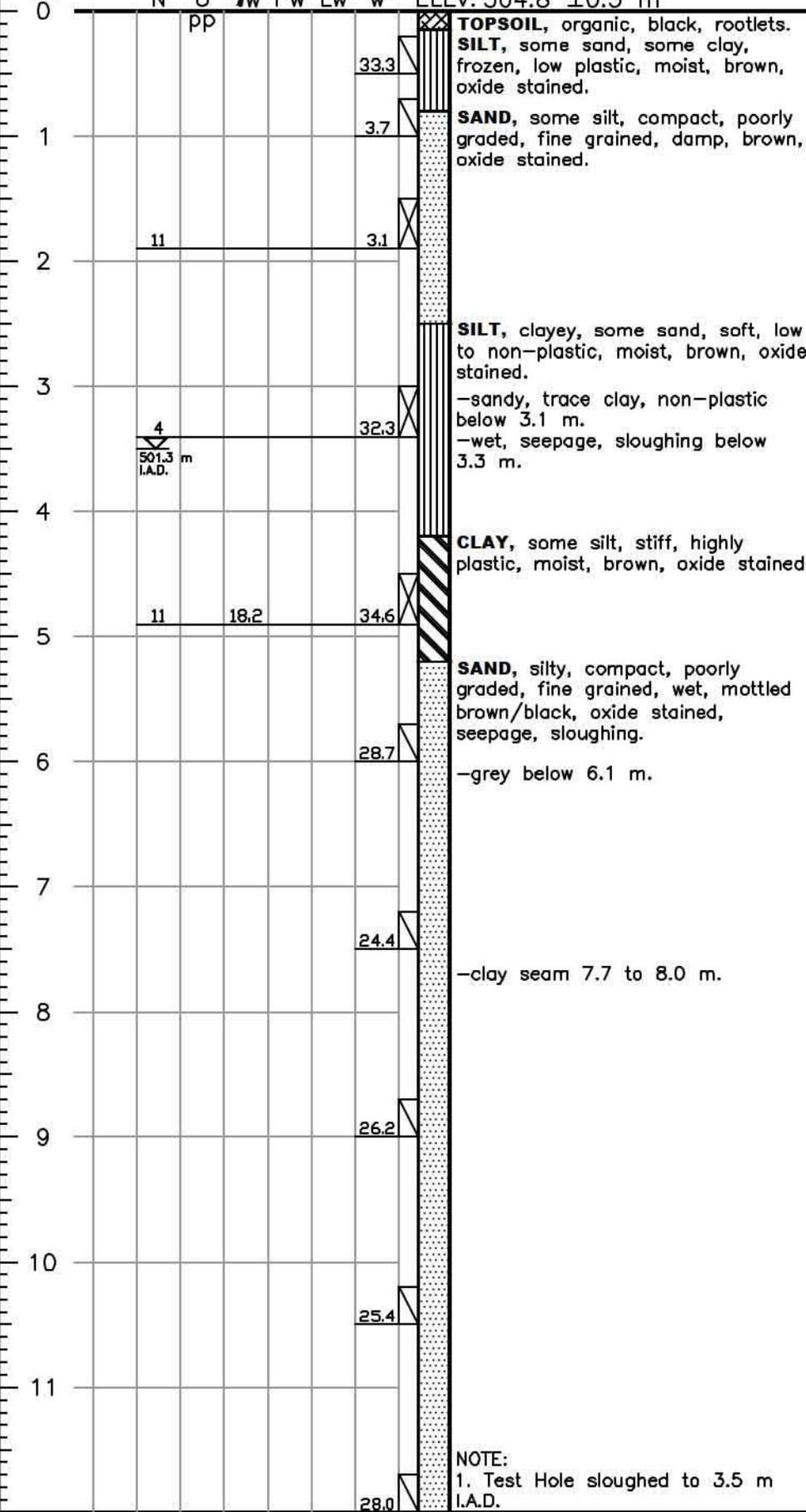
SCALE:

NOT TO SCALE

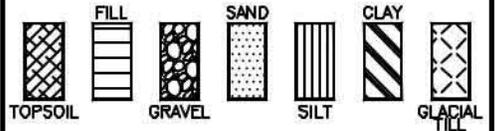
PIEZO. ELEV.= 505.8 ±0.5 m

TEST HOLE 17-1

DEPTH (m)



LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- L_w...LIQUID LIMIT
- P_w...PLASTIC LIMIT
- γ_w...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm.]
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▲...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊗ SPLIT SPOON
- ▤ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

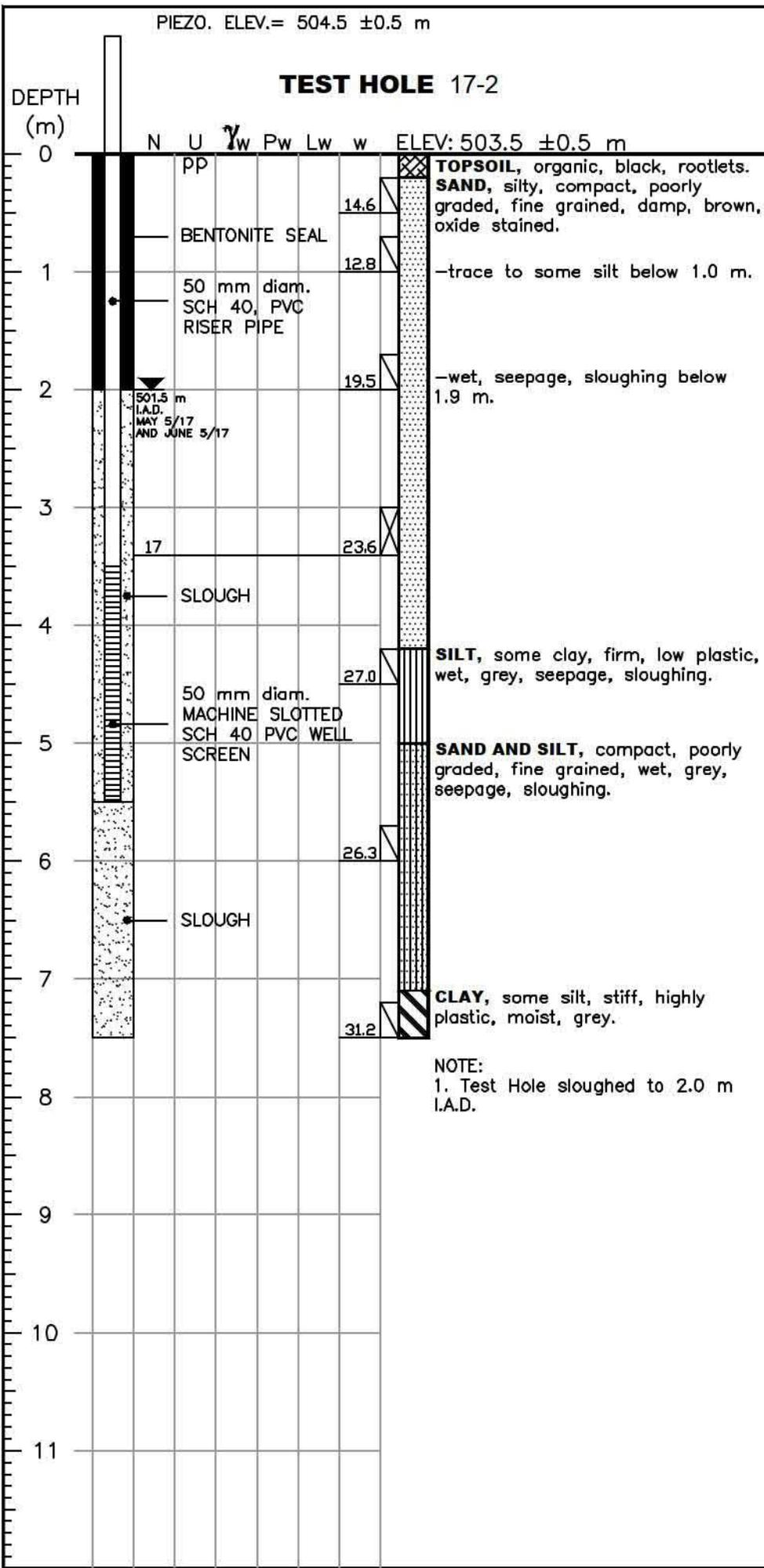


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FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT: PROPOSED RURAL SUBDIVISION	
LOCATION: NE-28-35-5-W3M, NEAR SASKATOON, SK	
NORTHING: 5766908 EASTING: 386322	
DATE DRILLED: APR 28/17	DRAWING NUMBER: 12980-2

NOTE:
1. Test Hole sloughed to 3.5 m I.A.D.



LEGEND:

TOPSOIL	FILL	GRAVEL	SAND	SILT	CLAY	GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
 L_w ...LIQUID LIMIT
 P_w ...PLASTIC LIMIT
 γ_w ...WET UNIT WEIGHT (kN/m³)
U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
pp...POCKET PENETROMETER (kg/cm²)
N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
P200...% PASSING No. 200 SIEVE
I.A.D.....IMMEDIATELY AFTER DRILLING
...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE	SPLIT SPOON	CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

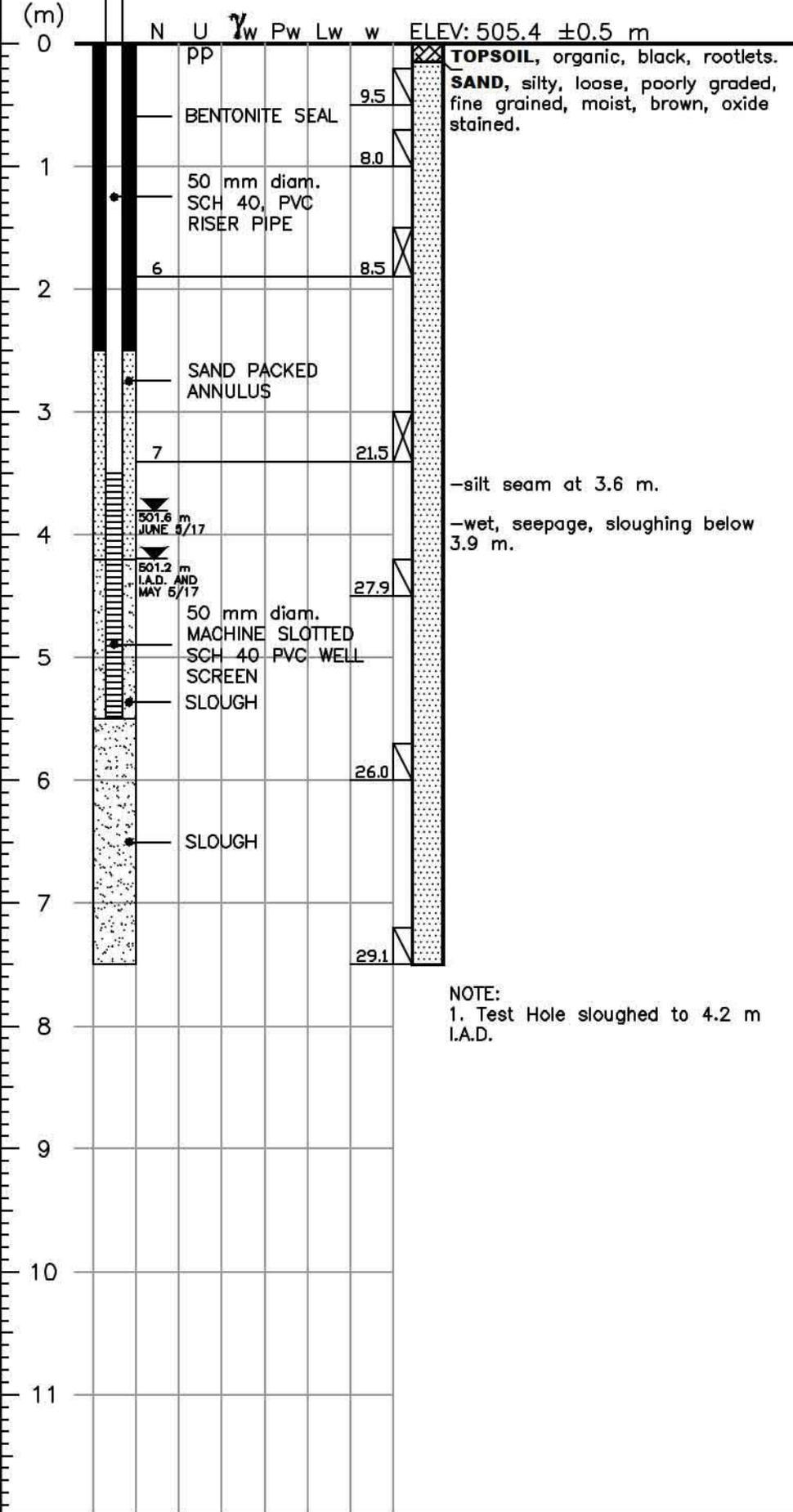
NORTHING: 5766845 **EASTING:** 386547

DATE DRILLED: APR 28/17	DRAWING NUMBER: 12980-3
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PIEZO. ELEV.= 506.5 ±0.5 m

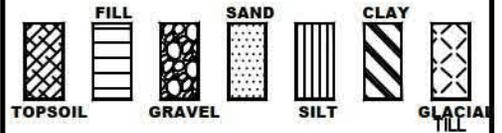
TEST HOLE 17-3

DEPTH (m)



NOTE:
1. Test Hole sloughed to 4.2 m I.A.D.

LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γw...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)



LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

PROJECT:

PROPOSED RURAL SUBDIVISION

LOCATION:

NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766909 **EASTING:** 386786

DATE DRILLED:
APR 27/17

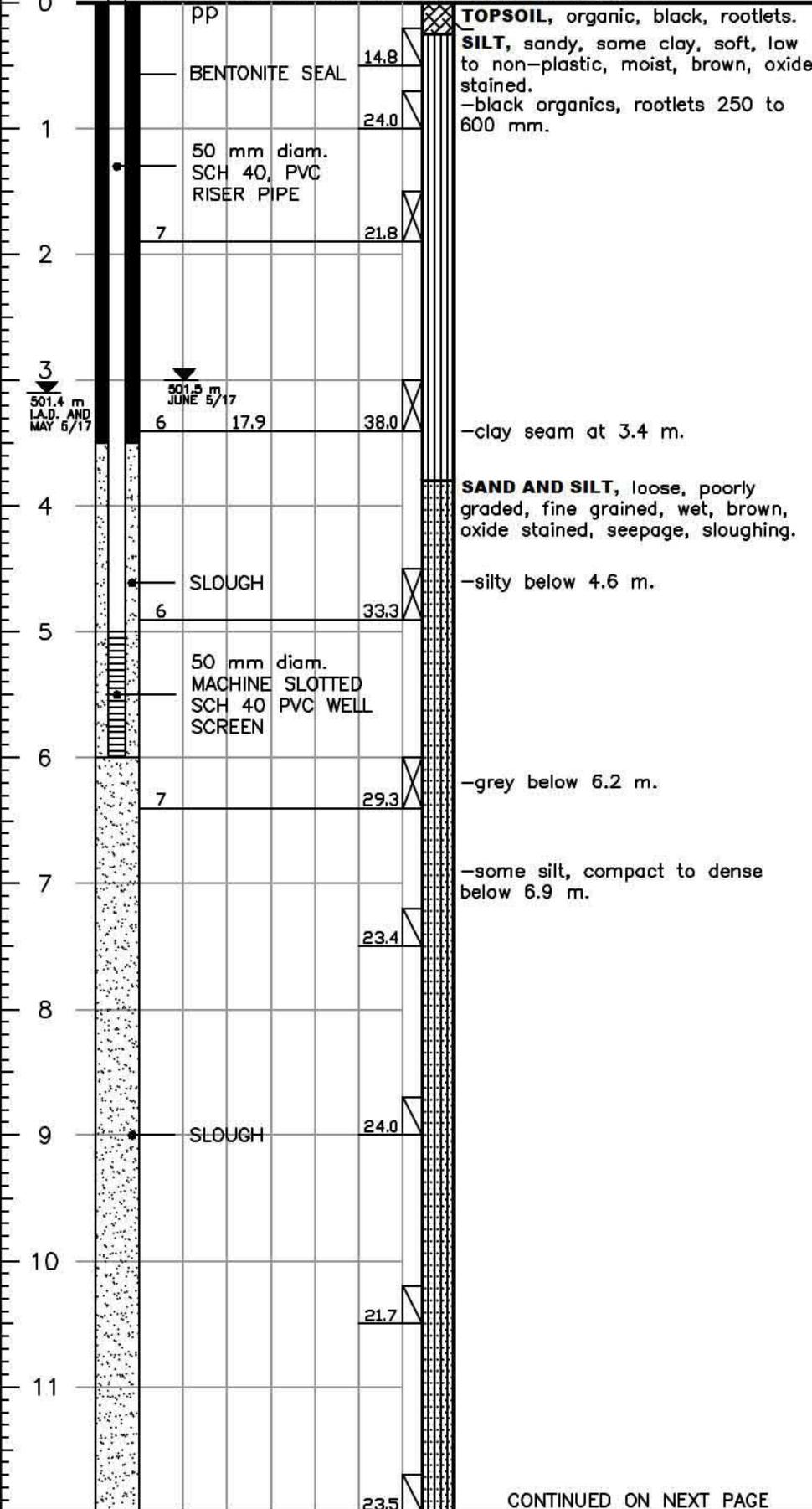
DRAWING NUMBER:
12980-4

PIEZO. ELEV.= 505.7 ±0.5 m

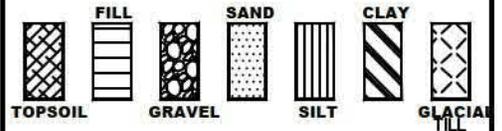
TEST HOLE 17-4

DEPTH (m)

N U γ_w Pw Lw w ELEV: 504.5 ±0.5 m



LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ∇...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- ◻ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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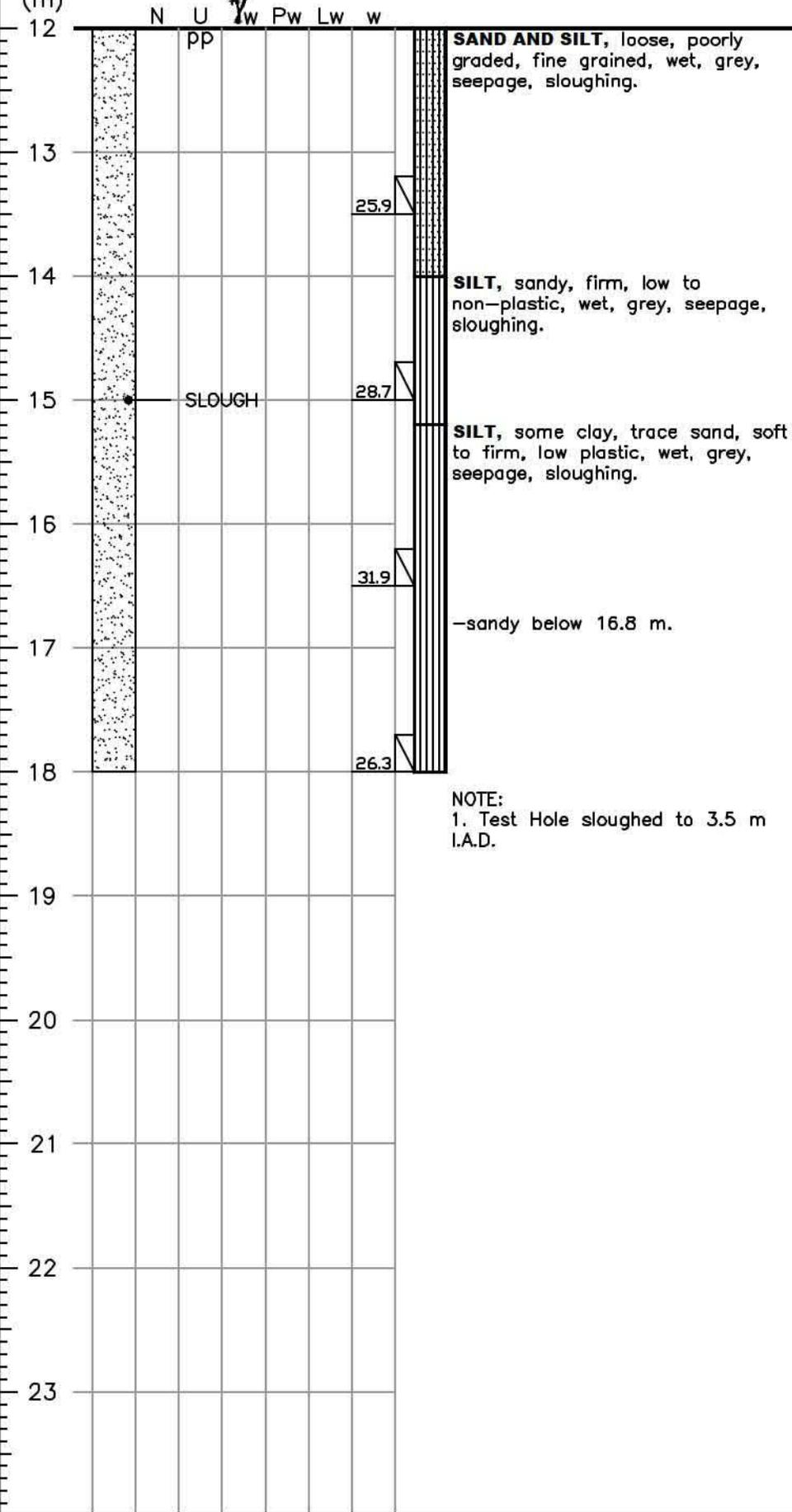
FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT: PROPOSED RURAL SUBDIVISION	
LOCATION: NE-28-35-5-W3M, NEAR SASKATOON, SK	
NORTHING: 5766618 EASTING: 386657	
DATE DRILLED: APR 27/17	DRAWING NUMBER: 12980-5

CONTINUED ON NEXT PAGE

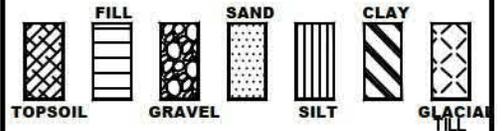
TEST HOLE 17-4

DEPTH
(m)



NOTE:
1. Test Hole sloughed to 3.5 m I.A.D.

LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ∇...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- ◻ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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LTD.**

**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

PROJECT:

PROPOSED RURAL SUBDIVISION

LOCATION:

NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766618 **EASTING:** 386657

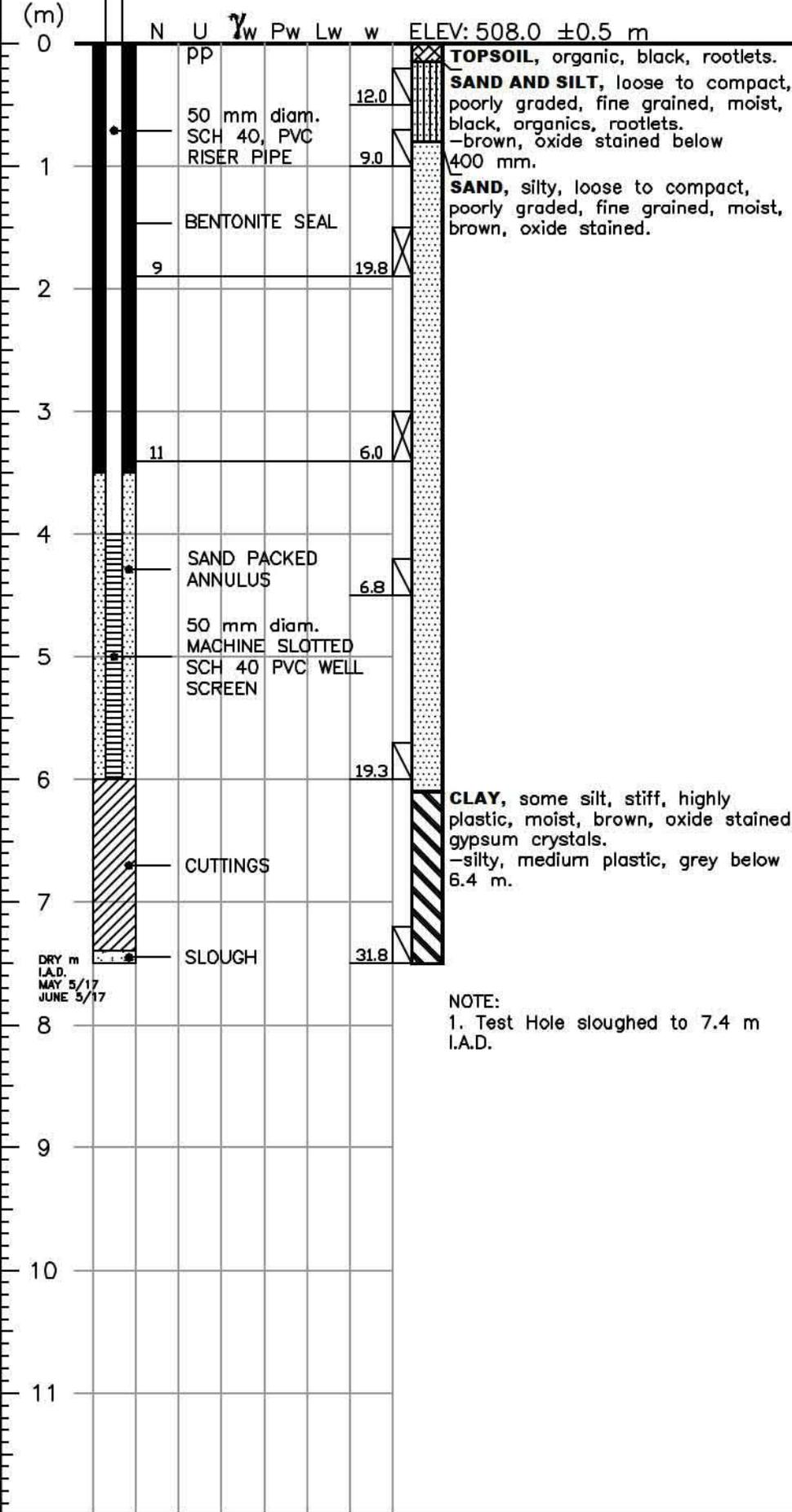
DATE DRILLED:
APR 27/17

DRAWING NUMBER:
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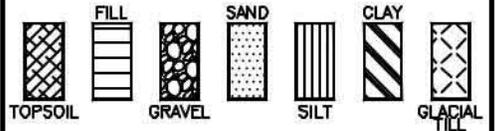
PIEZO. ELEV.= 509.1 ±0.5 m

TEST HOLE 17-5

DEPTH (m)



LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ∇...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)



LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

DRY m I.A.D. MAY 5/17 JUNE 5/17

NOTE:
1. Test Hole sloughed to 7.4 m I.A.D.



**P. MACHIBRODA
ENGINEERING
LTD.**

**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

PROJECT:

PROPOSED RURAL SUBDIVISION

LOCATION:

NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766447 **EASTING:** 386413

DATE DRILLED:

APR 2617

DRAWING NUMBER:

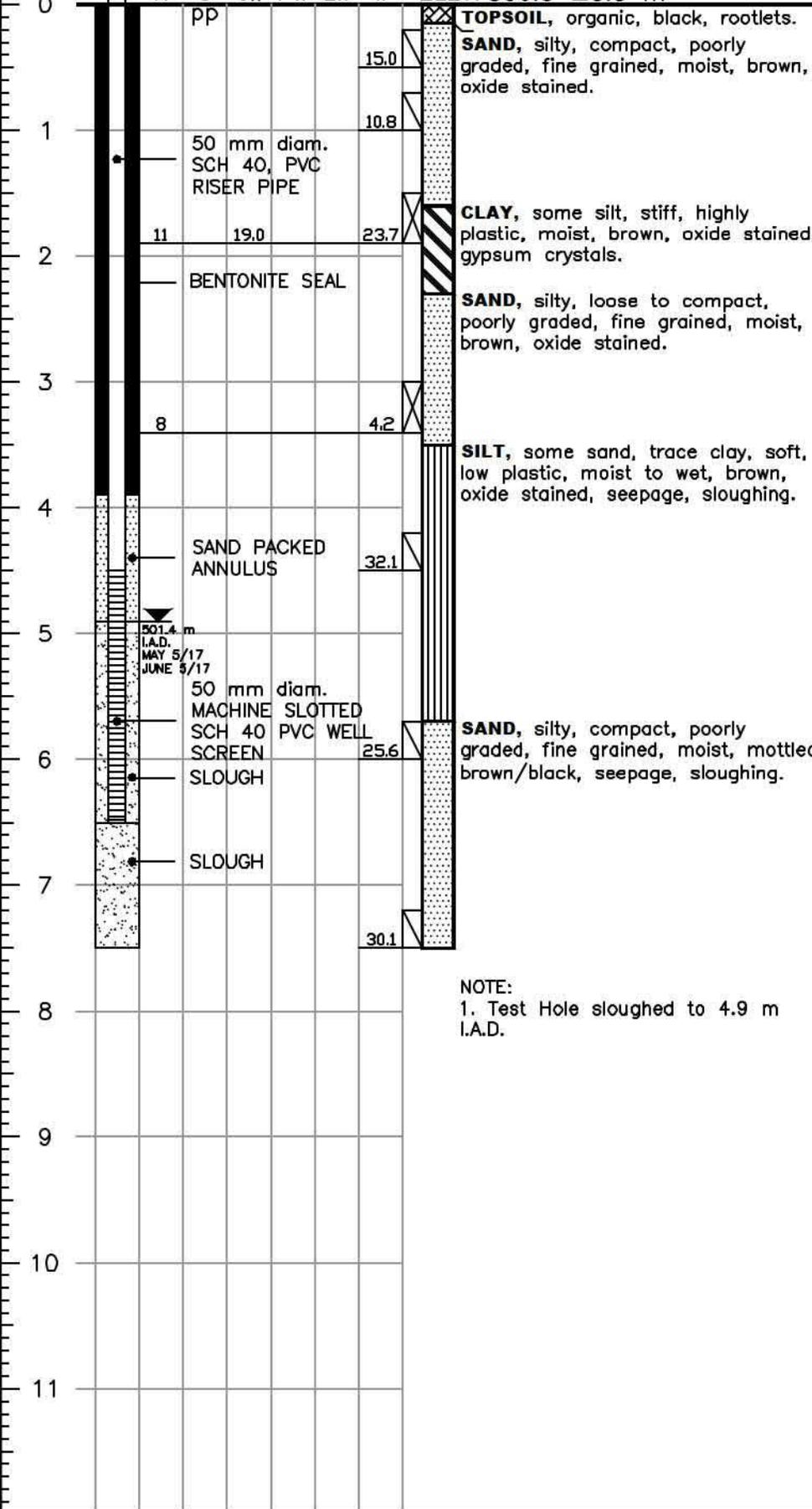
12980-6

PIEZO. ELEV.= 507.3 ±0.5 m

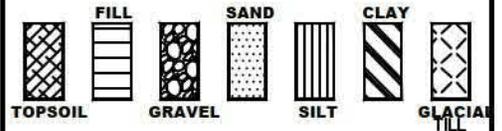
TEST HOLE 17-6

DEPTH (m)

N U γ_w Pw Lw w ELEV: 506.3 ±0.5 m



LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ∇...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- ◻ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



**P. MACHIBRODA
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LTD.**

**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

PROJECT:

PROPOSED RURAL SUBDIVISION

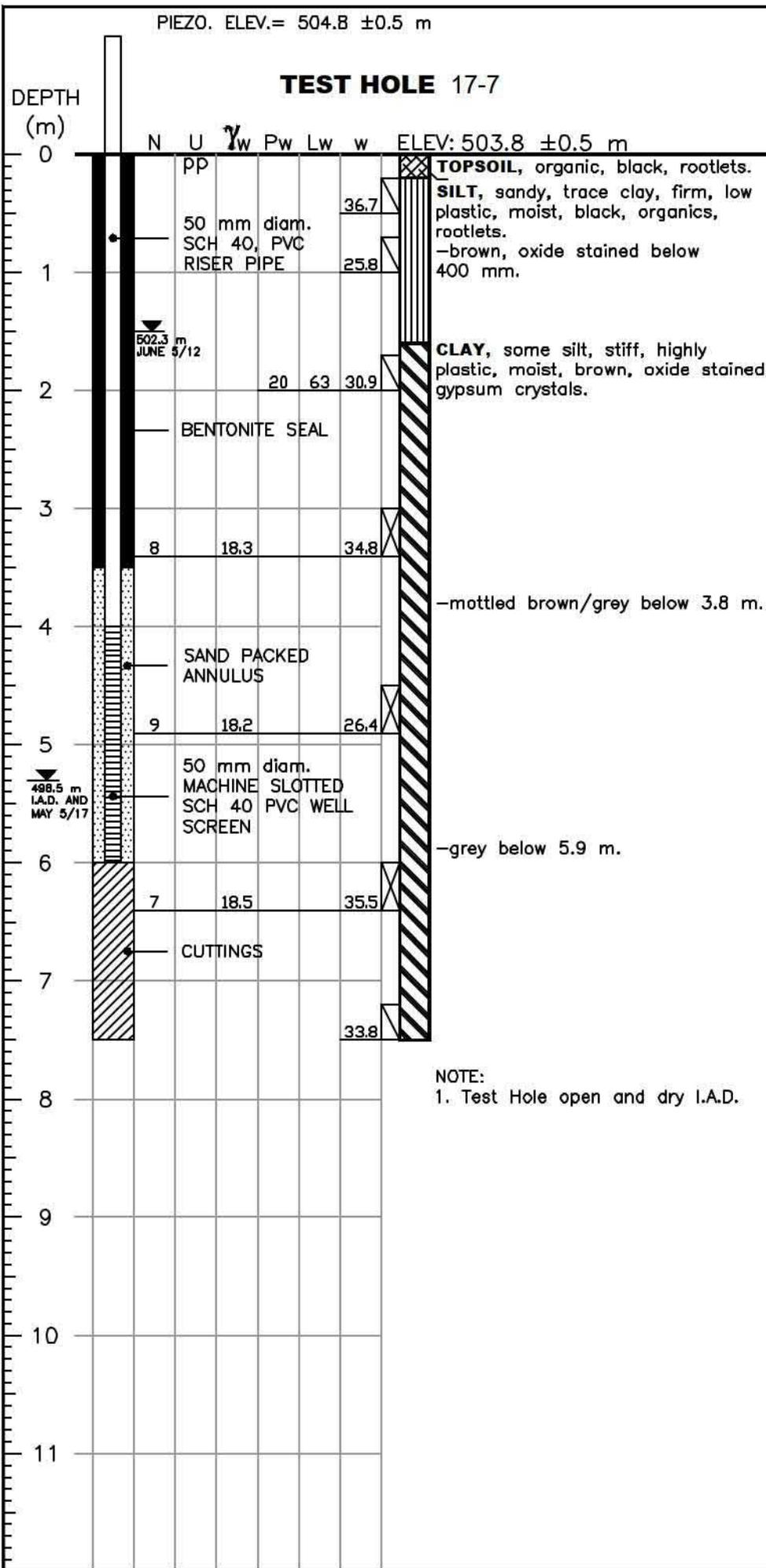
LOCATION:

NE-28-35-5-W3M,
NEAR SASKATOON, SK

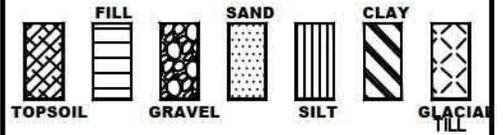
NORTHING: 5766458 **EASTING:** 386685

DATE DRILLED:
APR 26/17

DRAWING NUMBER:
12980-7



LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- L_w...LIQUID LIMIT
- P_w...PLASTIC LIMIT
- γ_w...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE ⊠ SPLIT SPOON □ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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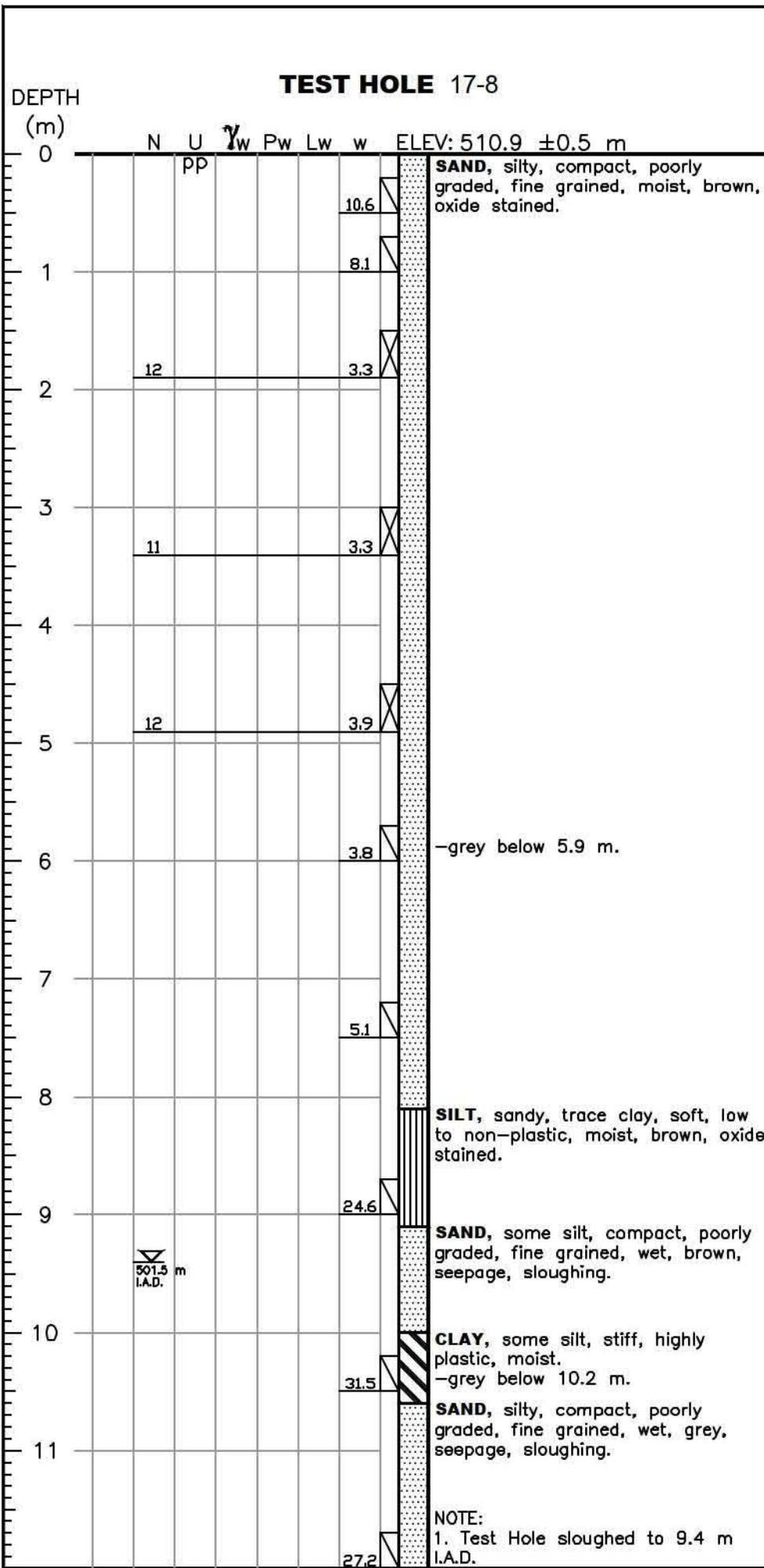
FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766452 **EASTING:** 386968

DATE DRILLED: APR 26/17 **DRAWING NUMBER:** 12980-8



LEGEND:

TOPSOIL	FILL	GRAVEL	SAND	SILT	CLAY	GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w ...WET UNIT WEIGHT (kN/m³)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm²)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE	SPLIT SPOON	CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

**P. MACHIBRODA
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LTD.**

**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766357 **EASTING:** 386280

DATE DRILLED: APR 26/17	DRAWING NUMBER: 12980-9
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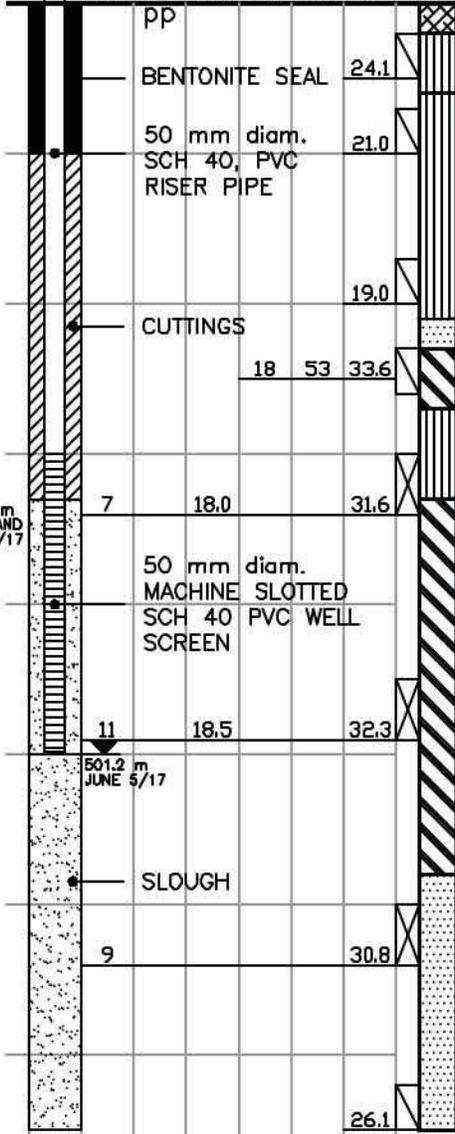
PIEZO. ELEV.= 507.2 ±0.5 m

TEST HOLE 17-9

DEPTH (m)
0
1
2
3
4
5
6
7
8
9
10
11

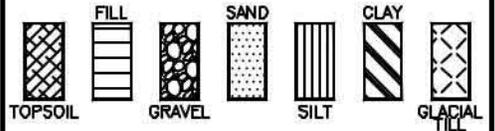
N U γ_w Pw Lw w

ELEV: 506.2 ±0.5 m



NOTE:
1. Test Hole sloughed to 3.3 m I.A.D.

LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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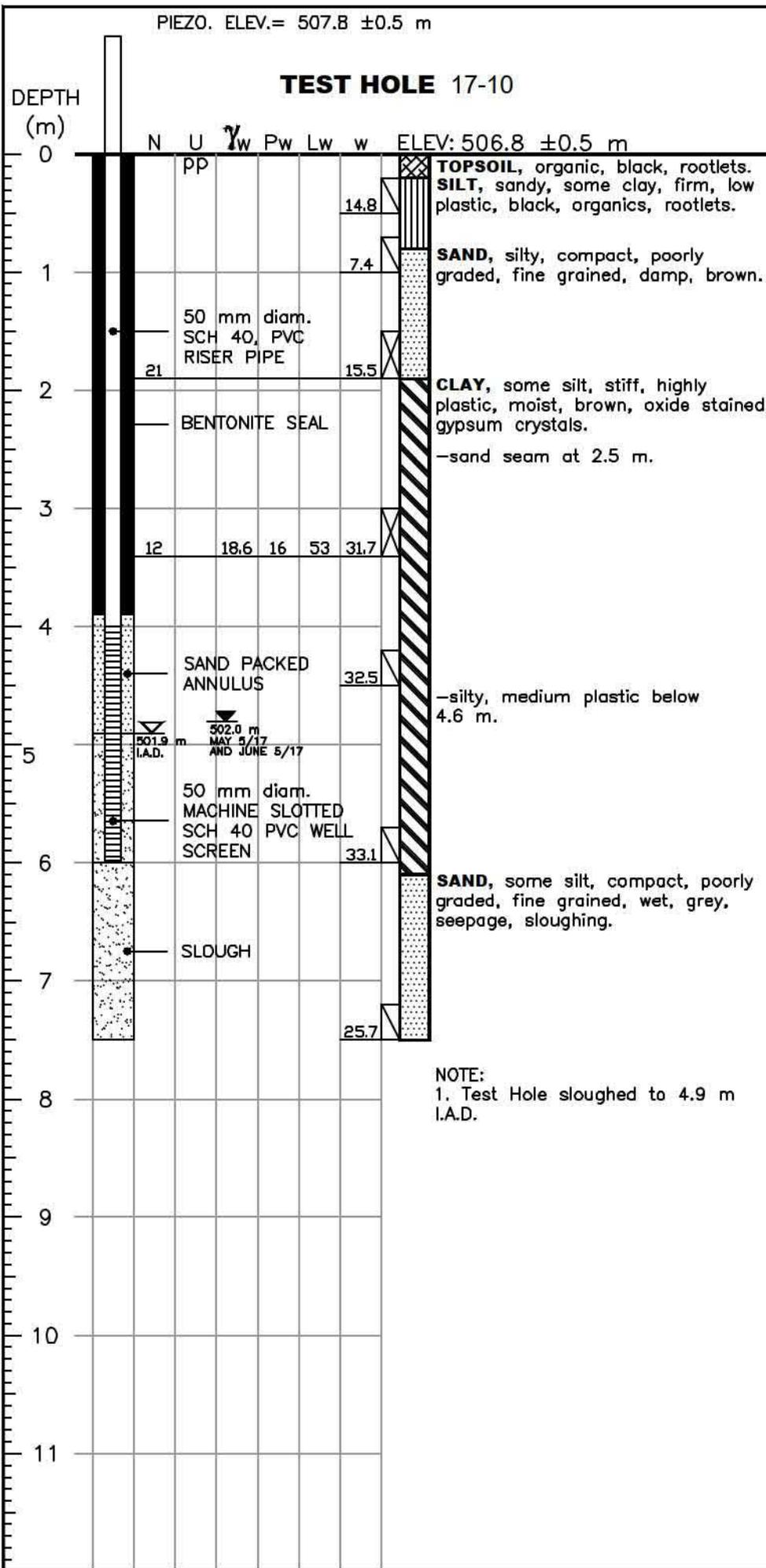
**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

PROJECT:
PROPOSED RURAL SUBDIVISION

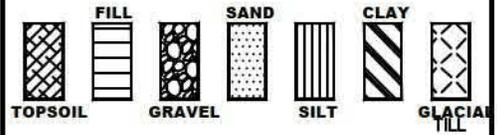
LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766280 **EASTING:** 386396

DATE DRILLED: APR 26/17 **DRAWING NUMBER:** 12980-10



LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ∇...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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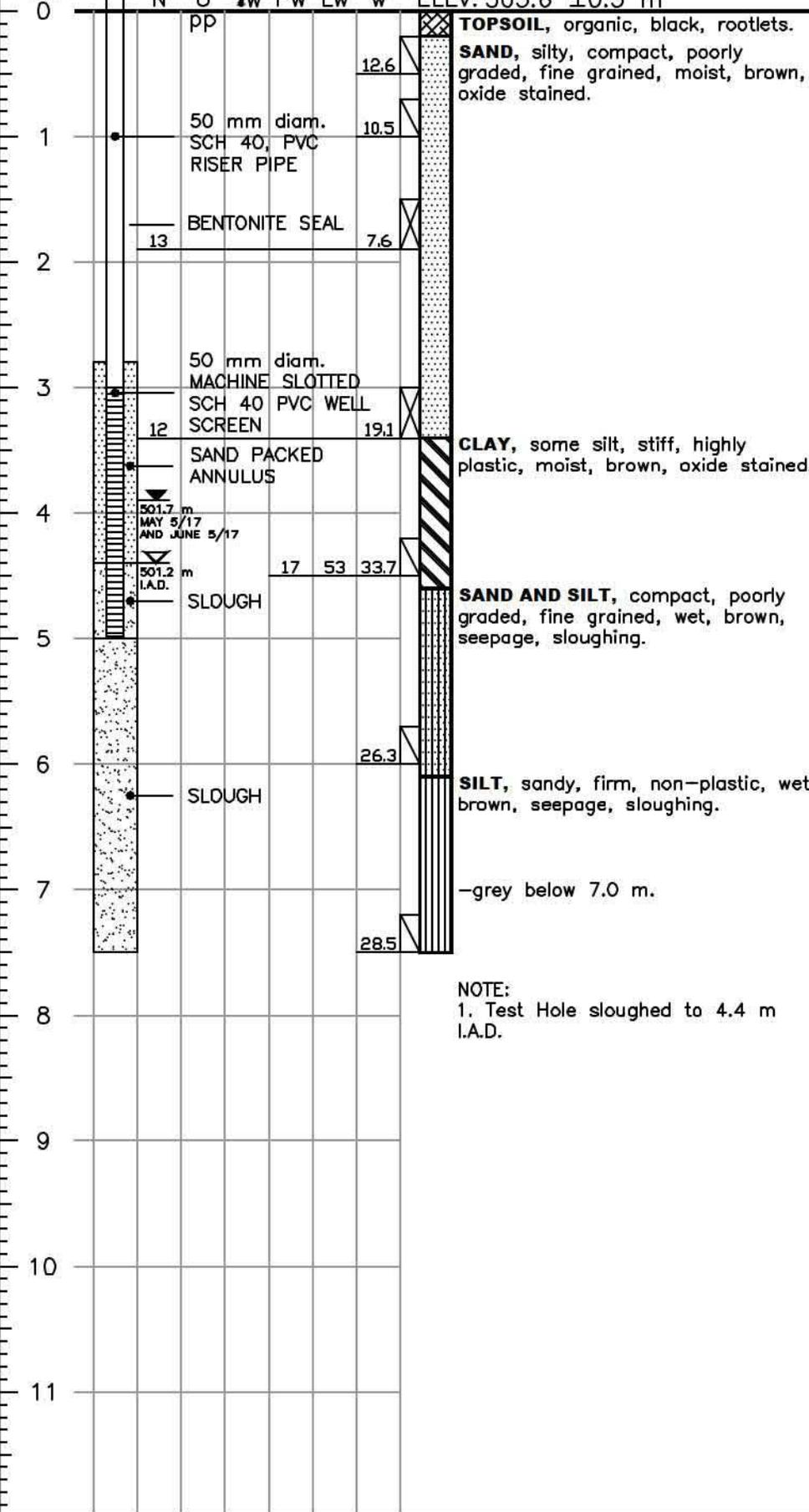
FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT: PROPOSED RURAL SUBDIVISION	
LOCATION: NE-28-35-5-W3M, NEAR SASKATOON, SK	
NORTHING: 5766279 EASTING: 386581	
DATE DRILLED: APR 26/17	DRAWING NUMBER: 12980-11

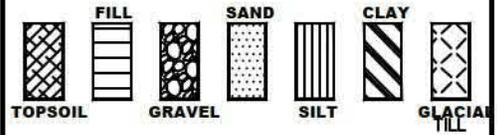
PIEZO. ELEV.= 506.6 ±0.5 m

TEST HOLE 17-11

DEPTH (m)



LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)



LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

NOTE:
1. Test Hole sloughed to 4.4 m I.A.D.



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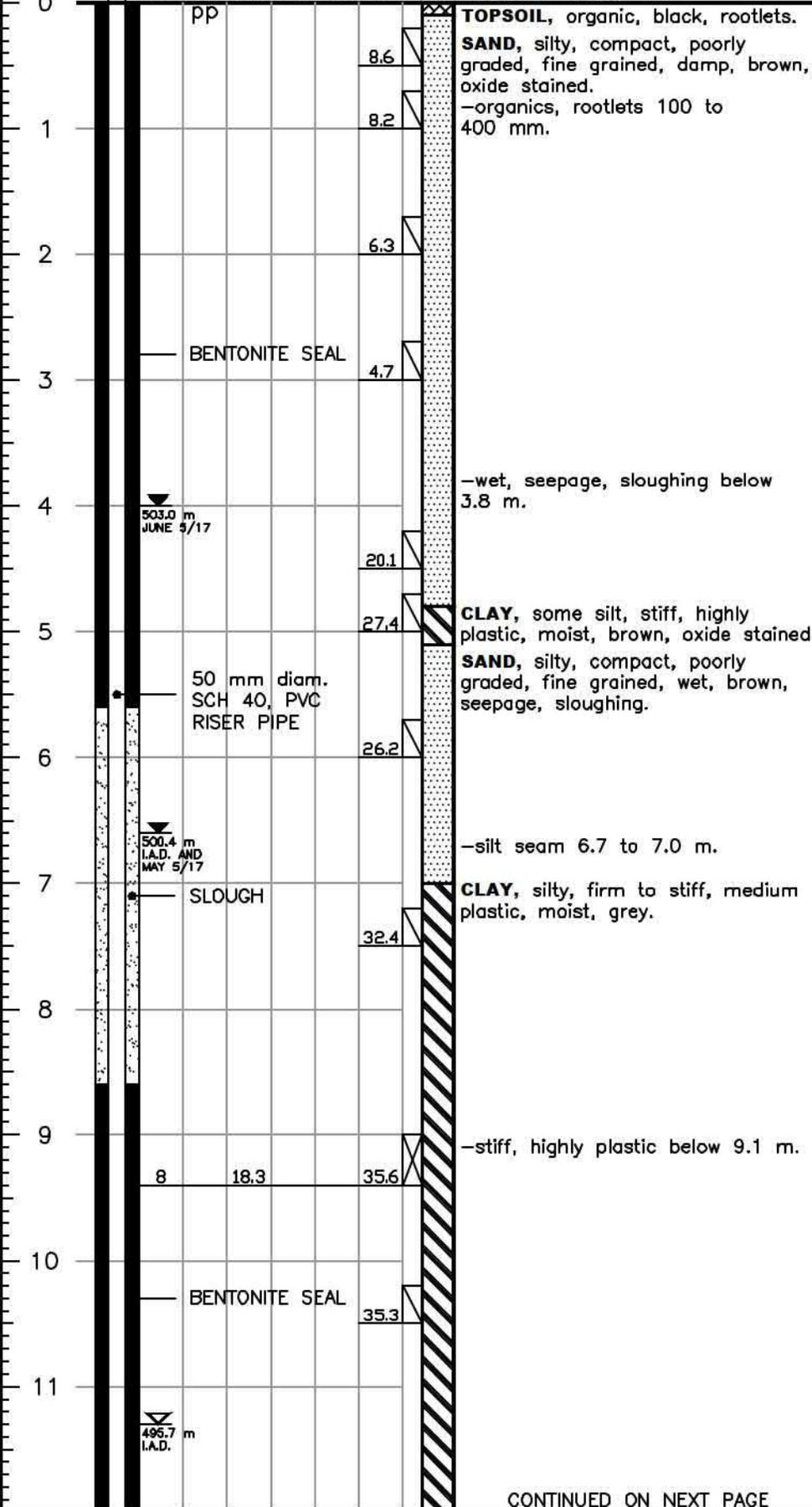
**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

PROJECT: PROPOSED RURAL SUBDIVISION	
LOCATION: NE-28-35-5-W3M, NEAR SASKATOON, SK	
NORTHING: 5766260 EASTING: 386763	
DATE DRILLED: APR 26/17	DRAWING NUMBER: 12980-12

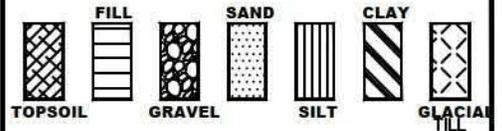
TEST HOLE 17-12

DEPTH (m)

N U γ_w Pw Lw w ELEV: 507.1 ±0.5 m



LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



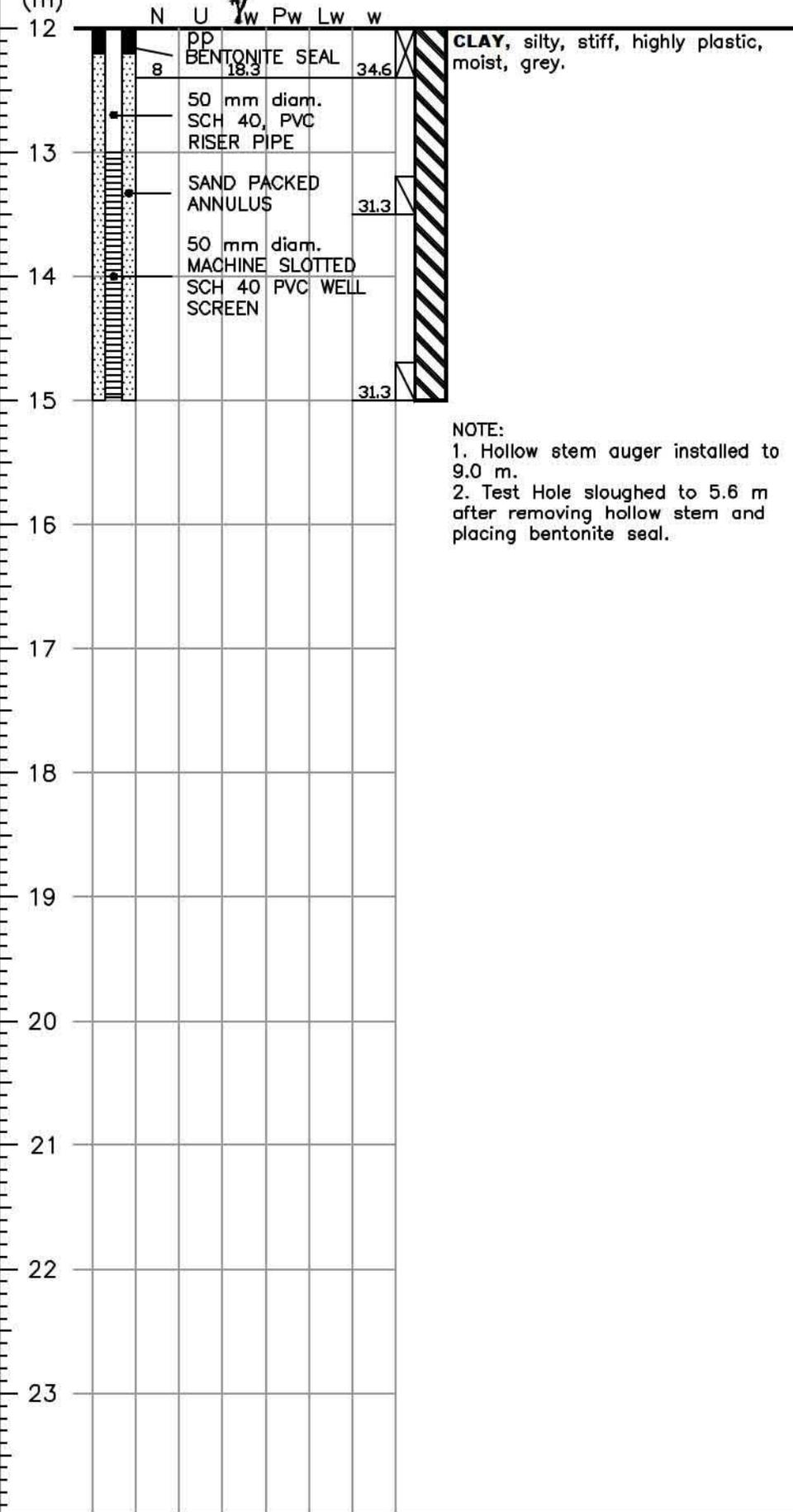
**P. MACHIBRODA
ENGINEERING
LTD.**

**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

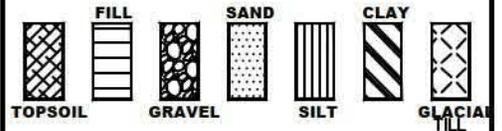
PROJECT: PROPOSED RURAL SUBDIVISION	
LOCATION: NE-28-35-5-W3M, NEAR SASKATOON, SK	
NORTHING: 5766209 EASTING: 386758	
DATE DRILLED: APR 27/17	DRAWING NUMBER: 12980-13

TEST HOLE 17-12

DEPTH
(m)



LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ∇...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- ◻ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



**P. MACHIBRODA
ENGINEERING
LTD.**

**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

PROJECT:

PROPOSED RURAL SUBDIVISION

LOCATION:

NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766208 **EASTING:** 386758

DATE DRILLED:
APR 27/17

DRAWING NUMBER:
12980-13A

PIEZO. ELEV.= 508.0 m

TEST HOLE 17-12A

DEPTH (m)

0

1

2

3

4

5

6

7

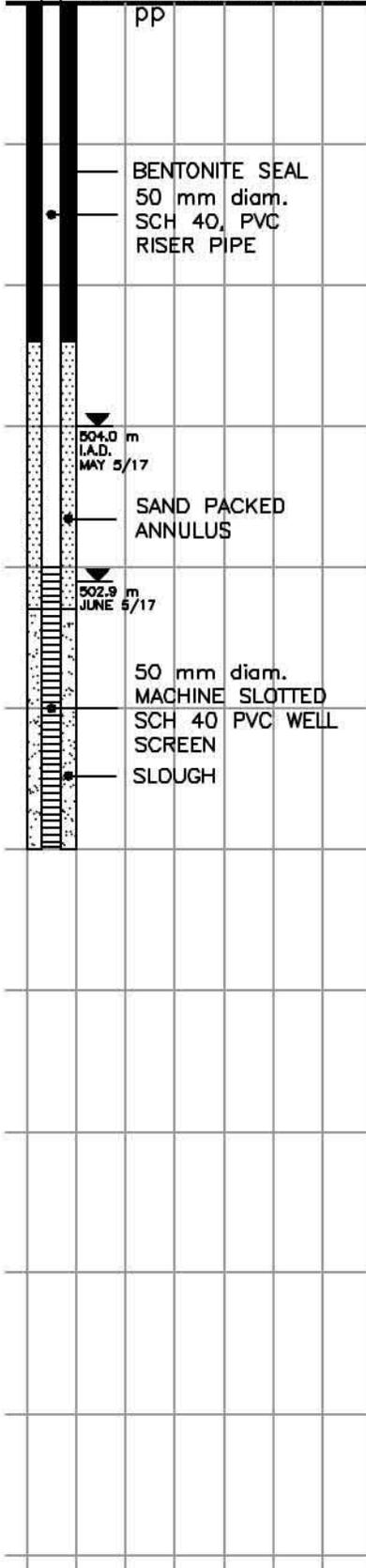
8

9

10

11

N U γ_w Pw Lw w ELEV: 507.0 m



TOPSOIL, organic, black, rootlets.

SAND, silty, compact, poorly graded, fine grained, damp, brown, oxide stained.
-organics, rootlets 100 to 400 mm.

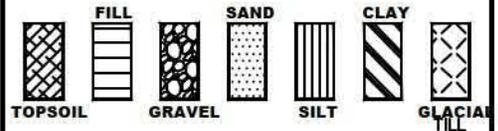
-wet, seepage, sloughing below 3.8 m.

CLAY, some silt, stiff, highly plastic, moist, brown, oxide stained.

SAND, silty, compact, poorly graded, fine grained, wet, brown, seepage, sloughing.

NOTE:
1. Test Hole sloughed to 4.3 m I.A.D.

LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- ◻ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

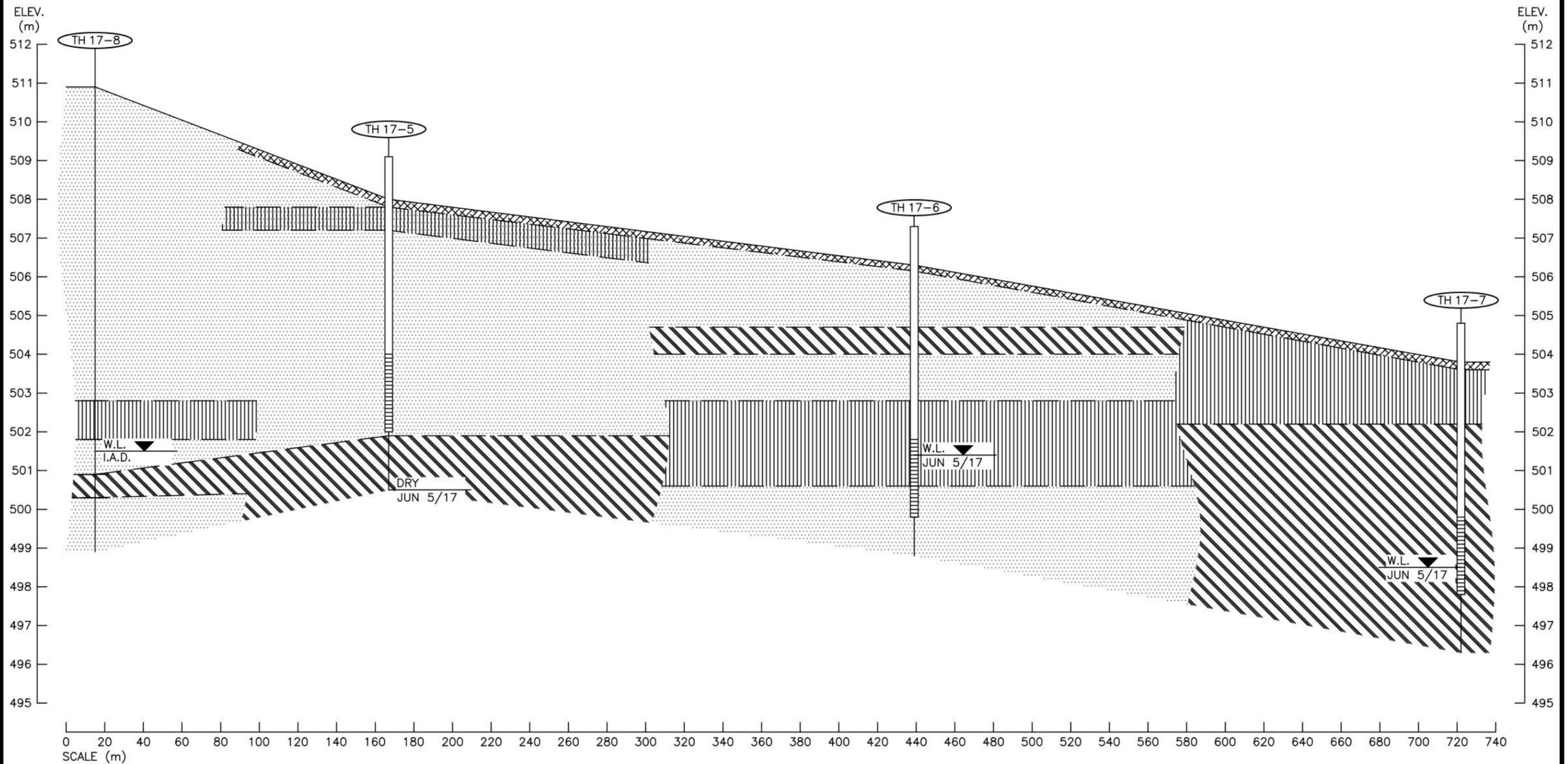


P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT: PROPOSED RURAL SUBDIVISION	
LOCATION: NE-28-35-5-W3M, NEAR SASKATOON, SK	
NORTHING: 5766209 EASTING: 386758	
DATE DRILLED: APR 27/17	DRAWING NUMBER: 12980-14

STRATIGRAPHIC SECTION A-A'



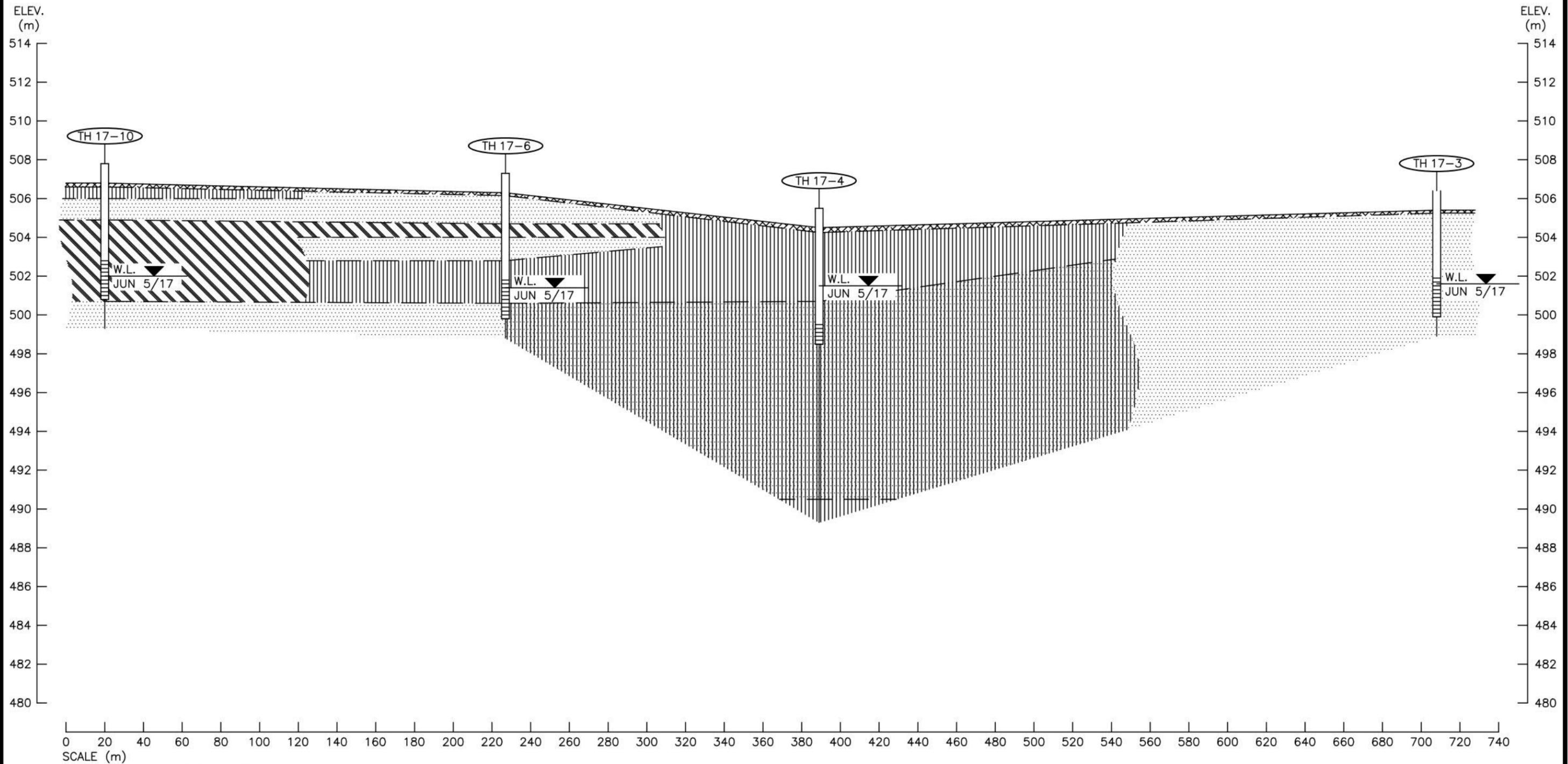
LEGEND

- | | | | | | |
|--|---------|--|------|--|----------------------|
| | TOPSOIL | | SAND | | GLACIAL TILL |
| | FILL | | SILT | | RECORDED WATER LEVEL |
| | GRAVEL | | CLAY | | |

LIMITATIONS
 THIS STRATIGRAPHIC SECTION IS A SUMMARY OF SUBSURFACE FIELD CONDITIONS INFERRED FROM DATA ENCOUNTERED AT SPECIFIC TEST HOLE LOCATIONS AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS AND, IN TIME, MAY CHANGE AT THE SPECIFIC LOCATION OF ANY TEST HOLE.

P. MACHIBRODA ENGINEERING LTD.		DRAWING TITLE: STRATIGRAPHIC SECTION A - A'	
CONSULTING GEOENVIRONMENTAL GEOTECHNICAL ENGINEERS 806 - 48th STREET EAST SASKATOON, SK S7K 3Y4		PROJECT: PROPOSED RURAL SUBDIVISION NE-28-35-5-W3M, NEAR SASKATOON, SK	
		APPROVED BY: RM	DRAWN BY: SD
		DATE: JULY, 2017	DRAWING NUMBER: 12980-15
		SCALE: AS SHOWN	

STRATIGRAPHIC SECTION B-B'



LEGEND

-  TOPSOIL
-  SAND
-  GLACIAL TILL
-  FILL
-  SILT
-  W.L.  JAN XX/10
-  GRAVEL
-  CLAY

LIMITATIONS
 THIS STRATIGRAPHIC SECTION IS A SUMMARY OF SUBSURFACE FIELD CONDITIONS INFERRED FROM DATA ENCOUNTERED AT SPECIFIC TEST HOLE LOCATIONS AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS AND, IN TIME, MAY CHANGE AT THE SPECIFIC LOCATION OF ANY TEST HOLE.

P. MACHIBRODA ENGINEERING LTD.		DRAWING TITLE: STRATIGRAPHIC SECTION B - B'	
 CONSULTING GEOENVIRONMENTAL GEOTECHNICAL ENGINEERS 806 - 48th STREET EAST SASKATOON, SK S7K 3Y4		PROJECT: PROPOSED RURAL SUBDIVISION NE-28-35-5-W3M, NEAR SASKATOON, SK	
		APPROVED BY: RM	DRAWN BY: SD
		DATE: JULY, 2017	DRAWING NUMBER: 12980-16
		SCALE: AS SHOWN	



NOTE:

1. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.
2. THIS DRAWING WAS COMPILED FROM GOOGLE EARTH PRO ©2017, IMAGE ©2017 DIGITALGLOBE, (IMAGERY DATE: 8/23/15),3
3. THIS DRAWING WAS COMPILED FROM APPROXIMATE LOCATES OF TEST PITS PROVIDED BY IMAGINE CONTRACTING INC.

LEGEND		-PMEL TEST HOLE PMEL REPORT NO. 12980-18		-PMEL TEST HOLE (MONITORING WELL INSTALLED)		-PMEL PIEZOCONE PENETRATION TEST (PMEL REPORT No. 12983)		-IMAGINE TEST PIT
	502.0 m —	GROUNDWATER ELEVATION CONTOUR (0.5 m CONTOUR INTERVAL)		APPARENT DIRECTION OF GROUNDWATER FLOW (JUN. 5/2017)	[502.67]	-DEEPER GROUNDWATER SURFACE ELEVATION (METRES ABOVE SEA LEVEL)—NOT USED IN CONTOURING		



CONSULTING
GEOENVIRONMENTAL
GEOTECHNICAL
ENGINEERS

**P. MACHIBRODA
ENGINEERING LTD.**

806 - 48th STREET EAST
SASKATOON, SK
S7K 3Y4

DRAWING TITLE: **GROUNDWATER SURFACE ELEVATIONS AND
INFERRED FLOW DIRECTIONS**

PROJECT: **PROPOSED RURAL SUBDIVISION
NE-28-35-5-W3M, NEAR SASKATOON, SK**

APPROVED BY: JL

DRAWN BY: TP

DRAWING NUMBER:

DATE: DECEMBER, 2020

SCALE: NOT TO SCALE

12980-17



NOTE:

1. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.
2. THIS DRAWING WAS COMPILED FROM GOOGLE EARTH PRO ©2017, IMAGE ©2017 DIGITALGLOBE, (IMAGERY DATE: 8/23/15),3
3. THIS DRAWING WAS COMPILED FROM APPROXIMATE LOCATES OF TEST PITS PROVIDED BY IMAGINE CONTRACTING INC.

LEGEND	-PMEL TEST HOLE PMEL REPORT NO. 12980-18	-PMEL TEST HOLE (MONITORING WELL INSTALLED)	-PMEL PIEZOCONE PENETRATION TEST (PMEL REPORT No. 12983)	-IMAGINE TEST PIT
	502.0 m — GROUNDWATER ELEVATION CONTOUR (0.5 m CONTOUR INTERVAL)	APPARENT DIRECTION OF GROUNDWATER FLOW (JUL. 20/2020)	[502.67] -DEEPER GROUNDWATER SURFACE ELEVATION (METRES ABOVE SEA LEVEL)-NOT USED IN CONTOURING	



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APPENDIX A

Imagine Contracting Inc. Wastewater
Management Evaluation Report

Executive Summary – Onsite Wastewater Treatment

Per section 2.1 of the Guidance Document for Developments and Subdivisions where OWTS are Proposed, under Scenario A, an assessment of the onsite sewage treatment and disposal practices in a subdivision development is required for the proposed Ravenswood subdivision as it meets the following criteria.

- The proposal includes an average lot size per residential unit (not including residual land) of less than 4 hectares;
- After development is complete, more than 9 residential units are present:
 - on the quarter-section where the proposed development is located; or,
 - within 0.4 km (1/4 mile) of the proposed subdivision (including previously approved, proposed in a previous concept plan, and existing developments).; and,
- Exclusion criteria (see section 2.1.1.) do not apply.

In addition to falling under Scenario A, the area of proposed development falls within a Sensitive Area due to its location over a large surficial sand (unconfined) aquifer, among other Medium to High Density Developments. Details regarding the aquifer are appended in P. ii, iii of the Hydrogeological Study.

Feasibility Findings:

In regards to the feasibility for 47 total lots to sustain Onsite Wastewater Treatment Systems (OWTS) at the proposed Ravenswood subdivision, located at NE-28-35-05 W3 in the RM of Corman Park No. 344; there is substantial physical evidence within the soils throughout the site to indicate that all of the proposed lots have adequate area and vertical separation (vadose zone) to accommodate OWTS systems of varying types.

It was found that the soils on site would be suitable for the installation of the following OWTS soil treatment system types, depending on the vertical separation on each individual parcel, in addition to the ability to meet all setbacks as required by the Saskatchewan Onsite Wastewater Disposal Guide, November 2018 Edition (SOWDG). All system types aside from the Holding Tank option will require an Advanced Treatment System in advance.

- Holding Tanks
- Pressurized Treatment Field
- Pressurized Raised Treatment Field
- Pressurized Type II Mound
- Advanced Enviro-Septic Field
- Advanced Enviro-Septic Mound

As with all homes and facilities requiring OWTS Systems in the Province of Saskatchewan, it will be necessary for each individual property to have a detailed site and soils assessment completed prior to finalizing building plans. The detailed site and soils assessment should be

completed by the owner/developer of each property so that it does not limit the design flexibility (e.g. house, garage, shop, and/or property boundaries, layout, etc...) of each property, given it does not contravene the prescribed limitations for any specific areas of the proposed subdivision as outlined in the following sections of this report (e.g., areas of high water table, limited vadose zone retention time, etc...).

Upon completion of the detailed site and soils assessment, a system design specific to each parcel, meeting all of the requirements of the Saskatchewan Onsite Wastewater Disposal Guide, Vol. 3; the CDR for the proposed Ravenswood subdivision; and all requirements of the RM of Corman Park No. 344 bylaws and regulations will be required. This design shall be reviewed by Saskatchewan Health Authority and the resulting approved permit for the proposed OWTS will be required in order to receive a Building Permit from the RM of Corman Park No. 344.

General Soil Conditions on Site:

Eight test pits scattered across the entirety of the proposed development were excavated and evaluated on August 16, 2020. It was found that in all but 1 test pit, there were suitable soils to support Onsite Wastewater Treatment Systems (OWTS), with suitable vadose zone capacity. The individual test pit that was not suitable was at the lowest elevation on the parcel, and it should be noted that the proposed lot for that portion of the development had substantial area, including area at a higher elevation within which soil conditions were suitable for an OWTS.

The suitable system for each lot will vary depending on the vertical separation on each individual lot, the size and features of the home, the expected water usage, and location of all property features in conjunction with the parcel's location within the development. E.g. parcels within 220m of the subdivision boundaries will require a higher level of treatment, and parcels exceeding 220m from the subdivision boundary will require more moderate treatment levels.

Evaluation of scattered test pits at various locations and elevations on the parcel proposed for development confirms the required details requested in Section 3.2: Field Program of the Guidance for Developments and Subdivisions where OWTS are proposed document.

Setback Considerations:

All undeveloped parcels within the proposed Ravenswood subdivision have adequate space to meet or exceed all setbacks required by the SOWDG, including the parcels on the North Perimeter of the existing parcel, where there will be a 20' easement between Ravenswood and Edgemont Park Estates.

As with any acreage parcel, care and consideration must be taken to ensure that property features are placed in such a way that required setbacks can be met. It is recommended that the seller predetermine the best site for septic systems on each parcel to ensure that the purchaser is aware of any limitations.

It is also recommended that as rural water is expected to be piped to the subdivision, that individual private wells be restricted to landscape usage. By not allowing potable wells on the development, it reduces the possibility of limiting or restricting the feasibility of septic systems for any parcels, as well as improving Nitrate-Nitrogen dispersal, since reduced water uptake will reduce the overall concentration of Nitrate-Nitrogen within the aquifer below.

Data Collection:

1. A Hydrogeological Study was completed in April 2017 (PMEL, 2017) and updated in April 2020 (PMEL, 2020). 13 Piezometers were installed, and data was collected in May of 2017 (PMEL, 2017) and July 2020 (PMEL, 2020). Data collected is appended in the Hydrogeological Study by P. Machibroda Engineering Ltd. (PMEL) In addition to providing historical and current measurements of water table elevation, samples from these piezometers have been submitted for testing to determine water quality concerns.
2. A Detailed Site & Soils Study was completed on August 16, 2020. At this time, 8 test pits were excavated and evaluated in detail. Samples from each test pit were submitted to an accredited lab and results were compiled along with the data collected on site. Detailed Soils Logs and Lab results are appended.

Water Table:

The Hydrogeological Survey completed by PMEL found that across their 13 piezometers, the average water table depth in May 2017 was 4.72m, in June 2020 was 4.11m, and in July 2020 was 4.34m.

The most elevated water level through the 3 measurement periods was 1.5m below grade at Piezometer #7. These findings were confirmed by the test pit dug in the vicinity of Piezometer TH17-7 in August 2020. The soils in this area were saturated and unsuitable for an OWTS. It should be noted that the proposed parcel that this Piezometer and Test Pit (1) were located on has at least 50% of it's area at a higher elevation, which had positive soil findings for OWTS in an additional Test Pit (2).

Aside from this one area of reduced capacity, the remainder of the development had vertical separations of between 1.09m (43") and 2.74m (108"), which are adequate for various soil treatment system types.

Soil Consistency:

Overall, the majority of the soil textures were characterized within the Sandy Loam/Loam categories across the parcel. Some areas at lower elevations had some heavier horizons, including several Clay Loam horizons, however, this is quite common in lower elevation areas.

Drainage Considerations:

The intent within the proposed Ravenswood subdivision is that the naturally rolling landscape be used to create natural pathways for surface water and rainwater drainage to the Municipal

Reserve Areas, as dedicated to the RM. Municipal Reserves will be at lower elevations, and may be excavated to achieve adequate storage for the required runoff volumes. Individual lots will generally be at higher elevations. All of the proposed lots have adequate area, including reserve areas at suitable elevations to support OWTS systems and should not be impacted by any water utilizing the proposed water drainage plan.

Landscape Considerations:

While the terrain on the parcel located at NE-28-35-05 W3 is naturally rolling and has a gentle slope to the East, there are no cuts, banks, slopes, or other landscape features that would prevent each lot from having a suitable location for an OWTS, based on the current development plan.

Vegetative Considerations:

Generally, the parcel located at NE-28-35-05 W3 is a well-drained agricultural parcel, having previously supported crops. The West side of the property hosts various treed areas with a mixture of coniferous and deciduous trees. The treed areas, adjacent to lots, are reasonably dense, but not located at elevations suggesting wet soil conditions. The East side of the property hosts maple and birch trees, both of which favour wet soil conditions. These trees were along the Eastern-most perimeter, and at the lower elevations closer to the property line, soil conditions were found to be unsuitable for a septic system.

Area Density:

The proposed Ravenswood development would be classified as a High Density project, with a proposed 47 total lots divided out of an existing 146.46 acre parcel.

Surrounding Development

Edgemont Park Estates, located to the North of the Ravenswood subdivision, which has 47 Lots currently approved, and another 52 Lots proposed for it's second phase. Edgemont Park Estates is classified as High Density, as it has 99 total lots approved/proposed, and average lot size is approx. 0.6 acres.

Casa Rio is located on the East and South Sides of the proposed subdivision, Casa Rio is spread over five quarter sections, with no more than 15 individual parcels per section, classifying it as a Low Density subdivision.

Wood Meadows is directly to the West of the proposed subdivision boundary. This development is low density, with less than 15 individual lots subdivided across the original quarter section.

The parcels to the North-West, North-East, and South-West of the proposed subdivision do not have any substantial development in place at current.

Grasswood Estates is located approx. 1.5km to the East of the proposed Ravenswood subdivision, and is classified as Medium Density with 78 total lots over two quarter sections.

Grasswood-North and Grasswood-South lie north of the proposed development, approx. 0.8km from the Northmost boundary of the proposed Ravenswood. These subdivisions are both classified as Medium Density subdivisions.

There is an existing group home located on the same quarter section as Ravenswood Development.

Wastewater Treatment in Surrounding Development:

Edgemont Park Estates – All lots require the use of an Advanced Treatment System meeting or exceeding the following standard, NSF-40, NSF-245, and NSF-350 with TKN of $\leq 10\text{mg}$, to meet potable water standards. The CDR for this development, as approved by the RM of Corman Park CDR calls for the use of the Biomicrobics BioBarrier system or equivalent.

Casa Rio – All lots require the use of an Advanced Treatment System meeting or exceeding the following standard, NSF-40. The CDR for this development, as approved by the RM of Corman Park calls for the use of the MicroFAST system or equivalent.

Wood Meadows – Each lot is required to have a lot specific site and soils assessment to determine suitable OWTS.

Grasswood Estates – All lots require the use of an Advanced Treatment System meeting or exceeding the following standard, NSF-40. The RM of Corman Park CDR calls for the use of the Advanced Enviro-Septic System.

Grasswood-North and Grasswood South – Each lot is required to have a lot specific site and soils assessment to determine suitable OWTS.

Proposed Wastewater Treatment in Ravenswood:

Required Process, Initial Treatment Component:

A desktop Nitrate-Nitrogen Assessment Model was completed, and is appended within the PMEL Hydrogeological Study.

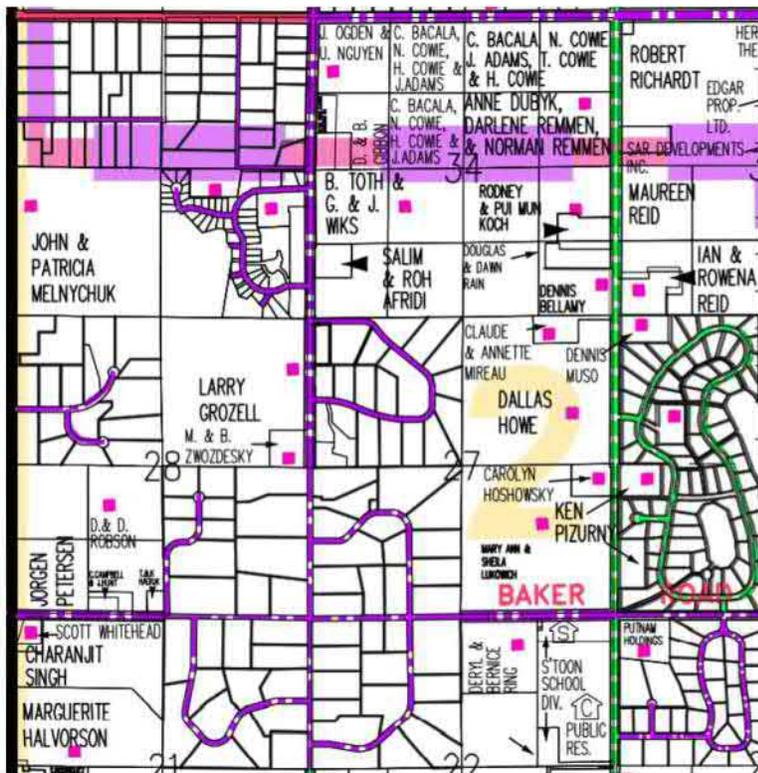
Required Process, Soil Treatment Component:

Each individual lot will require a detailed site and soils assessment as per Section 6 of the SOWDG, V. 3 and Annex 10. The expected flow rates, site & soils evaluation and determination of system type per the development's horizontal setbacks in relation to being less than or greater than 220m from the development boundary, for each lot will determine what the

appropriate size and type of soil treatment component is required. This is a provincial requirement for all facilities and homes requiring OWTS systems in the Province of Saskatchewan.

Contingency Areas:

Generally speaking, all parcels in the proposed subdivision of Ravenswood will have adequate area available for system revision/replacement as necessary. It is recommended that the approved OWTS system location allows a suitable secondary location for system installation as required in the future.



REFERENCES:

General Regulations: Guidance Document for Developments and Subdivisions where OWTS are Proposed, http://www.rqhealth.ca/service-lines/master/files/review_process.pdf

General Regulations: Saskatchewan Onsite Wastewater Disposal Guide, Version 3, Published November 2018, <https://www.saskatchewan.ca/residents/environment-public-health-and-safety/environmental-health/plumbing-sewage>

Vadose Zone: <https://www.doh.wa.gov/Portals/1/Documents/Pubs/337-083.pdf> , Section II : Factors Affecting System Performance, Page 2, Part A: Soils

Vadose Zone: <https://www.doh.wa.gov/Portals/1/Documents/Pubs/337-083.pdf> , Section II : Factors Affecting System Performance, Page 3, Part B: Wastewater Characteristics

Characteristics	Raw Sewage ¹	Septic Tank Effluent ²	
	Range	Range for 95% of Samples	Average
pH			7.2
Total suspended solids (mg/l)	200-290	47-62	54
BOD ₅ (mg/l)	200-290	142-174	158
Total Nitrogen	35-100	48.9-61.6	55.3
Total Phosphorus	18-29	11.4-17.7	14.6
Fecal coliforms (MF) per 100ml	10 ⁷ -10 ⁹	2.88x10 ⁵ -6.16x10 ⁵	4.21x10 ⁵

¹ From EPA Design Manual, Onsite Wastewater Treatment and Disposal Systems

² From Olin, R.J., W.C. Boyle and D.K. Sauter, 1974. "The Performance of Household Wastewater Treatment Units Under Field Conditions", *Home Sewage Treatment*, American Society of Agricultural Engineers Publication, St. Joseph, MI.

Sewage Contaminants: <https://www.doh.wa.gov/Portals/1/Documents/Pubs/337-083.pdf> , Section IV : Sewage Treatment, Page 7, Part B : When is sewage no longer sewage?

Source of Samples	Total Suspended Solids (mg/l)	BOD ₅ (mg/ml)	Nitrogen (mg/l)	Phosphate (mg/l)	Fecal Coliforms (per 100ml)
Raw Domestic Sewage	200-290	200-290	35-100	18-29	10 ⁷ -10 ⁹
Septic Tank Effluent	50.8	158	54.3	14.6	4.2x10 ⁵
Following Treatment Component	<10	<10	>18.3	0	<200

Sewage Contaminants: https://www.epa.gov/sites/production/files/2015-06/documents/2004_07_07_septics_septic_2002_osdm_all.pdf , USEPA Onsite Wastewater Treatment Systems Manual, Table 3-19, P.3-29

Table 3-19. Wastewater constituents of concern and representative concentrations in the effluent of various treatment units

Constituents of concern	Example direct or indirect measures (Units)	Tank-based treatment unit effluent concentrations					SWIS percolate into ground water at 3 to 5 ft depth (% removal)
		Domestic STE ¹	Domestic STE with N-removal recycle ²	Aerobic unit effluent	Sand filter effluent	Foam or textile filter effluent	
Oxygen demand	BOD ₅ (mg/L)	140-200	80-120	5-50	2-15	5-15	>90%
Particulate solids	TSS (mg/L)	50-100	50-80	5-100	5-20	5-10	>90%
Nitrogen	Total N (mg N/L)	40-100	10-30	25-60	10-50	30-60	10-20%
Phosphorus	Total P (mg P/L)	5-15	5-15	4-10	<1-10 ³	5-15 ³	0-100%
Bacteria (e.g., <i>Clostridium perfringens</i> , <i>Salmonella</i> , <i>Shigella</i>)	Fecal coliform (organisms per 100 mL)	10 ³ -10 ⁶	10 ³ -10 ⁵	10 ³ -10 ⁶	10 ³ -10 ⁷	10 ³ -10 ⁷	>99.99%
Virus (e.g., hepatitis, polio, echo, coxsackie, coliphage)	Specific virus (pfu/mL)	0-10 ³ (episodically present at high levels)	>99.9%				
Organic chemicals (e.g., solvents, petrochemicals, pesticides)	Specific organics or totals (µg/L)	0 to trace levels (?)	>99%				
Heavy metals (e.g., Pb, Cu, Ag, Hg)	Individual metals (µg/L)	0 to trace levels	>99%				

¹Septic tank effluent (STE) concentrations given are for domestic wastewater. However, restaurant STE is markedly higher particularly in BOD₅, COD, and suspended solids while concentrations in graywater STE are noticeably lower in total nitrogen.

²N-removal accomplished by recycling STE through a packed bed for nitrification with discharge into the influent end of the septic tank for denitrification.

³P-removal by adsorption/precipitation is highly dependent on media capacity, P loading, and system operation.

Source: Siegrist, 2001 (after Siegrist et al., 2000)

Source: Siegrist, 2001 (after Siegrist et al., 2000).

Development Considerations: <https://www.rmccormanpark.ca/271/Maps>

Development Considerations: <https://earth.google.com/web/@52.04012172,-106.65336186,504.53471441a,6583.2748368d,35y,0h,0t,0r>

Development Considerations: <https://apps.isc.ca/MapSearch2/MapSearchWeb/MapSearchPage.aspx>

Image 1: 1:25 year event news article

'1-in-25 year storm' slams Saskatoon with flooding, hail and major power outages



BY PETER QUINLAN - GLOBAL NEWS

Posted July 11, 2017 12:52 pm

Updated July 12, 2017 10:28 am



<https://globalnews.ca/news/3590500/saskatoon-weather-outlook-forecast-storm-flooding-hail/>

Image 2: D21



Image 3: D19



Image 4: D18



Image 5: D18 different angle



Image 6: D17 and D15



Image 7: D16



Image 8: D14 and D20



Image 9: D10



Image 10: D9 and D10



Image 11: D8



Image 12: D4



Appendix D: Potable Water Information

R. M. OF CORMAN PARK NO. 344

WATER SUPPLY AGREEMENT

THIS AGREEMENT made in duplicate this 12th day of October, 2000.

BETWEEN RURAL MUNICIPALITY OF CORMAN PARK NO. 344
111 Pinehouse Drive
Saskatoon SK S7K 5W1
Hereinafter referred to as the "Municipality"

- AND -

Larry Grozell
R. R. #5
Saskatoon SK S7K 3J8
(Location of Holding: NW-28-35-5-W3)
Hereinafter referred to as the "Consumer"

WHEREAS the Consumer has applied to the Municipality for a water connection for the supply of a maximum volume of two thousand, one hundred and sixty (2,160) gallons of water per day at a maximum flow rate of 1.5 imperial gallons per minute for domestic and/or stockwatering purposes subject to SaskWater confirmation attached as Schedule "A"; and

WHEREAS the Municipality agrees to supply water and the Consumer agrees to take and pay for the supply of water upon and subject to the following terms and conditions.

NOW THEREFORE, it is agreed by and between the parties as follows:

1. The Municipality agrees to supply treated water to the Consumer at the following point of delivery:
 - Saskatoon treated water supply system – East
 - Approximate stationage: STA 2+062 – Hamlet of Grasswood Pipeline
 - Point of Delivery NE-28-35-5-W3 (West side of road allowance)
2. The Municipality agrees to install the necessary connecting facilities such as the meter chamber, meter, valves and fittings required to connect to the Municipality pipeline. All such connecting facilities shall, with the exception of the meter be the sole property and responsibility of the Consumer. Any damage caused to the aforementioned connecting facilities shall not be the responsibility of the Municipality, unless caused by direct negligence of the Municipality. Notwithstanding the above, the Municipality shall be the authority for repairing and maintaining such connecting facilities at the expense of the Consumer.
3. The Consumer shall obtain all necessary approvals and comply with the conditions of approval and all regulations that are now applicable to or may become applicable to this Agreement and failure to do so shall entitle the Municipality to immediately discontinue the supply of water hereunder.
4. The consumer shall install and be responsible for all costs and construction of the distribution system from the point of delivery. Control of the water supplied and taken under this Agreement shall pass from the Municipality to the Consumer at the point of delivery. After such passage, the Consumer shall be deemed to be in control of and be responsible for such water. The point of delivery is the Municipality pipeline.

5. The Consumer shall install water storage facilities and shall be responsible for pressurization of the Consumer's water supply system should a continuous supply of water be required.
6. The Consumer shall permit the Municipality the right of ingress and egress to the site of the connecting facilities for the purpose of installation, maintenance and operation of such connecting facilities.
7. The Municipality does not guarantee a continuous supply of water. The supply of water and pressure will be subject to the service requirements of the major municipal and industrial users and to such other operating and maintenance requirements that are or may be established by the MUNICIPALITY. The Consumer will be subject to disruptions of services and agrees to conform to restrictions of water supply at the direction of the Municipality.
8. The Municipality reserve the right to change the source of treated water supplied hereunder by giving one (1) month's notice in writing to the Consumer.
9. The Consumer shall accept full responsibility for the quality of water supplied and shall hold the Municipality harmless from all claims, losses and damages therefrom.
10. The Consumer shall be responsible for any and all water treatment which may be required to comply with any condition, regulation or Act which may be applicable or become applicable in regard to utilization of the water supplied.
11. The Consumer shall pay to the Municipality Forty Thousand, Five Hundred and Fifty Three Dollars (\$40,553.00) in respect of the connecting facilities referred to in Article 2 above, such payment to be made prior to the acceptance of this Agreement by the Municipality. It is further agreed that there shall not be a connection fee applied in the event the Consumer establishes additional development on NE-28-35-5-W3.
12. The Consumer shall pay to the Municipality the price of Four Dollars and Forty-two cents (\$4.42) for each one thousand (1,000) gallons of water taken subject to a minimum quarterly charge of One Hundred and Fifty-Nine Dollars and Twelve Cents (\$159.12) which represents a consumption of thirty-six thousand (36,000) gallons. The Municipality reserves the right to change the price of water supplied hereunder when there is a change in the price of water purchased from Sask. Water by giving written notice to the Consumer one (1) month in advance of such change.

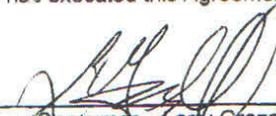
The Consumer agrees that any taxes applicable to charges under this Agreement shall be the responsibility of the Consumer, and will be paid in excess of the charges set out in this Agreement. It is also agreed that such payments of tax are to be made at the same periodic times as has been agreed to pay such charges.
13. The Municipality shall invoice the Consumer each quarter for the price of water supplied hereunder and payment shall be made in full by the Consumer forthwith upon receipt of such invoice directly to the Municipality at its office. The Municipality shall be entitled to disconnect service to the Consumer if the accounts submitted hereunder remain unpaid ninety (90) days after the date of invoice.

14. The Consumer shall not supply water to any other party located outside the Wood Meadows subdivision (NW-2E-35-5-1/3) without first obtaining the written consent of the Municipality.
15. The Consumer shall not transfer ownership of a water supply connection to any other party without first obtaining the written consent of the Municipality. Such consent will not be unreasonably withheld.
16. The Municipality reserves the right, at any time, to discontinue its service and remove the Municipality's facilities from the Consumer's premises in any case where, in the Municipality's opinion and such opinion is confirmed by the Minister of Environment and Public Safety, the operations of the Consumer contravene any federal, provincial, or municipal law relating to the pollution of the environment, whether such violation involves the pollution of air, soil or water or constitutes any other industrial nuisance. In the event the Municipality should elect to discontinue the supply of water hereunder as hereinbefore provided, then this Agreement shall thereupon terminate without further formality effective as of the date indicated by the Municipality in a notice to the Consumer to that effect.
17. This Agreement shall take effect from the date first above written and shall continue until terminated by the Consumer or the Municipality upon three (3) months, notice in writing, with cause.

IN WITNESS WHEREOF, the Consumer has executed this Agreement the 12th day of October, A.D., 2000.



Witness

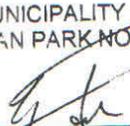


Consumer - Lark Grozell

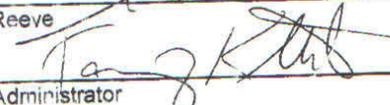
AND IN WITNESS WHEREOF the Rural Municipality of Corman Park No. 344 has caused to be set its corporate seal duly attested by the signatures of proper officers in that behalf the 12th day of October A.D., 2000.



RURAL MUNICIPALITY
OF CORMAN PARK NO. 344



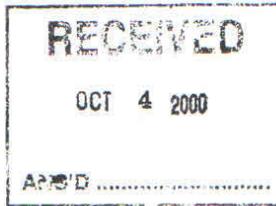
Reeve



Administrator



Schedule 'A'



October 3, 2000

(306) 946-3204

Ms. Tammy Knuttila
Administrator, R.M. of Corman Park, No 344
111 Pinehouse Drive
Saskatoon SK S7K 5W1

W11-1
(CORMAN PARK, R.M. -
WOOD MEADOWS)

Dear Ms. Knuttila:

**RE: WATER SUPPLY AGREEMENT
FOR WOOD MEADOWS SUBDIVISION**

Enclosed for execution by the R.M. are three copies of the Water Supply Agreement for Wood Meadows subdivision in the NW 1/4 Sec. 28-35-5-W3M. As we discussed by phone it is my understanding that you have reached an agreement with the developer, Mr. Larry Grozell, that the R.M. will be Sask Water's customer, and will in turn supply water to Wood Meadows sub-division and other sub-divisions in the future.

The agreement is currently written to allow diversion of 1.5 imperial gallons per minute for use on three lots in the sub-division. As more lots are developed we will prepare amendments to the agreement to reflect the change in volumes to be delivered.

After the agreements have been signed by the R.M. please return all copies to this office together with a cheque for the amount detailed on the attached sheet. Sask Water will then execute the agreements and one copy will be returned for our records.

Respectfully yours,

Mart R. Cram, P.Eng.
Director
Utility Operations

MRC/se
Enclosures

P.O. Box 310, 403 Main Street, Watrous, Saskatchewan S0K 4T0
(306) 946-3200 Fax 946-3533

To: Larry Grozell <grozell55@gmail.com>
Cc: Michelle Chuhaniuk <mchuhaniuk@hotmail.com>, Adam Toth <atoth@rmcormanpark.ca>

Hi Larry,

Your water allocation is in place. Based on a new rate structure the City of Saskatoon is looking to receive a levy of a not yet determined amount for each connection, however we are requesting that it not be applied in this case. While we may not be successful in this, I will let you know when I have heard more, but there is water.

Adam Tittlemore
Administrator
R.M. of Corman Park No. 344
(306) 975-1651 (Office)
www.rmcormanpark.ca
[Quoted text hidden]

Dukart, Shawn GR <shawn.dukart@gov.sk.ca> Mon, Mar 30, 2020 at 7:51 PM
To: Larry Grozell <grozell55@gmail.com>
Cc: Adam Toth <atoth@rmcormanpark.ca>, Rebecca Row <rrow@rmcormanpark.ca>, Brad Luey <bluey@midwestsurveys.com>, "chabermehl@rmcormanpark.ca" <chabermehl@rmcormanpark.ca>, Michelle Chuhaniuk <mchuhaniuk@hotmail.com>, Adam Tittlemore <atittlemore@rmcormanpark.ca>

Hi Larry,

Thank you for the update, much appreciated. I am glad to hear you are continuing to move forward.

The appeal or closure options are provided for consideration. No further action is necessary in that regard.

Thanks again.

Regards,

Shawn Dukart, RPP, MCIP.
Government of Saskatchewan
Planning Consultant
Community Planning Branch, Ministry of Government Relations
Room 978, 122 - 3rd Avenue North
Saskatoon, Saskatchewan S7K 2H6
Bus: (306) 933-7883
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-----Original Message-----

From: Larry Grozell <grozell55@gmail.com>

Maggie Schwab

From: Larry Grozell <grozell55@gmail.com>
Sent: Thursday, July 11, 2019 10:25 AM
To: Maggie Schwab
Subject: Fwd: Water

Water information as requested let me know if you get what you need

----- Forwarded message -----

From: Larry Grozell <grozell55@gmail.com>
Date: Mon, Oct 29, 2018 at 12:56 PM
Subject: Re: Water
To: Adam Tittlemore <atittlemore@rmcormanpark.ca>

Hi Adam

Thank you very much for undertaking this situation. I will look forward to whatever documentation they send.

Thanks again

lg



Virus-free. www.avast.com

On Mon, Oct 29, 2018 at 11:22 AM Adam Tittlemore <atittlemore@rmcormanpark.ca> wrote:

Hi Larry,

I met with SaskWater on Friday, and there are no issues with your water supply from their standpoint. They have infrastructure capacity to provide the water, and will require only about \$2500 work of plumbing work in order to increase the supply to that point. They have made the formal request now to the City of Saskatoon for the additional allocation.

As I receive formal letters I will send them your way.

Adam Tittlemore

Administrator

R.M. of Corman Park No. 344

(306) 975-1651 (Office)

(306) 242-6965 (Fax)

www.rmccormanpark.ca

From: Larry Grozell [mailto:grozell55@gmail.com]
Sent: October-11-18 11:07 AM
To: Adam Tittlemore <atittlemore@rmccormanpark.ca>
Subject: Re: Water

Hi Adam

That is great. As the approval of Edgemont is the 15th and your meeting isn't until the 26th would you be able to share what kind of assurances Sask Water has given you that they are prepared to provide the required volumes of water to both projects. To be comfortable I would appreciate some insight. My concern is available service volume isn't somehow restricted or consumed exclusively by Edgemont after they may have been approved by the RM at the expense of what my project will require. As you can appreciate I am just attempting to avoid any curves that may develop.

Thank you for your help in this matter

Larry

On Tue, Oct 9, 2018 at 3:11 PM Adam Tittlemore <atittlemore@rmccormanpark.ca> wrote:

Hi Larry,

Things are looking good. I have received a response and am meeting with SaskWater on the 26th to finalize this and a couple other items.

Adam Tittlemore

Administrator

R.M. of Corman Park No. 344

(306) 975-1651 (Office)

(306) 242-6965 (Fax)

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From: Larry Grozell [mailto:grozell55@gmail.com]
Sent: October-09-18 9:40 AM
To: Adam Tittlemore <atittlemore@rmccormanpark.ca>
Subject: Re: Water

Hi Adam

Does it look like you are going to get an answer from Sask Water today?

lg

On Wed, Oct 3, 2018 at 10:01 AM Larry Grozell <grozell55@gmail.com> wrote:

Hi Adam

I will approach it as you wish.

thanks

lg

On Wed, Oct 3, 2018 at 9:49 AM Adam Tittlemore <atittlemore@rmccormanpark.ca> wrote:

As a further update, I have spoken to a contact at SaskWater who indicated that the account manager we had previously been working with has moved on. I have provided the request to the new manager, and cc'd it to senior management at SaskWater with a request to have it expedited. Based on the conversation I am not anticipating an issue, but will follow up as soon as I hear back again.

Thanks,

Adam Tittlemore

Administrator

R.M. of Corman Park No. 344

(306) 975-1651 (Office)

(306) 242-6965 (Fax)

www.rmccormanpark.ca

From: Adam Tittlemore

Sent: October-03-18 9:41 AM

To: 'Larry Grozell' <grozell55@gmail.com>; Michelle Chuhaniuk <mchuhaniuk@hotmail.com>

Subject: RE: Water

Hi Larry,

At this point as we have been working hard at building a relationship between the City and SaskWater to try and solve some supply issues outside of City limits I would prefer for the very short term for me to try and pursue a solution. I would suggest that if I am unable to get a firm answer by Tuesday of next week that we can escalate things from there.

Let me know your thoughts.

Thanks,

Adam Tittlemore

Administrator

R.M. of Corman Park No. 344

(306) 975-1651 (Office)

(306) 242-6965 (Fax)

www.rmccormanpark.ca

From: Larry Grozell [<mailto:grozell55@gmail.com>]

Sent: October-03-18 9:37 AM

To: Adam Tittlemore <atittlemore@rmccormanpark.ca>; Michelle Chuhaniuk <mchuhaniuk@hotmail.com>

Subject: Water

HI Adam and Michelle

It is very important and critically time sensitive to get an answer as to what Sask Water's intent is should the RM's approval for Edgemont be slated for Oct 15th

as such a multi prong approach may get more timely answers with Adam pursuing it from one end and I would be prepared to chase this with contacts I have from the other. Between all of us this question needs to be resolved quickly. Adam, if you are OK with some assistance, I would need copies of the letters of request. Would you mind e mailing a scanned copy of last Septembers letter and the new request so I have information to go in with.

Thank you

Larry

Appendix E: Storm Water Management Plan



Issue Date:	May 30, 2022	File No.:	AERIS
To:	Spencer McNie	Previous Issue Date:	n/a
From:	Jason Forest, A.Sc.T	Project No.:	2020-4488-00
Client:	Larry Grozell		
Project Name:	Ravenswood		
Subject:	Stormwater Management and MR Land		

This technical memorandum is intended to act as an addendum to the *Drainage and Stormwater Management Report* (January 2021) prepared by WSP for the proposed Ravenswood Development. The developer is proposing to change the lot layout by adding a dual-purpose public park space and stormwater management area to a future phase of the development. This memorandum describes how the reconfiguration of the lots and introduction of the park space alters the conceptual stormwater plan for the development.

The proposed public park area is planned to include a pathway and disc golf course, taking advantage of the natural terrain and vegetation. The pathway is planned to be raised above the natural ground elevation to ensure that it remains accessible shortly after storm events.

The proposed plan alteration would decrease the number of lots from 47 to 45 and increase the amount of land being publicly dedicated from 5,556 m² (previously identified as MU3) to 21,767 m². The proposed dedicated lands would encompass D7 in its entirety, and by enlarging this parcel, the previous assumption that 5,066 m³ of existing permanent storage would be lost due to development on privately owned property is no longer valid for this area.

Table 3-1 – Municipal Utilities from the WSP report has been updated with changes highlighted in green:

Where, $(A + B) - D = E$
 and
 If E exceeds C, then $E = C$

**Table 3-1
Municipal Utilities**

Catchment Area	Increased Runoff (m ³) A	Infilled Permanent Storage (m ³) B	1:100 Runoff (m ³) C	Available Permanent Storage (m ³) D	Pond Storage Required (m ³) E
CA1	173	0	635	1262	0
CA2 (MU 1)	403	6824	1478	0	1478
CA3 (MU 2)	379	549	1391	246	682
CA4 (MU 3)	1839	3849	6742	5066	622
CA5	0	0	1314	921	0
CA6 (MU 4)	234	152	857	0	386

C:\Users\priestley\Documents\workingfiles\AERIS\AERIS\mem_ravenswood_stormwater_addendum.docx

Memo To: Spencer McNie, Larry Grozell
May 30, 2022
Page 2

Catchment Area	Increased Runoff (m ³) A	Infilled Permanent Storage (m ³) B	1:100 Runoff (m ³) C	Available Permanent Storage (m ³) D	Pond Storage Required (m ³) E
CA7 (MU 5)	814	1312	2984	0	2126
CA8 (MU 6)	469	1522	1720	0	1991

The grading is designed to excavate within depression D7 to build up the walking paths and provide the additional 622 m³ stormwater storage required. An estimated 1,400 m³ of excess excavation during construction will be hauled off-site, more than the required 622 m³ to meet the permanent storage requirements. The spill elevation will be left unchanged at 502.50 at the NW end of the new MR parcel. Two (2) culverts will be installed to allow stormwater to flow through the NW discharge, where it will pond and eventually spill to the West.

This technical memorandum was prepared for Ravenswood to act as an addendum to the *Drainage and Stormwater Management Report* (January 2021) prepared by WSP for the proposed Ravenswood Development.

Prepared by:

 Jason Forest
2022.05.30
14:00:14 -06'00'

Jason Forest, A.Sc.T
Project Technologist

Reviewed by:



Ryan Karsgaard, P.Eng.

ASSOCIATION OF PROFESSIONAL ENGINEERS
AND GEOSCIENTISTS OF SASKATCHEWAN
CERTIFICATE OF AUTHORIZATION
ASSOCIATED ENGINEERING (SASK.) LTD.

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CIVIL	09763	



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Signature:	
Date:	May 30, 2022

LARRY GROZELL

RAVENSWOOD SUBDIVISION DRAINAGE AND STORMWATER MANAGEMENT REPORT REVISION 3



RAVENSWOOD SUBDIVISION

DRAINAGE AND STORMWATER MANAGEMENT REPORT

LARRY GROZELL

FINAL REPORT (REVISION 3)

PROJECT NO.: 201-02834-00
DATE: FEBRUARY 23, 2021

WSP

WSP.COM

SIGNATURES

PREPARED BY



Riley Jestin, P.Eng
Senior Engineer, Municipal Engineering

Feb 23, 2021

Date

APPROVED¹ BY *(must be reviewed for technical accuracy prior to approval)*



Chad Bialobzyski, P.Eng
Manager, Infrastructure

Feb 23, 2021

Date

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1 GENERAL

1.1 INTRODUCTION

WSP was retained to complete a drainage and stormwater management report for the Ravenswood Development, a proposed rural residential development located on NE 28-35-5 W3M within the RM of Corman Park. The purpose of this report is to summarize the preliminary drainage design and stormwater management review completed for the proposed development. Associated Engineering (AE) was approached for a second opinion and revised some of WSP's original assumptions, specifically AE removed the 25% increase to the storm water runoff calculations and lowered the SBE elevation from 1.0m to 0.5m from the nearest spill point elevation, along with some minor revisions to the road and lot layouts. The Client has claimed that this was approved by WSA. The original safe building elevation was chosen based on the development not having defined major overland flow outlet. WSP accepts the safe building elevation of 0.5m as approved by WSA. This report reflects these changes.

1.2 PROJECT DESCRIPTION

The proposed development will be located on private agricultural land located West of Clarence Avenue and the Casa Rio Estates. The project will include up to 47 individual residential lots averaging approximately 0.8ha (2 acres) in size. In addition, the project includes 2km of asphalt road to access the properties. The plan is divided up into 2 Blocks; Block 1 has 41 lots and Block 2 has 6 lots as well as a parcel dedicated for Ag Holding zoning. Lot 1 Block 2 and the Ag Holding Land are already developed and would not be altered within this development.

1.3 EXISTING LAND USE

The primary use of the existing land is for agricultural purposes with trees located in localized depressions. The existing site topography includes rolling hills with a substantial vegetated area and localized low areas. There is an existing Community Care Centre and Community Facility located on the east portion of the quarter section. This area will not be changed or disturbed as part of this development. The soil on the site is described as sandy in the Hydrogeological Investigation (attached in Appendix D) and Geotechnical Investigation (available upon request), both prepared by P.Machibroda Engineering Ltd. The site area totals 59.4ha.

1.4 TOPOGRAPHY

The pre-development drainage pattern is rolling topography that results in "fill and spill" drainage patterns within should these areas ever fill to capacity. The majority of the site presently drains to internal localized low point or depressions, where water would infiltrate into the sandy soil.

There are five locations where these depressions would drain onto adjacent properties if sufficient ponding were to occur:

- In the north west corner there is a natural depression at approximately 502.75 that spills to the west if the water elevation was to exceed approximately 503.70,
- along the west property line there is a natural depression at approximately 501.75 that spills to the west if the water elevation was to exceed approximately 502.75,

- on the south east area of the property there is an existing low area in the treed bluff south of the existing community care facility at an elevation of 502.25, which eventually spills to the ditch along the west side of Clarence Ave. at an elevation of approximately 502.5,
- on the west side of the south property line there is a natural depression at approximately 505.25 that spills to the south if the water elevation was to exceed approximately 505.90,
- on the east side of the south property line there is a natural depression at approximately 503.30 that spills to the south if the water elevation was to exceed approximately 503.70.

1.5 HISTORICAL DATA

Appendix B contains air photos from between 2002 and 2017 that are overlain with the proposed subdivision and existing local depressions. A review of the historical imagery indicates that almost all of the depressions are normally dry. This indicates high rates of infiltration throughout the proposed development area. The only depression that has an indication of standing water from 2002 to 2017 is D3 in the North East corner of the development. As the majority of the existing depressions are normally dry, it is assumed that under normal circumstances local depressions or constructed stormwater ponds will be available to use as permanent stormwater storage. D3 will be assumed to have standing water and stormwater for this catchment area will be handled differently as described in later sections.

In addition to the aerial photos over the years, on July 11th, 2017, a 1:25 year storm event occurred in the direct vicinity of the subdivision where a recorded 49.3mm of rainfall occurred. The owner recorded pictures taken within 24hrs of that event. Appendix C contains a news article for the event, as well as photos from the area within 24 hours. The pictures show that almost all of the depressions were absent of standing water with the exception of D4 that contained a very small amount. It is understood that this area dried up shortly after. Providing that even after a 1:25 year rain event the site shows very little standing water demonstrates that the site is capable of handling consecutive major rain events, and that the on-site permanent depression storage would be available for the 1:100 year event.

1.6 HYDROGEOLOGICAL INVESTIGATION

A hydrogeological investigation, supplied in Appendix D, was conducted on the proposed project site by P.Machibroda Engineering on June 30, 2017 for the purposes of investigation the suitability of the soil for sanitary treatment mounds. The field investigation consisted of drilling 13 test holes at various locations on the site ranging in depth from 6 to 18m deep. Four monitoring wells were installed for the purpose of monitoring groundwater elevations, collection of groundwater samples and to allow hydraulic conductivity testing.

This project is not considering sanitary treatment options; however, the review of the ground water monitoring results indicated a downward vertical gradient of 0.1 exists on the site. This is an indication that the site is located in an area of ground water recharge and that the groundwater at the site is flowing downward from the ground surface towards the water table. Hydraulic conductivity tests were performed on the subsurface soils (3.5m to 6.0m deep) and were found to be vary from between 10^{-6} to 10^{-7} for sandy soils and 10^{-8} for clay soils.

Results of soil classification and index tests conducted on representative samples of soil revealed that the surficial soils at the site are classified as “loam”, “sandy loam”, “silty clay loam” and /or “silty clay”.

The ground water levels measured on June 5, 2017 were between 1.5 and 5m deep, and there was very little difference in groundwater levels between May 2017 and June 2017. It is noted that the airphoto in Appendix B for July 8 2017 indicates that the northeast corner had standing water, with no other standing water in existing on site depressions, which is consistent with the findings of the Hydrogeological Report. During the investigation, no

surface water was located within the footprint of the proposed subdivision, there was however a slough located at the northeast corner of the ¼ section, which corresponds to local depression D3.

The conceptual hydrogeological model indicated that the property overlies a large surficial aquifer that includes stratified sand, silt and clay deposits. All of the water in the surficial aquifer originates as precipitation which has infiltrated downward from the ground surface to the water table which forms the upper surface of the aquifer. Recharge occurs seasonally, mainly during intensive or long duration rainstorms. Ground water which enters the surficial aquifer moves downward and laterally, either to charge deeper aquifers or to discharge to local topographic depressions. One of these local depressions could be depression D3 in the North East corner of the ¼ section. There is no indication that the aquifer discharges to any other location on the site.

1.7 GEOTECHNICAL INVESTIGATION

A geotechnical investigation was conducted on the proposed project site by P.Machibroda Engineering in April, 2017. The field investigation consisted of drilling 12 test holes at various locations on the site.

Based on the assessment of the soils from the test holes, the soil profile consisted of a thin layer of organic topsoil at the ground surface (50 mm to 100 mm thick) that was underlain by variable deposits of silt, sand and/or clay that extended to the maximum depth explored during investigation (18m) Clay was generally encountered below a depth of 1.5 meters from the ground surface. Cobblestones and/or boulders were not encountered to the full depth explored.

Groundwater seepage and sloughing were encountered in saturated sand and/or silty layers during test drilling. The ground water table appeared to be situated at depths between 1.5m to 6.7 m below the existing ground surface.

2 ANALYSIS METHODOLOGY

2.1 PRE AND POST DEVELOPMENT DRAINAGE

Conservatively, we recommend using the runoff generated during wet antecedent moisture conditions to determine the storage required for the post-development scenario; this required storage can be achieved by utilizing natural depressions or excavating stormwater ponds where necessary. Each catchment area will have a dedicated Municipal Utility that will be designated around a permanent storage areas or constructed pond to protect it from future alterations. In order to decrease the area required by Municipal Utilities, constructed storage ponds will be strategically located to capture the runoff for the specified catchment area. The ponds will be constructed in an existing depression to limit the amount grading required to collect runoff.

The tributary catchment areas and the local depressions for the pre-development condition are presented in Drawing C-1, and the tributary catchment areas and local depressions as well as constructed municipal utilities for the post-development condition are presented in Drawing C-2. The pre-development and post-development tributary catchment areas were delineated to determine the runoff volumes for the design storm to assess the relative runoff generation for the pre-development and post-development condition. In the post-development condition, the MU's will be used as depression storage and are sized so that existing depressions may be filled in and the MU's will still have adequate capacity for the post-development runoff volumes.

2.2 DESIGN RAINFALL EVENTS

The City of Saskatoon Design Standards for major systems was used for the runoff calculations for this area. Table B-4 in Appendix B of the City of Saskatoon Design and Development Standards Manual indicates the 1:100 year 24 event produces 96.5mm of rain fall. As per RM of Corman Park policies, the 1:100 event will be used for stormwater calculations for the pre-development and the post-development conditions.

Additional parameters to compute runoff volumes include the physical parameters of the subcatchments, such as drainage areas and the land surface characteristics.

The Natural Resources Conservation Service (NRCS) method was used to determine the runoff characteristics of the soils in the study area.

In the NRCS method soils are divided into four hydrologic soil groups (HSG), A, B, C and D, according to their minimum infiltration rate. The characteristics of the hydrologic soil groups are as follows:

- Group A: High infiltration rates (low runoff potential); well to excessively drained deep sands or gravel; deep loess; aggregated silts.
- Group B: Moderate infiltration rates when thoroughly wetted; moderately deep to deep; moderately well to well drained; moderately fine to moderately coarse textures, shallow loess; sandy loam.
- Group C: Low infiltration rates when thoroughly wetted; soils with a layer that impedes downward water movement; moderately fine to fine texture; clay loams; shallow sandy loams; soils low in organic content; soils usually high in clay.

Group D: Very low infiltration rates (high runoff potential) when thoroughly wetted; clay soils with high swelling potential; permanent high water table; claypan or clay layer at or near the surface; heavy plastic clays; certain saline soils.

Based on the above description of the HSGs and the subsurface soils within the study area being predominately comprised of sandy soils as described in the geotechnical report, which is conducive to high infiltration rates, the soils were classified as HSG A.

The rational method was used to compute runoff volumes for the pre-development and post-development condition. The runoff coefficient, C, is a number between 0 and 1 that reflects the ability of the drainage area to convert rainfall to runoff. It is a composite runoff factor representing the combined effect of ground cover, soil type, soil moisture condition, surface slope, rainfall intensity, storm return period, and other hydrologic factors. Values of the runoff coefficient, C, are provided in the literature that are based on the Natural Resources Conservation Service Hydrologic Soil Groups (NRCS HSG), average surface slope, and storm return period.

The following runoff coefficients which were determined from values provided in the literature and shown in Table 2.1 were used to compute runoff volumes for the pre-development and post-development condition.

Table 2.1 Runoff Coefficients, C, for Storms with a Return Period of 100 Years

Slope	Soil Group A		
	<2%	2-6%	>6%
Forrest	0.08	0.11	0.14
Meadow	0.14	0.22	0.30
Pasture	0.15	0.25	0.37
Farmland	0.14	0.18	0.22
Industrial	0.85	0.85	0.86
Commercial	0.88	0.88	0.89
Streets	0.76	0.77	0.79
Parking	0.95	0.96	0.97
Disturbed Areas	0.65	0.67	0.69
Residential Lot	0.22	0.26	0.29

As described above, the runoff coefficient varies with the return period of the storm, therefore Table 2.1 indicates runoff coefficients as a function of the storm return period. The pre-development condition is predominantly rolling farmland with slopes greater than 6%. The post-development will add harder surfaces such as roads, driveways and structures that will increase the runoff coefficient for those area. The grading design will try to limit the road and driveway grades to a maximum of 6% where allowed.

2.3 PRE-DEVELOPMENT CONDITIONS

Table 2.2 on the following page shows the total direct runoff calculated for the wet antecedent moisture condition for the entire development for the 1:100 year storm, divided into the individual catchment areas identified in Drawing C-1. Due to the sandy soil onsite, there is very little direct runoff even given the Wet Antecedent Moisture Condition. This was confirmed via historical aerial photo review in Appendix B, the recorded 1:25 year storm event in Appendix C and the Hydrogeological Report in Appendix D.

Table 2.2 Pre-development Runoff

Catchment	Area	Depression	Spill elevation	Permanent Storage	Runoff Coefficient	Pre-development Runoff
	(m ²)		(m)	(m ³)		(m ³)
Catchment 1	21,760	D1	503.70	1,262	0.22	462
Catchment 2	51,077	D4	504.40	6,824	0.22	1,084
Catchment 3	47,654	D2	502.20	246	0.22	1,012
		D3	501.25	549		
Subtotal				795		
Catchment 4	224,365	D5	502.90	844	0.22	4,763
		D6	502.75	1,128		
		D7	502.50	5,066		
		D8	503.20	1,191		
		D9	503.40	178		
		D10	503.75	508		
Subtotal				8,915		
Catchment 5	53,103	D11	503.75	549	0.26	1,332
		D12	503.40	265		
		D13	502.90	107		
Subtotal				921		
Catchment 6	29,592	D22	502.50	152	0.22	628
Catchment 7	102,434	D14	504.00	206	0.22	2,175
		D18	504.90	307		
		D19	504.40	124		
		D20	504.00	425		
		D21	503.70	250		
Subtotal				1,312		
Catchment 8	63,086	D15	505.90	608	0.22	1,339
		D16	506.20	460		
		D17	505.90	454		
Subtotal				1,522		

Catchment	Area	Depression	Spill elevation	Permanent Storage	Runoff Coefficient	Pre-development Runoff
TOTAL	593,071			14,879		12,796

2.4 POST-DEVELOPMENT CONDITIONS

The post-development condition will result in a greater proportion of the site developed and therefore an increase in impermeable surfaces resulting in greater runoff volumes. The SCS Method calculations take into consideration the percentage of impervious surfaces for the post-development scenario. The percent of impervious surfaces of the average residential lot is estimated to be 15%, which allows for a 400 m² house, 300 m² outbuildings, and 600 m² driveway within an average 8,000m² lot. The percent impervious of the entire development for the post-development scenario is estimated to be 15%, which conservatively assumes sealed roads and driveways. In addition to more runoff, a most of the depressions will be filled in to create roads, or for practical drainage reasons and will not be available for storage. In addition, the depressions that are not located within a MU have been assumed to be filled in and are not available for the depression storage calculations. Their volumes have been included in the MU volume calculations.

Table 2.3 below shows the total direct runoff calculated for the post-development condition for the 1:100 year storm, divided into the individual catchment areas identified in Drawing C-2. Depressions that may be filled in have been removed (crossed out) from the available storage calculation and considered permanent storage infill that will be taken into account when calculating the required storage.

Table 2.3 Post-development Runoff

Catchment	Area	Dep	Spill EL.	Perm Storage	Runoff Coefficient		Post-development Runoff	Diff of Pre and Post Runoff	Permanent Storage infill
	(m ²)		(m)	(m ³)	85% Farmland	15% hard Surface	(m ³)	(m ³)	
Catchment 1	21,760	D1	503.70	1,262	0.22	0.77	635	173	0
Catchment 2	51,077	D4	504.40	6824	0.22	0.77	1,491	407	6,824
Catchment 3	47,654	D2	502.20	246	0.22	0.77	1,391	379	549
		D3	501.25	549					
Subtotal				246					
Catchment 4	224,365	D5	502.90	844	0.22	0.77	6,549	1,786	8,915
		D6	502.75	1128					
		D7	502.50	5066					

Catchment	Area	Dep	Spill EL.	Perm Storage	Runoff Coefficient		Post-development Runoff	Diff of Pre and Post Runoff	Permanent Storage infill
		D8	503.20	1191					
		D9	503.40	178					
		D10	503.75	508					
Subtotal				0					
Catchment 5	53,103	D11	503.75	549	0.26	0.26	1,332	0	0
		D12	503.40	265					
		D13	502.90	107					
Subtotal				921					
Catchment 6	29,592	D22	502.50	152.32	0.22	0.77	864	236	152
Catchment 7	102,434	D14	504.00	206	0.22	0.77	2,990	816	1,312
		D18	504.90	307					
		D19	504.40	124					
		D20	504.00	425					
		D21	503.70	250					
Subtotal				0					
Catchment 8	63,086	D15	505.9	608	0.22	0.77	1,842	502	1,522
		D16	506.2	460					
		D17	505.9	454					
Subtotal				0					
TOTAL	593,071			2,581			17,095	4,299	19,274

A summary of each catchment’s storage requirements is found in Section 3.2 Municipal Utilities.

3 PRELIMINARY GRADING DESIGN

3.1 GENERAL GRADING PLAN

The general grading and drainage of the site has been incorporated into Drawing C-2 Post-Development Site Plan. The grading plan includes general road design elevations and slopes, drainage culverts, drainage easements, local depression storage and Municipal Reserves. The grading plan attempts to match into the existing site grading as much as possible in order to minimize earthworks excavation required for development and to maintain pre-existing flow conditions. On each local depression and constructed stormwater pond, the spill over point and elevation are shown that indicate how the surface runoff is anticipated to flow on site and where it would drain off the site in a storm event greater than the 1:100 year event. Final drainage flow paths are to be further developed during detailed design to control flows in road right-of-way ditches and to mitigate concentrated flows from crossing the middle of lots. Additionally, grading between low points could be considered during detailed design to lower the tip-out elevations and improve drainage for this subdivision.

3.2 MUNICIPAL UTILITY PARCELS

The purpose of the Municipal Utility (MU) parcels is to have areas of development that are protected from future development or alteration. MU's will be areas designated for stormwater collection and be designated land for stormwater ponds. Existing depressions are relatively shallow with a large footprint and while they could contain some of the required stormwater storage, they will mostly not be located within the protection of the MU and will be at risk of being infilled by property owners. Stormwater ponds within the MU's will be constructed in areas of existing depressions to take advantage of the existing drainage patterns and will be sized to contain the required stormwater storage assuming all local depressions outside of the MU's are filled in. The stormwater ponds will be sized so that all stormwater will be held on site as permanent storage.

Constructed ponds should be designed and constructed to permit infiltration at the same rate as provided by the native sandy soils. It is recommended that geotechnical investigations at Municipal Utility locations be completed to confirm absence of silt layer at the specific locations.

The differentiation between active and permanent can be simplified to, whether the water leaves site or not. Permanent storage must remain on-site, whether in open water or infiltrates/evaporates, whereas active storage generally flows offsite at a pre-development rate. Each catchment area will have sufficient permanent storage within the Municipal Utility. Local depressions that are not located within the Municipal Utility will also be considered lost permanent storage, since they will not be protected from future infill.

A few different methods will be utilized for capturing and controlling the stormwater runoff that will depend on the specifics in each catchment area. In general, the difference between the pre-development and post-development condition is required to be captured before overflowing onto the adjacent land. Each catchment area will be required to have sufficient on-site permanent storage to contain the difference between the pre-development and post-development 1:100 year runoff as well as any permanent storage lost due to infilling local depressions with roads or other topographical features. Local depressions that are not located within the Municipal Utility will also be considered lost permanent storage, since they will not be protected from future infill.

In cases where the difference between the pre-development and post-development condition plus the lost permanent storage is greater than the total amount of runoff generated by the 1:100yr event, a single pond will be constructed to hold the entire 1:100yr event runoff. This will provide an adequate amount of storage for the catchment area.

Table 3.1 on the following page indicates the pond requirement for each catchment area given the above criteria.

Table 3.1 Municipal Utilities

Catchment Area	Increased Runoff	Infilled Permanent Storage	1:100 runoff	Available Permanent Storage	Pond Storage Required
	(m ³)	(m ³)	(m ³)	(m ³)	(m ³)
CA1	173	0	635	1262	0
CA2 (MU 1)	407	6824	1491	0	1491
CA3 (MU 2)	379	549	1391	246	682
CA4 (MU 3)	1786	8915	6549	0	6549
CA5	0	0	1332	921	0
CA6 (MU 4)	236	152	864	0	388
CA7 (MU 5)	816	1312	2990	0	2128
CA8 (MU 6)	502	1522	1842	0	2024

- Catchment 1 has sufficient permanent storage available on site. No permanent storage is lost to infilling. The area of the existing depression is located within utility easements and will be protected from future infilling by land owners.
- Catchment 2 has one depression, D4, that will not be fully located within the MU and will therefore be considered lost permanent storage. The increased runoff is 407m³ and the lost permanent storage from D4 is 6,824m³, for a total of 7,231m³. The total runoff generated from the 1:100yr storm event is 1,491m³. A single stormwater pond will be constructed within MU 1 to hold the 1:100 yr runoff that will be a minimum of 1,491m³. Preliminary calculations indicate that a pond with area of 1,344m² with rough dimensions of 65m long, 21m wide, and 1.5m deep with a spill over point of 504.0 would have sufficient storage to accommodate the difference between the pre-development and post-development runoff, as well as the infilled permanent storage.
- Catchment 3 has two depressions, D2, and D3. As noted in Section 1.5 depression D3 was noted to already have standing water in it and will be considered lost permanent storage of 549m³, while D2 provides 246m³ of storage and is located within a proposed utility easement. The increased amount of runoff is 379m³. A single stormwater pond will be constructed within MU 2 to the increased runoff plus the lost permanent storage, minus the available storage from D2 for a total of 682m³. Preliminary calculations indicate that a pond with area of 1,337m² with rough dimensions of 91m long, 15m wide, and 1.5m deep with a spill over point of 501.30 would have sufficient storage.
- Catchment 4 has six depressions on site that will either be filled in for roads or will not be located within the MU and will therefore be considered lost permanent storage. Depressions D9 and D10 will be infilled to create the North/South subdivision road. Depression D8 will remain on Lot 19, D5 will remain on Lot 10, and D6 will remain on Lot 9 and will not be located within MU 3. A single pond will be constructed in the location of D7. The increased runoff is 1,786m³ and the lost permanent storage from the depressions is 8,915m³, for a total of 10,701m³. The total runoff generated from the 1:100yr storm event is 6,549m³. A single stormwater pond will be constructed to hold the 1:100 yr runoff that will be a minimum of 6,549m³.

Preliminary calculations indicate that a pond with area of 5,556m² with rough dimensions of 150m long, 37m wide, and 1.5m deep with a spill over point of 502.9 would have sufficient storage to accommodate the difference between the pre-development and post-development runoff, as well as the infilled permanent storage.

- Catchment 5 is comprised of an existing developed area and will not be altered for this project, therefore no additional storage is required.
- Catchment 6 currently has one natural depression, D22, located within trees on Lot 2 Block 2. The pond currently does not have sufficient capacity to handle the increased runoff and will not be located within the MU. A single pond within MU 4 will be constructed south of D22 and will intercept the runoff that is collected in D22. The volume of D22 will be considered lost permanent storage. The pond will be required to hold the increased runoff plus the lost permanent infilled storage for a total 388m³ of water before spilling over into the adjacent land. Preliminary calculations indicate that a pond with area of 282m² with rough dimensions of 20m long, 14m wide, and 2.5m deep with a spill over point of 502.50 would have sufficient storage to accommodate the difference between the pre-development and post-development runoff, as well as the infilled permanent storage.
- Catchment 7 has five depressions on site that will either be filled in for roads or will not be located within the MU and will therefore be considered lost permanent storage. Depressions D14 and D20 will be infilled to create the North/South subdivision road. Depressions D18 and D19 will remain on lots 35, 36, 37, and 38 and not be located within the MU. The single pond will be constructed in MU 5 and near the location of D21 south between lots 39 and 40 in Block 1. The pond will be required to hold 2,128m³ of water before spilling over into the adjacent land. Preliminary calculations indicate that a pond with area of 2,340m² with rough dimensions of 102m long, 22m wide, and 1.5m deep with a spill over point of 503.75 would have sufficient storage to accommodate the difference between the pre-development and post-development runoff, as well as the infilled permanent storage.
- Catchment 8 has insufficient permanent storage available on site. Depression D16 will be filled to create the cul-de-sac and Depression D15 will remain in lot 27 but will not be located within the MU. A single dedicated pond will be constructed in MU 6 in between lots 28 and 29 near Depression D17. The pond will be constructed to hold at least 2,024m³ of runoff before spilling over at 505.9m. Preliminary calculations indicate a pond 8m wide, 250m long and 1.5m deep will have sufficient capacity. The volume will have sufficient permanent storage to hold the difference between the pre-development and the post-development runoff as well as the lost permanent storage from infilling D15, D16, and D17. Depression D15 will remain on Lot 27 with a drainage path to ensure that it spills to the same spill location as the constructed utility. Preliminary calculations indicate that a pond with area of 1,684m² with rough dimensions of 91m long, 18m wide, and 2.5m deep with a spill over point of 505.90 would have sufficient storage to accommodate the difference between the pre-development and post-development runoff, as well as the infilled permanent storage.

3.3 SAFE BUILDING ELEVATIONS

The original safe building elevation of 1.0m was chosen based on the development not having defined major overland flow outlet. Section 6.7.4 of The Statements of Provincial Interest Regulations requires flood-proofing of new buildings and additions to buildings to an elevation 0.5 metres above the 1:500 year flood elevation of any watercourse or water body in the flood fringe. WSP therefore accepts Associated Engineering's modification of the Safe Building Elevations (SBE) to be 0.5m above the spillover elevation of the nearest Municipal Utility. Since all local depression storage has been accounted for in the Municipal utilities, a landowner would be able to fill in local depressions to avoid ponding in those areas if required. All lots have a suitable spot on the property that would accommodate this elevation and would only need to have material moved around on site to make a level pad for a building. WSP has identified a possible building location for each lot that would accommodate this building elevation. Drawing C-3 shows a possible location for a 400m² house on lots that have a suitable area at or above the

safe building elevation. Table 3.1 on the following page indicates the SBE for each lot and the corresponding MU spill point elevation. Gravel or asphalt driveways would be constructed at grade which would allow water to drain over them and not impede any existing drainage.

Table 3.2 Safe Building Elevations

Block	Lot	Nearest Municipal Utility	Nearest Spill Elevation	Safe Building Elevation	Available on Site	Block	Lot	Nearest Depression	Nearest Spill Elevation	Safe Building Elevation	Available on Site
1	1	MU 2	501.30	501.80	YES	1	25	MU 6	505.90	506.40	YES
1	2	MU 1	504.00	504.50	YES	1	26	MU 6	505.90	506.40	YES
1	3	MU 1	504.00	504.50	YES	1	27	MU 6	505.90	506.40	YES
1	4	MU 1	504.00	504.50	YES	1	28	MU 6	505.90	506.40	YES
1	5	MU 1	504.00	504.50	YES	1	29	MU 6	505.90	506.40	YES
1	6	MU 1	504.00	504.50	YES	1	30	MU 6	505.90	506.40	YES
1	7	D1	503.70	504.20	YES	1	31	MU 6	505.90	506.40	YES
1	8	D1	503.70	504.20	YES	1	32	MU 6	505.90	506.40	YES
1	9	MU 3	502.90	503.40	YES	1	33	MU 5	503.75	504.25	YES
1	10	MU 3	502.90	503.40	YES	1	34	MU 5	503.75	504.25	YES
1	11	MU 3	502.90	503.40	YES	1	35	MU 5	503.75	504.25	YES
1	12	MU 3	502.90	503.40	YES	1	36	MU 5	503.75	504.25	YES
1	13	MU 3	502.90	503.40	YES	1	37	MU 5	503.75	504.25	YES
1	14	MU 3	502.90	503.40	YES	1	38	MU 5	503.75	504.25	YES
1	15	MU 3	502.90	503.40	YES	1	39	MU 5	503.75	504.25	YES
1	16	MU 3	502.90	503.40	YES	1	40	MU 5	503.75	504.25	YES
1	17	MU 3	502.90	503.40	YES	1	41	MU 4	502.50	503.00	YES
1	18	MU 3	502.90	503.40	YES	2	1	MU 4	502.50	503.00	Existing
1	19	MU 3	502.90	503.40	YES	2	2	MU 4	502.50	503.00	YES
1	20	MU 3	502.90	503.40	YES	2	3	MU 4	502.50	503.00	YES
1	21	MU 3	502.90	503.40	YES	2	4	MU 5	503.75	504.25	YES
1	22	MU 3	502.90	503.40	YES	2	5	MU 3	502.90	503.40	YES
1	23	MU 3	502.90	503.40	YES	2	6	MU 3	502.90	503.40	YES
1	24	MU 6	505.90	506.40	YES						

4 SUMMARY

The findings of this drainage and stormwater management report conclude that due to the sandy site soil and rolling topography of the site, the stormwater can be handled with permanent on-site storage. While the existing depressions could handle much of the required volume, they would not be protected from future infill. Permanent storage ponds will be constructed in Municipal Utilities. The report calculates the estimated post-development runoff from each catchment.

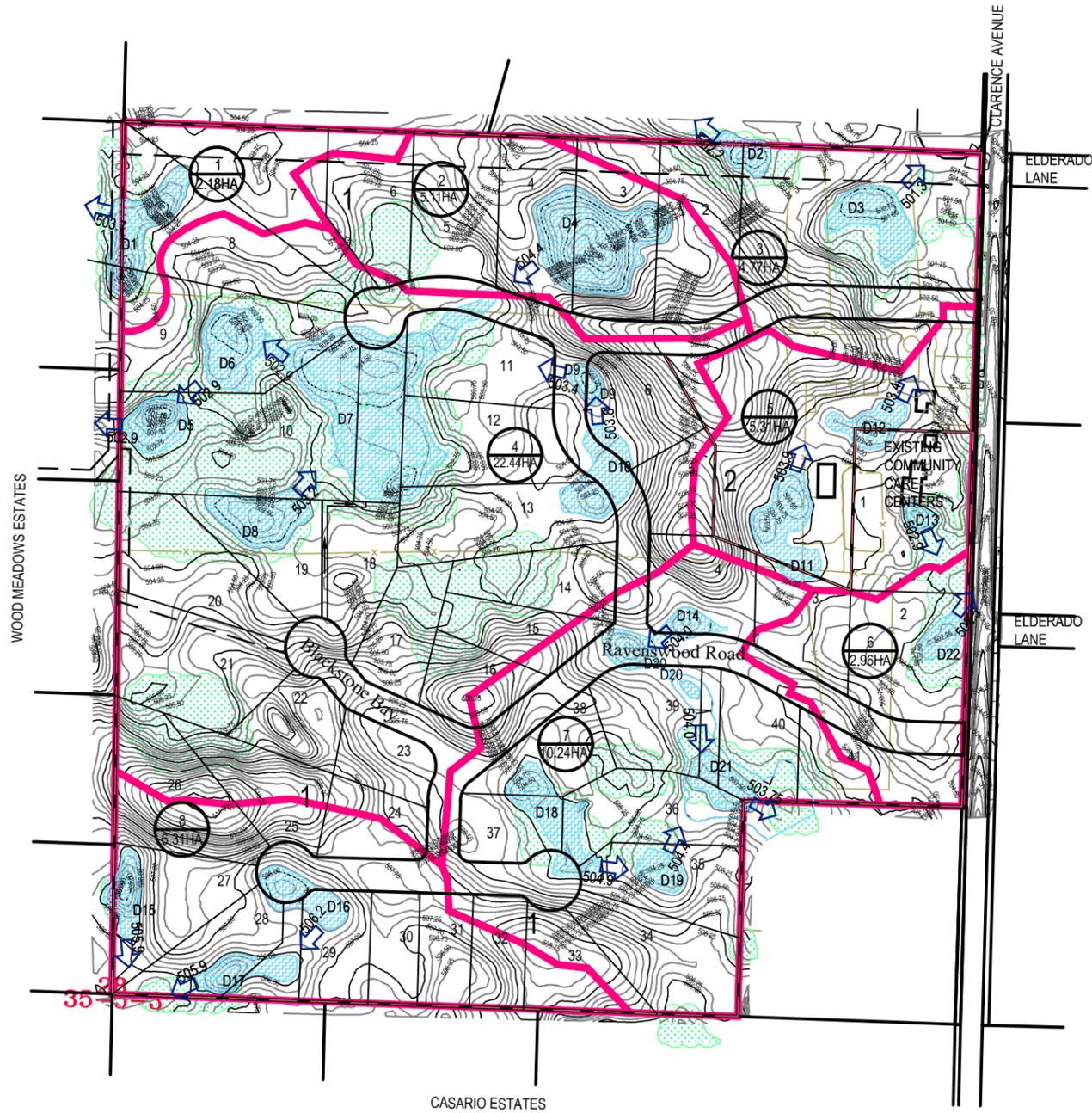
- The preliminary grading plan ensures that there is sufficient stormwater storage available to accommodate the 1:100 year storm event by way of existing permanent storage or constructed stormwater ponds.
- Each Catchment Area will require a designated Municipal Utility area.
- Safe Building elevations have been shown and proposed building locations for each lot have been identified.

This report was prepared using preliminary design grading for the purposes of conceptual stormwater management review. Detailed design of roads, lots grades and constructed detention ponds will be required during the detailed design phase of the development.

APPENDIX

A DRAWINGS





LEGEND

- EXIST. GROUND CONTOUR — 504.00 —
- EXIST. BUSH
- EXIST. FENCE — x — x —
- EXIST. DEPRESSION AREA
- SPILL OVER DIRECTION/ELEVATION 504.9
- MUNICIPAL UTILITY (MU)
- CATCHMENT DELINEATION
- CATCHMENT LABEL / AREA LABEL AREA
- PHASE NUMBER 2

NOTE:
ELEVATIONS ARE
REFERENCING FEDERAL
BENCHMARK 79S295,
ELEVATION 507.156



203 WELLMAN CRESCENT
SASKATOON SASKATCHEWAN CANADA S7T 0J1
TEL.: 306-665-6223 | FAX: 306-665-8589 | WWW.WSPGROUP.COM

CLIENT:

**RAVENSWOOD
SUBDIVISION**

CLIENT REF. #:

PROJECT:

**STORMWATER
DRAINAGE STUDY**

SEAL:

PRELIMINARY ONLY
FOR REVIEW ONLY—NOT FOR CONSTRUCTION

PROJECT NO:
201-02834-00

DATE:
FEB 22 2021

ORIGINAL SCALE:
1:5000

IF THIS BAR IS NOT 1" LONG,
ADJUST YOUR PLOTTING SCALE.

DESIGNED BY:
RJJ

DRAWN BY:
MRL

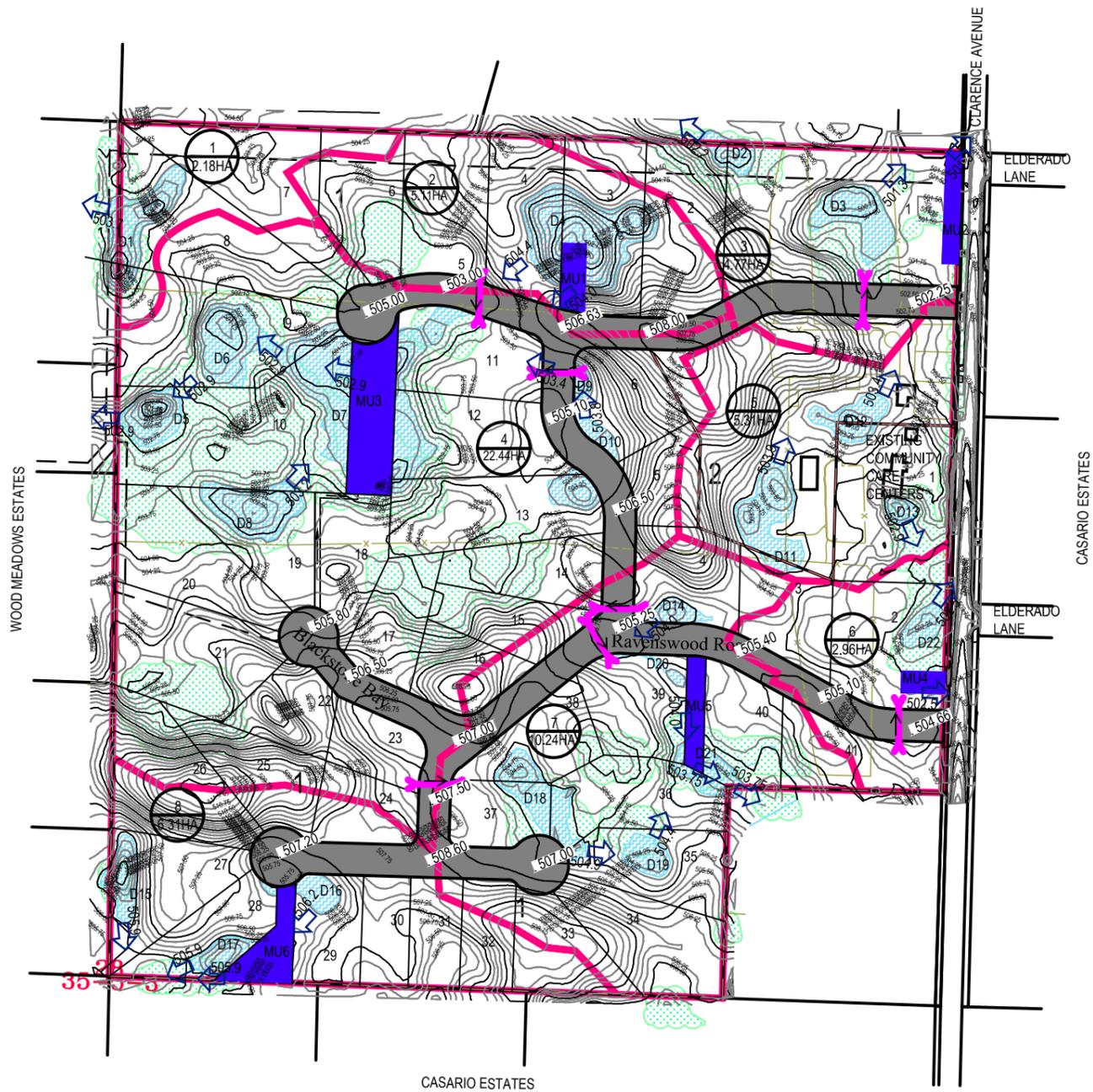


TITLE:

**PRE-DEVELOPMENT
SITE PLAN**

DRAWING NO:
C-1

RV. #
D



LEGEND

- EXIST. GROUND CONTOUR — 504.00 —
- EXIST. BUSH 
- EXIST. FENCE — x — x —
- EXIST. DEPRESSION AREA 
- SPILL OVER DIRECTION/ELEVATION  504.9
- MUNICIPAL UTILITY (MU) 
- CATCHMENT DELINEATION 
- CATCHMENT LABEL / AREA 
- LOT NUMBER 12
- BLOCK NUMBER 2
- PROPERTY LIMIT 
- CULVERT AND FLOW DIRECTION 
- ROAD ELEVATION 507.15

NOTE:
ELEVATIONS ARE
REFERENCING FEDERAL
BENCHMARK 79S295,
ELEVATION 507.156



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SASKATOON SASKATCHEWAN CANADA S7T 0J1
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FEB 22 2021

ORIGINAL SCALE:
1:5000

IF THIS BAR IS NOT 1" LONG,
ADJUST YOUR PLOTTING SCALE.

DESIGNED BY:
RJJ

DRAWN BY:
MRL

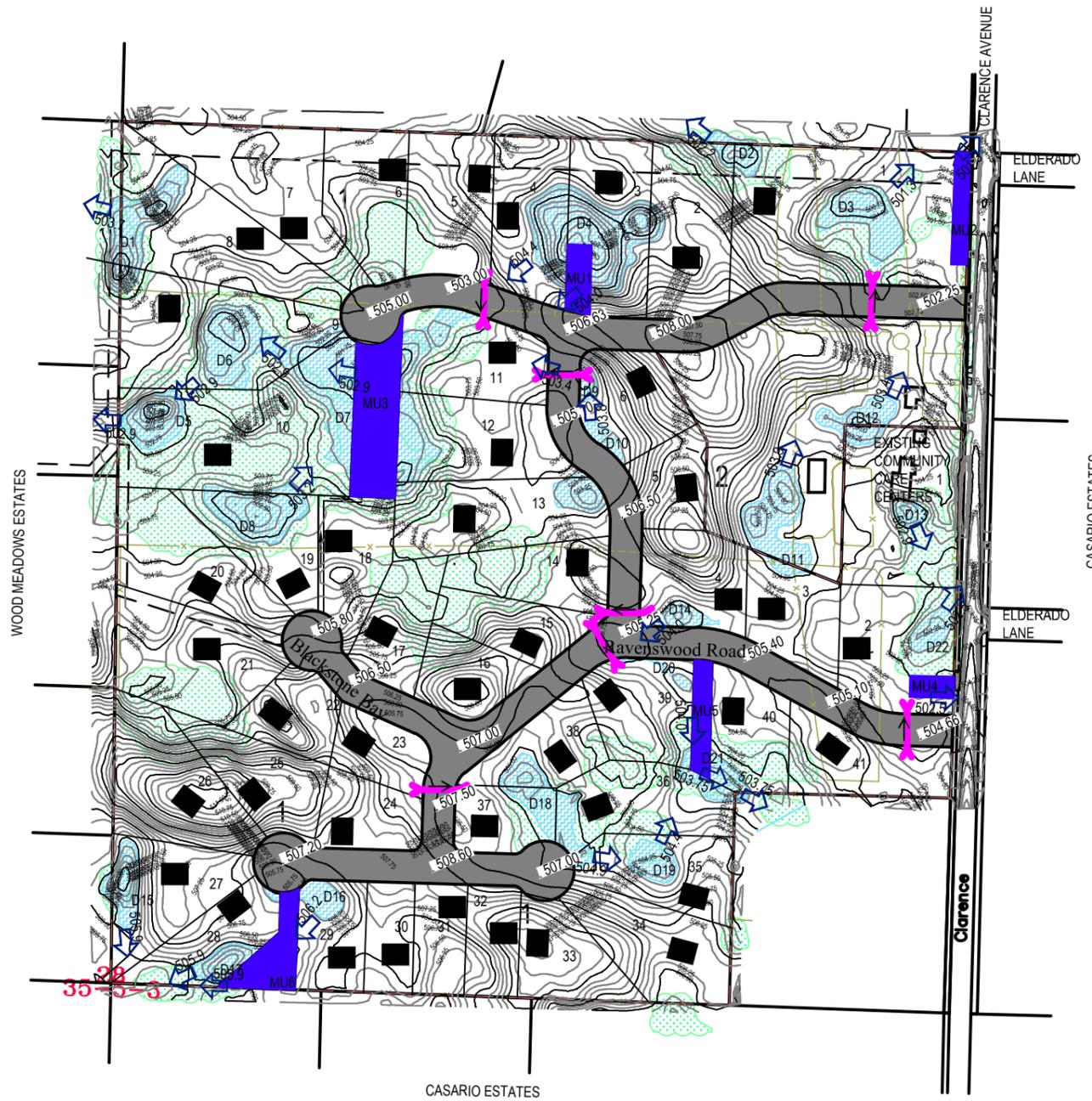


TITLE:

**POST-DEVELOPMENT
SITE PLAN**

DRAWING NO:
C-2

RV. #
D



- EXIST. BUSH
- EXIST. FENCE
- EXIST. DEPRESSION AREA
- SPILL OVER DIRECTION/ELEVATION 501.3
- MUNICIPAL UTILITY (MU)
- LOT NUMBER 12
- BLOCK NUMBER 2
- PROPERTY LINE
- PROPOSED HOUSE LOCATION
- CULVERT AND FLOW DIRECTION
- ROAD ELEVATION 507.15

NOTE:
ELEVATIONS ARE
REFERENCING FEDERAL
BENCHMARK 79S295,
ELEVATION 507.156



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SUBDIVISION**

CLIENT REF. #:

PROJECT:

**STORMWATER
DRAINAGE STUDY**

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PROJECT NO:
201-02834-00

DATE:
FEB 22 2021

ORIGINAL SCALE:
1:5000

IF THIS BAR IS NOT 1" LONG,
ADJUST YOUR PLOTTING SCALE.

DESIGNED BY:
RJJ

DRAWN BY:
MRL



TITLE:

**SAFE BUILDING ELEVATION
SITE PLAN**

DRAWING NO:
C-3

RV. #
D

APPENDIX

B AIRPHOTOS



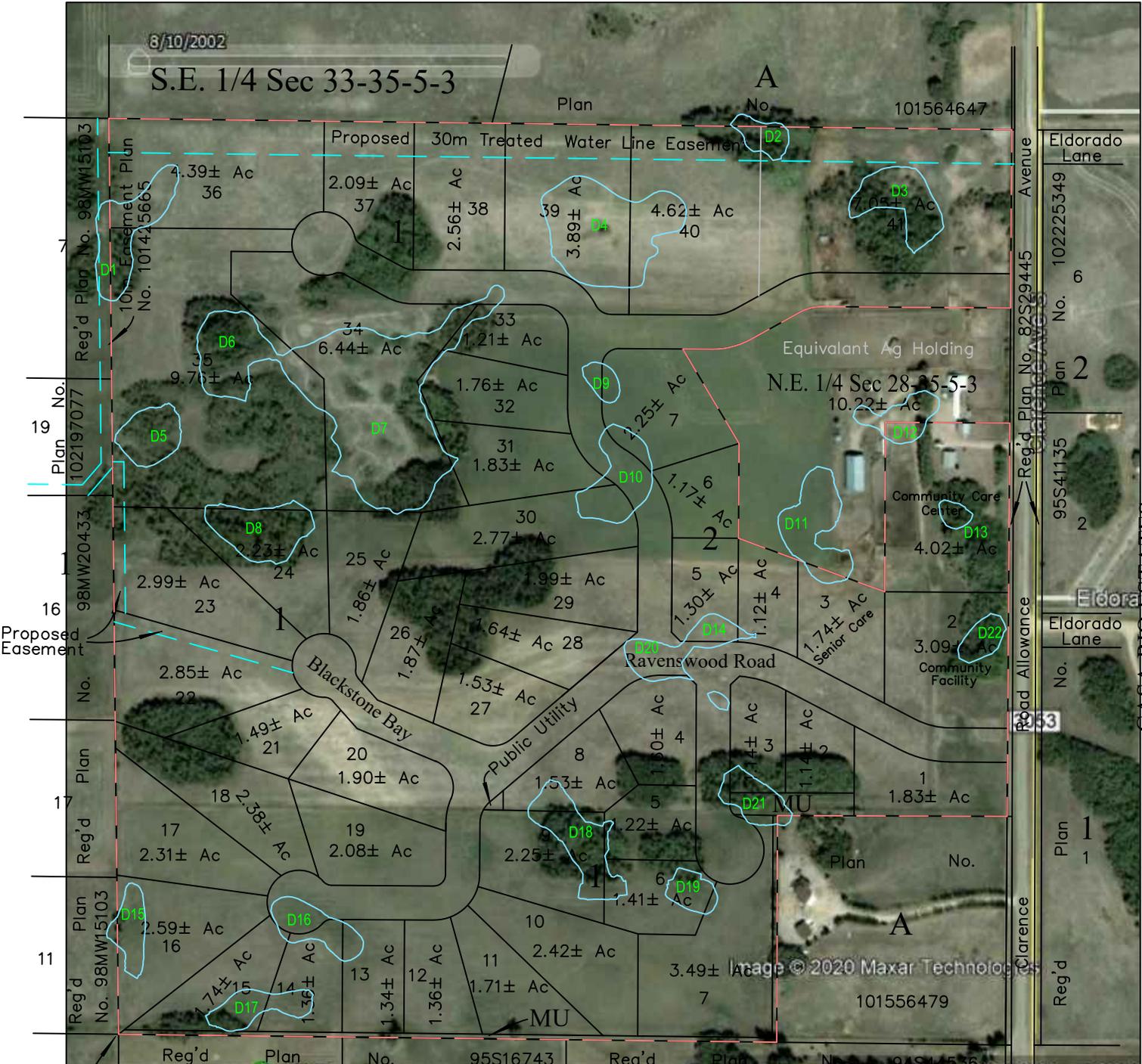
August 10, 2002

8/10/2002

S.E. 1/4 Sec 33-35-5-3

Plan No. 101564647

Proposed 30m Treated Water Line Easement



28
35-5-3

CASA RIO ESTATES

A

CASA RIO ESTATES

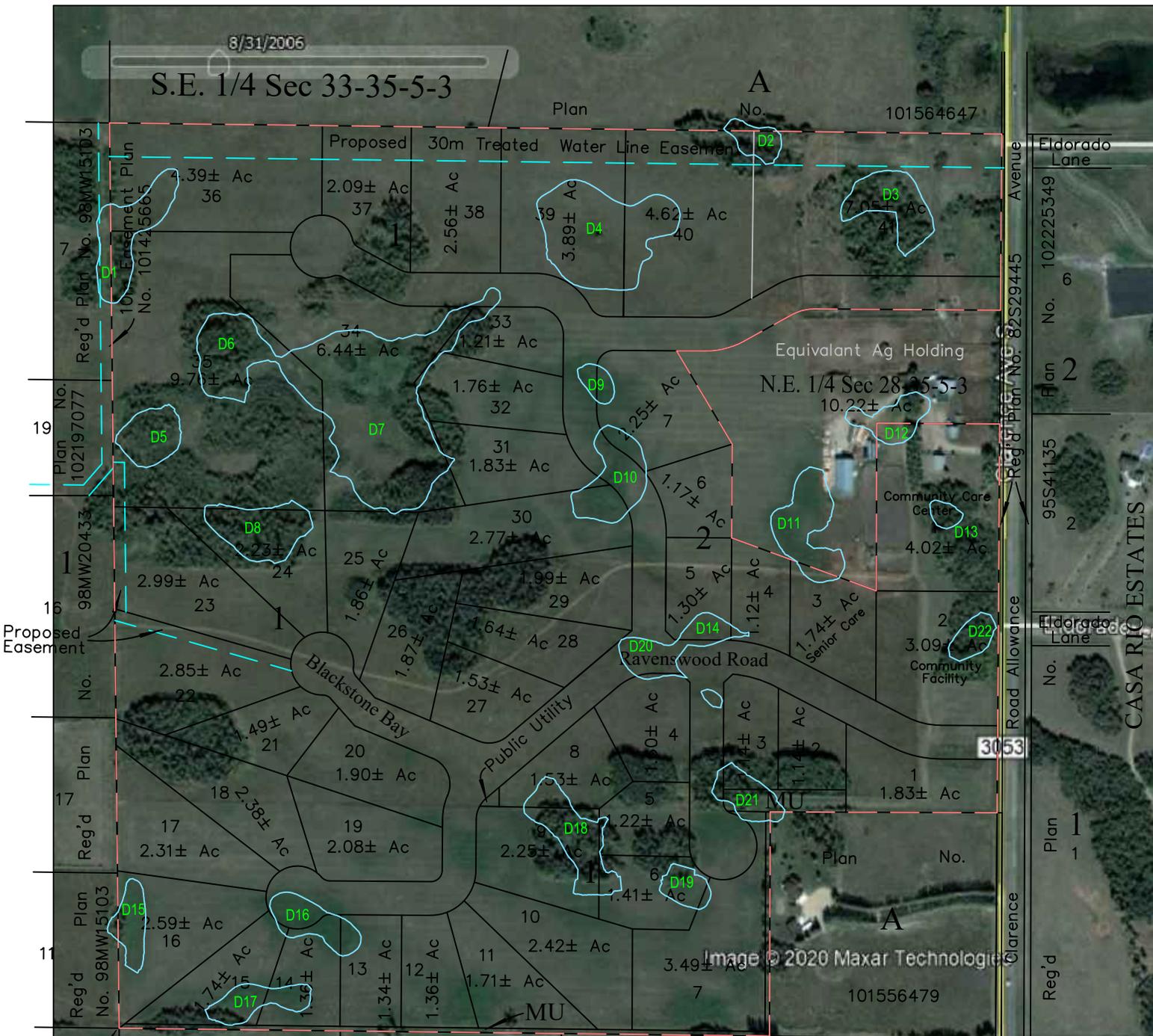
August 31, 2006

8/31/2006

S.E. 1/4 Sec 33-35-5-3

Plan No. 101564647

Proposed 30m Treated Water Line Easement



Florida Lane
Avenue No. 102225349
6
2
95S41135
2
Florida Lane
No. 3053
1
1
Reg'd Plan No. 10156479

CASA RIO ESTATES

28
35-5-3

CASA RIO ESTATES

A

Image © 2020 Maxar Technologies

May 12, 2014

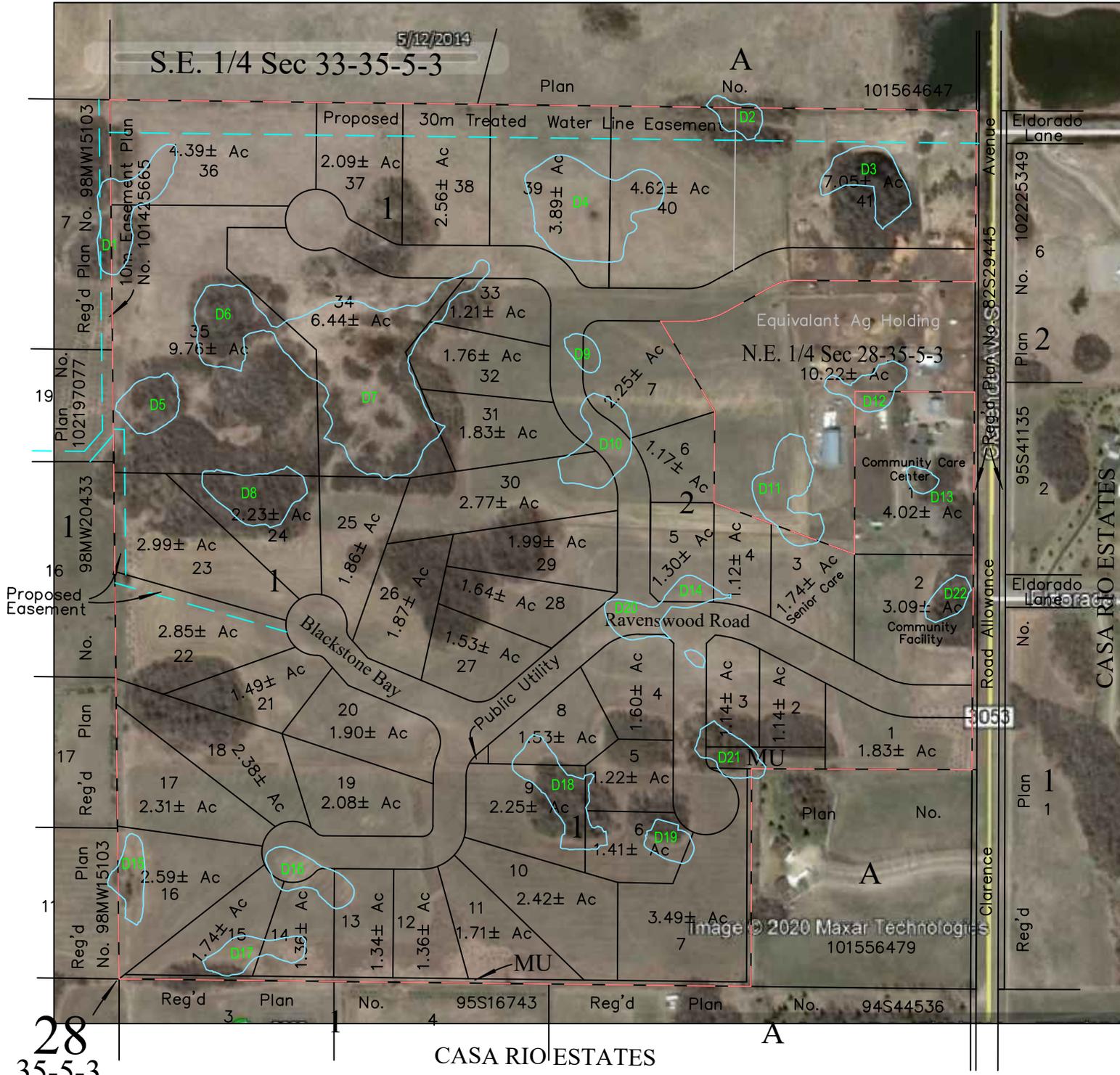
S.E. 1/4 Sec 33-35-5-3

5/12/2014

Plan No. 10156467
Proposed 30m Treated Water Line Easement

A

10156467



Eldorado Lane

Reg'd Plan No. 102197077

Reg'd Plan No. 98MW20433

Reg'd Plan No. 98MW15103

Reg'd Plan No. 95S41135

Reg'd Plan No. 95S16743

Reg'd Plan No. 94S44536

Reg'd Plan No. 102225349

Reg'd Plan No. 982529445

Reg'd Plan No. 10156479

28
35-5-3

CASA RIO ESTATES

A

CASA RIO ESTATES

5053

Clarence

Road Allowance

Image © 2020 Maxar Technologies
10156479

MU

MU

MU

Blackstone Bay

Ravenswood Road

Public Utility

MU

MU

MU

MU

MU

A

A

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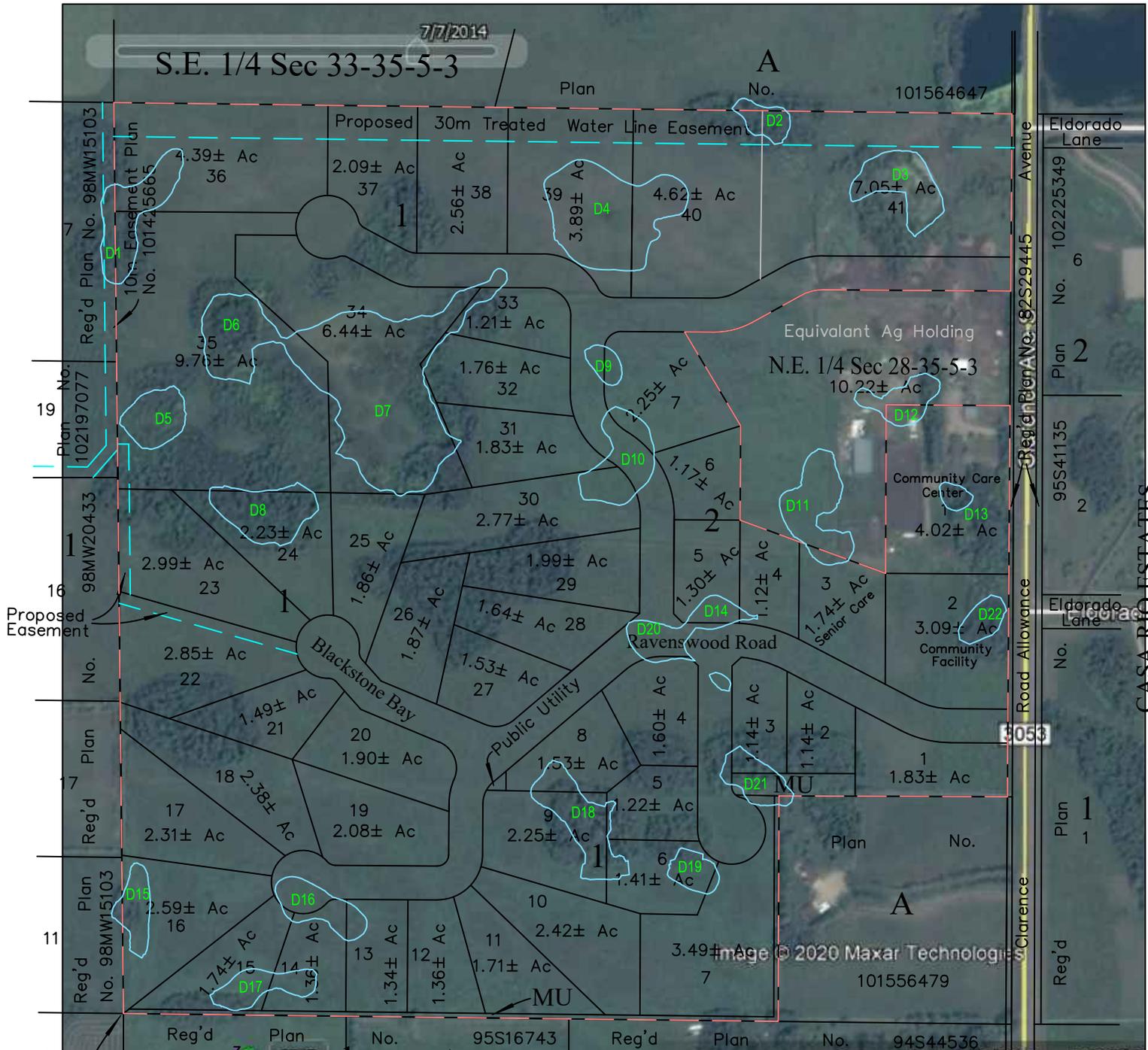
July 7, 2014

S.E. 1/4 Sec 33-35-5-3

7/7/2014

Plan No. 101564647

Proposed 30m Treated Water Line Easement



28
35-5-3

CASA RIO ESTATES

A

CASA RIO ESTATES

Image © 2020 Maxar Technologies

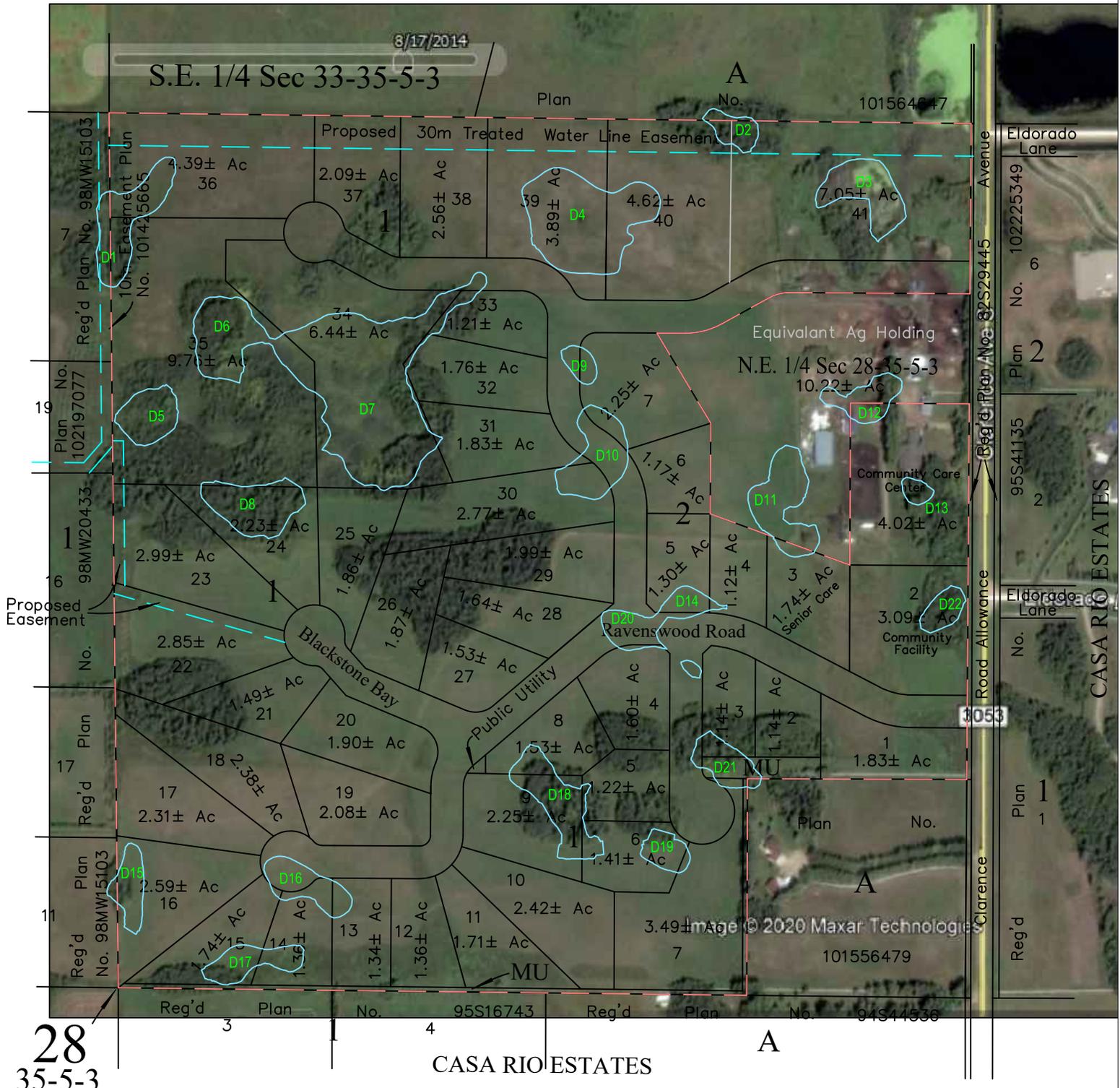
August 17, 2014

8/17/2014

S.E. 1/4 Sec 33-35-5-3

Plan No. 101564647

Proposed 30m Treated Water Line Easement



28
35-5-3

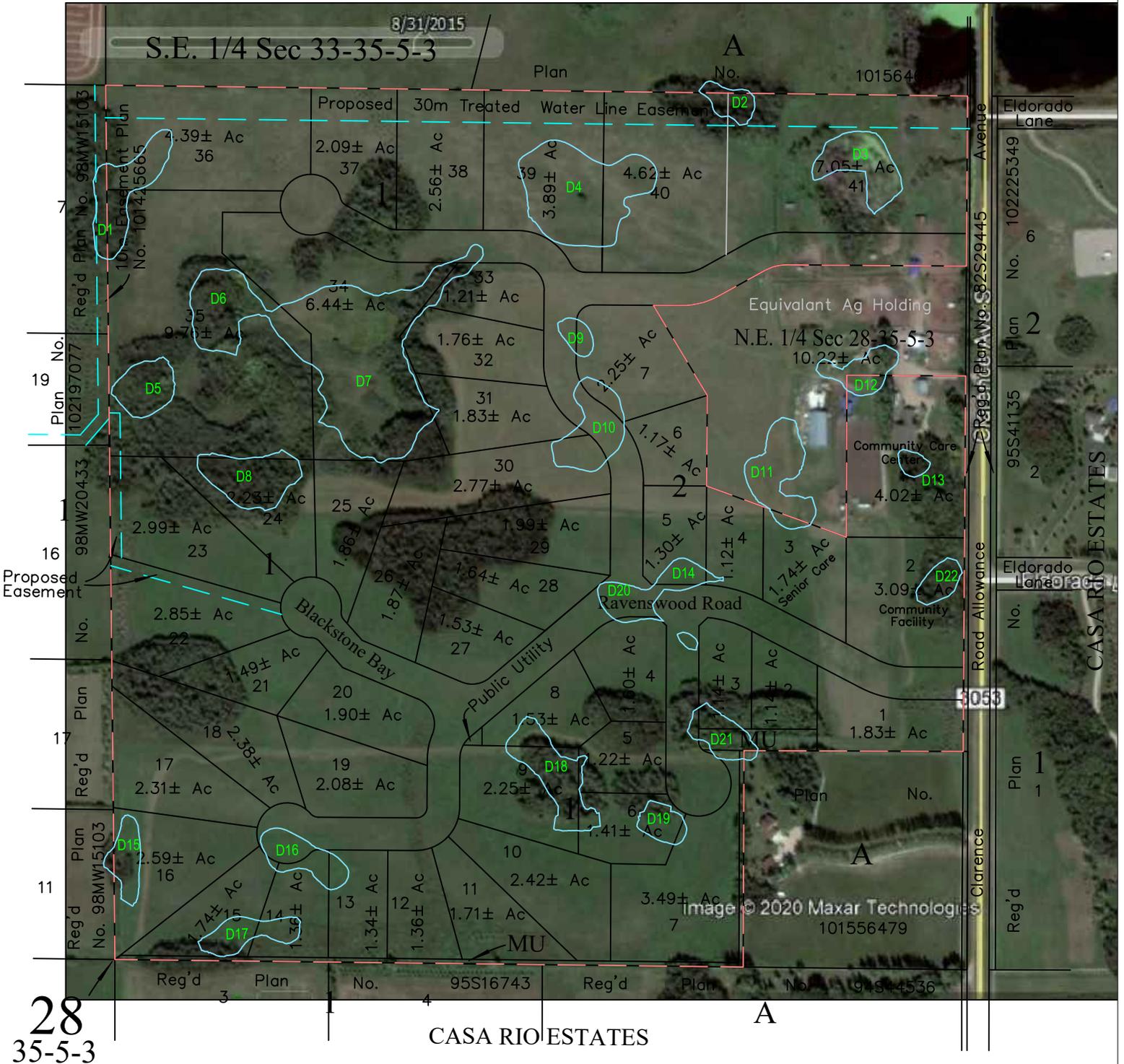
CASA RIO ESTATES

A

CASA RIO ESTATES

Image © 2020 Maxar Technologies

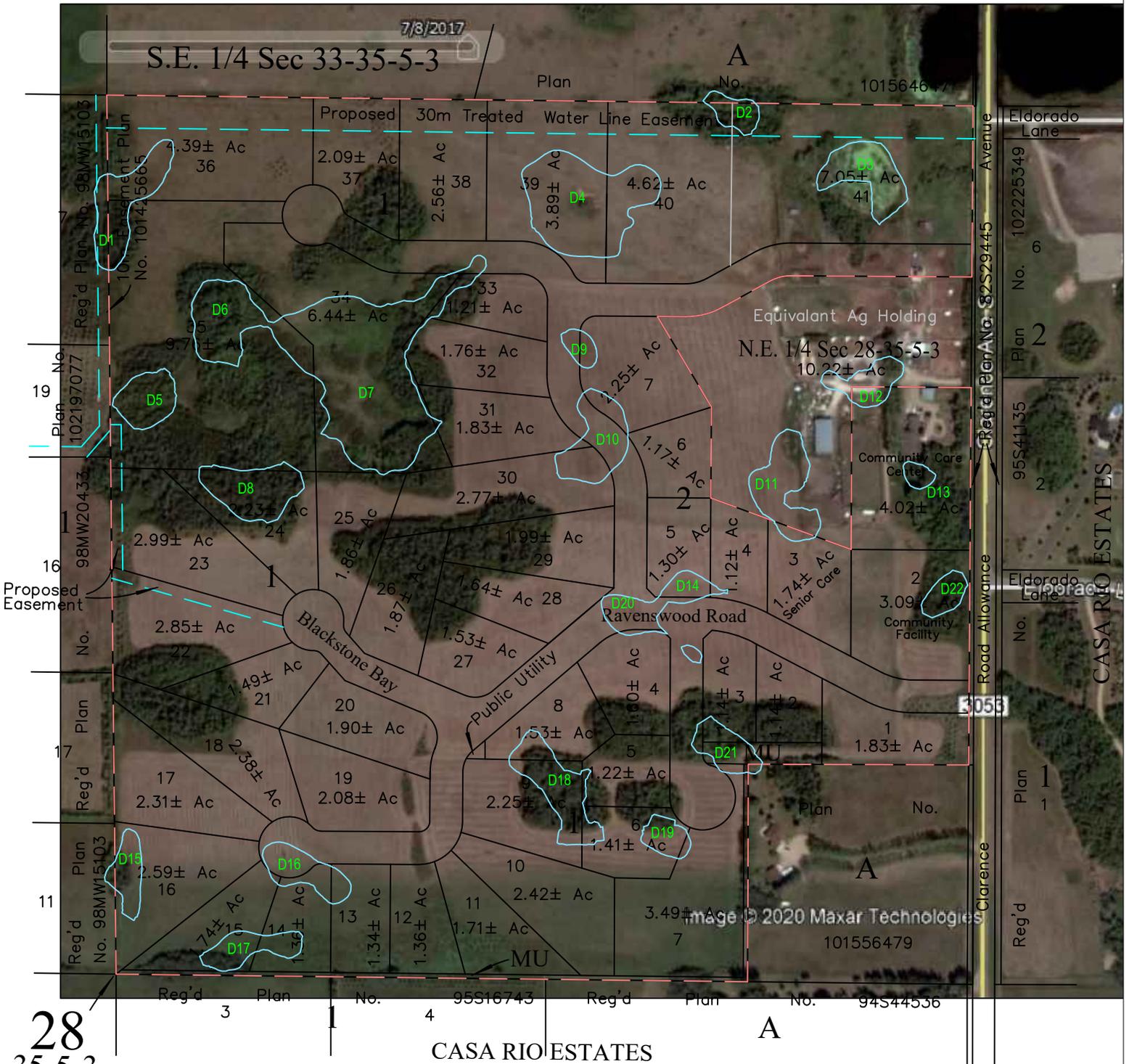
August 31, 2015



July 8, 2017

S.E. 1/4 Sec 33-35-5-3

7/8/2017



28
35-5-3

CASA RIO ESTATES

A

APPENDIX

C JULY 2017
1:25YR RAIN
EVENT

Image 1: 1:25 year event news article

'1-in-25 year storm' slams Saskatoon with flooding, hail and major power outages



BY PETER QUINLAN - GLOBAL NEWS

Posted July 11, 2017 12:52 pm

Updated July 12, 2017 10:28 am



<https://globalnews.ca/news/3590500/saskatoon-weather-outlook-forecast-storm-flooding-hail/>

Image 2: D21



Image 3: D19



Image 4: D18



Image 5: D18 different angle



Image 6: D17 and D15



Image 7: D16



Image 8: D14 and D20



Image 9: D10



Image 10: D9 and D10



Image 11: D8



Image 12: D4



Bill Delaine

From: Adam Antoine <Adam.Antoine@wsask.ca>
Sent: Saturday, January 2, 2021 9:30 PM
To: Bill Delaine
Cc: Dukart, Shawn MA
Subject: RE: 2020-4488-00 - Ravenswood CDR - AE Drainage Memo

I don't have any concerns with the memo, as it is consistent with our recent discussion. I do however suggest you confirm with the RM regarding the 25% requirement prior to consulting with WSP to amend there design, as this may not be something that cannot be amended. As we discussed, it has been commonplace for sometime for the RM of Corman to require an additional 25% "safety factor" capacity to rural development, but it appears this may have been applied inconsistently in recent years. With respect to WSP's 1.0 metre freeboard, it is mandated that any and all development be consistent with the Provincial Statement of Interests as you allude to. Perhaps further discussion with WSP would provide some insight as to why they went with that value.

Adam Antoine - A.Sc.T.

Manager, Compliance Assurance
402 Royal Bank Tower 1101 - 101st Street
North Battleford, SK S9A 0Z5
Ph: 306.446.7456 | Cell: 306.480.6046 | Fax: 306.446.7461
wsask.ca | adam.antoine@wsask.ca

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From: Bill Delaine <delaineyb@ae.ca>
Sent: Friday, December 18, 2020 7:03 PM
To: Adam Antoine <Adam.Antoine@wsask.ca>
Cc: Dukart, Shawn MA (shawn.dukart@gov.sk.ca) <shawn.dukart@gov.sk.ca>
Subject: 2020-4488-00 - Ravenswood CDR - AE Drainage Memo

Good evening Adam, I had occasion to speak with Larry Grozell today and he asked me to reach out to you to see if you had an opportunity to review the drainage memo we submitted a few weeks ago. To be completely transparent on the steps moving forward, assuming that your office has no significant concerns with the memo, we plan on meeting with WSP to discuss the possibility of them making revisions to their report to align with the direction represented in our memo. In our opinion, this eliminates the need for Larry to pay us to effectively redo the WSP report or worse, submitting a "choose your own adventure drainage plan" that will require significant cross references to interpret.

Regards,

Bill Delaine, RPP

Group Manager, Urban Planning

Associated Engineering (Sask.) Ltd.

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As COVID-19 cases continue to increase, to support provincial governments' and health authorities' recommendations to limit interactions, our office will close from 5 pm Friday, December 18, 2020 to 8 am Monday, January 11, 2021. During this period, I will be working from home, except during the holidays from December 24, 2020 to January 4, 2021. Your projects are our priority. Please contact me with any concerns

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Appendix F: Loraas Disposal Services Correspondence



F

CROSBY HANNA & ASSOCIATES
407C 1st Ave N
Saskatoon, SK S7K 1X5

May 22/19

Attn: Maggie Schwab

Please accept this letter of confirmation in providing Waste/Recycle Services in future for the Ravenswood Subdivision NE 28 35 5 W3. RM of Corman Park.

Any further questions please feel free in contacting us.

Thank you,

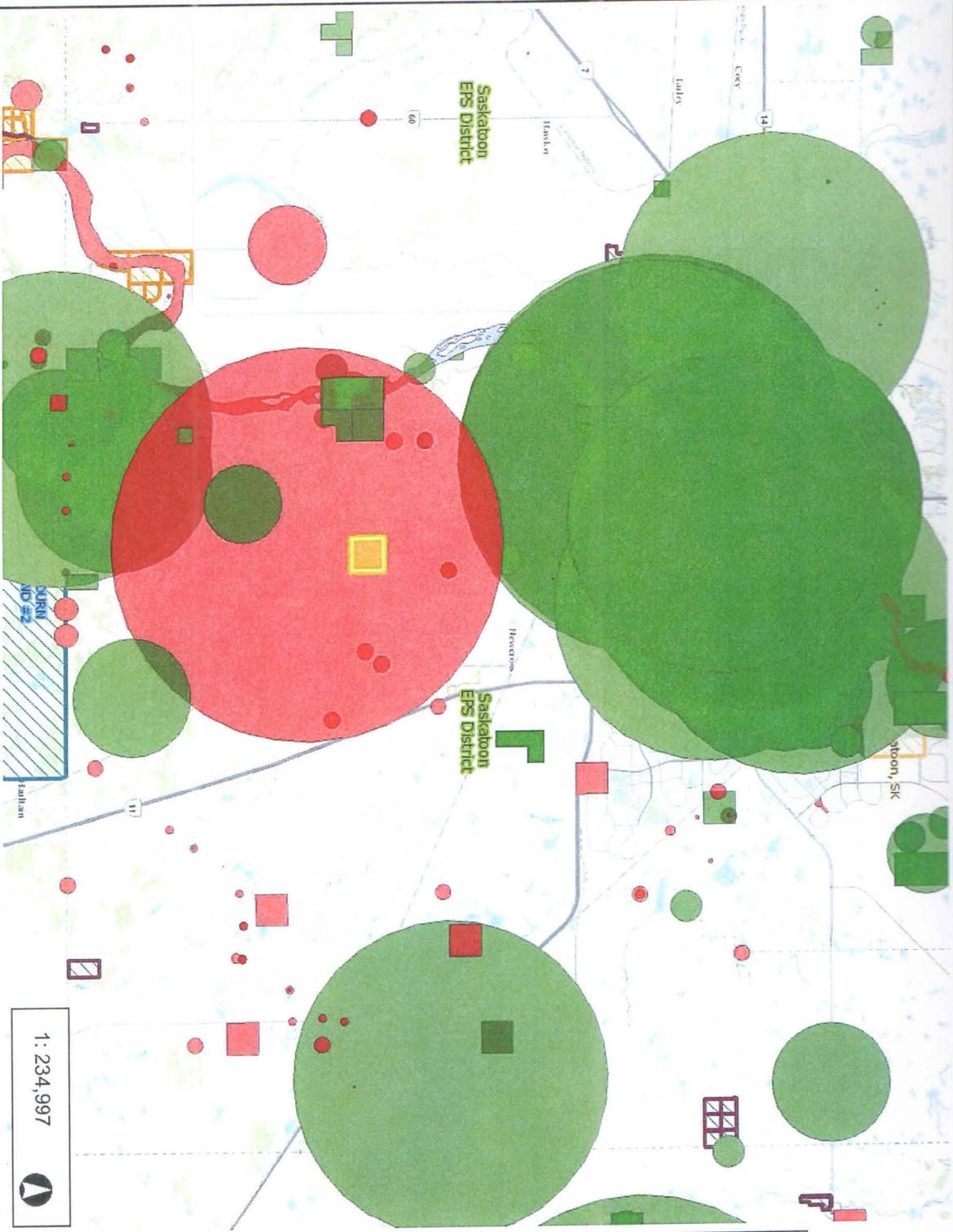
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Appendix G: Heritage and Environmental Screening

Ravenswood Environmental Screening



11.9
0 5.97 11.9 Kilometers
WGS_1984_Web_Mercator_Auxiliary_Sphere
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1: 234,997



Legend

- Provincial Boundary
- Ecological Protection Specialists
- Rare and Endangered Species
- Vertebrate Animal
- Invertebrate Animal
- Animal Assemblage
- Vascular Plant
- Nonvascular Plant
- Other (Botanical)
- Fungus
- Water Security Agency
- Game Preserve
- National Wildlife Area
- Migratory Bird Sanctuary
- Conservation Easements
- Crown Land Subdivisions
- Ecological Reserves
- Fish and Wildlife Development
- Community Pastures - Federal
- Ramsar Wetland
- Reservoir Development Areas
- Representative Areas
- Community Pastures - Provincial
- Special Management Areas
- Wildlife Habitat Protection (WHP)
- Wildlife Refuge

Notes

Appendix H: Geotechnical Report



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- Soils Testing
- Concrete Testing
- Asphalt Testing
- Pile Driving Analyzer (PDA)
Testing



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**GEOTECHNICAL INVESTIGATION
PROPOSED RURAL SUBDIVISION
NE-28-35-5-W3M
CLARENCE AVENUE SOUTH
NEAR SASKATOON, SASKATCHEWAN
PMEL FILE NO. 12983
JUNE 9, 2017**

PREPARED FOR:

**MR. LARRY GROZELL
51 WOOD MEADOWS LANE
R.M. OF CORMAN PARK, SASKATCHEWAN
S7T 1C7**

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1.0 INTRODUCTION

The following report has been prepared on the subsurface soil conditions existing at the site of the proposed Rural Subdivision to be constructed along Clarence Avenue South within NE-28-35-5-W3M near Saskatoon, Saskatchewan.

Written authorization to proceed with this investigation was provided on April 13, 2017. The Terms of Reference were presented in P. Machibroda Engineering Ltd. (PMEL) Proposal No. 12983, dated March 30, 2017.

The field test drilling, soil sampling and cone penetration testing (CPTu) were conducted on April 26, 27 and 28, 2017. Groundwater monitoring was conducted on May 5 and June 5, 2017.

2.0 FIELD INVESTIGATION

2.1 Field Drilling Program

Twelve (12) test holes, located as shown on the Site Plan, Drawing No. 12983-1 were dry drilled using our truck-mounted, continuous flight, solid stem auger drill rig. The test holes were 150 mm in diameter and extended to depths of 7.5 to 18 metres below the existing ground surface.

Test hole drill logs were compiled during test drilling to record the soil stratification, the groundwater conditions, the position of unstable sloughing soils and the depths at which cobblestones and/or boulders were encountered.

Disturbed samples of auger cuttings were collected during test drilling and sealed in plastic bags to minimize moisture loss. The soil samples were taken to our laboratory for analysis.

Standard penetration tests (N-index), utilizing a safety hammer with automatic trip, were performed during test drilling.

Standpipe piezometers (50 mm diameter slotted PVC pipe) were installed in all test holes with the exception of Test Hole Nos. 17-1 and 17-8 to monitor the existing groundwater conditions.

2.2 Piezocone Penetration Testing

Three (3) piezocone penetration tests (CPTu) were conducted during the field investigation. The CPTu tests were extended to depths of 12.2 to 15.3 metres below ground surface. The CPTu test locations have been shown on the Site Plan, Drawing No. 12983-1.

The piezocone penetration tests consisted of pushing a cone, on the end of a series of rods, into the ground at a constant rate and near continuous measurements were made of the resistance to penetration of the cone. Local side friction resistance measurements were also made on a friction sleeve during penetration. Pore-water pressure response generated from the advancement of the cone into the soil was measured via a pore pressure filter located directly behind the cone tip. The piezocone tip had an apex angle of 60° and a 15 cm² base area. The friction sleeve had a perimeter area of 225 cm².

The equipment and procedures for conducting the cone penetration testing were undertaken in accordance with ASTM D-5778, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Testing of Soils".

The test plots recorded during the cone soundings have been presented in Appendix B.

3.0 FIELD DRILL LOGS

The field drill logs recorded during test drilling have been shown plotted on Drawing Nos. 12983-2 to 14, inclusive.

The surface elevation and location of the Test Holes was surveyed by PMEL using hand held Global Positioning Equipment (Trimble, Model No. GeoXH 6000). The accuracy of the measured elevation is within ±0.5 metres.

3.1 Soil Profile

An examination of the test hole logs and CPTu plots revealed that the general subsoil conditions consisted of a thin layer of organic topsoil followed by variable deposits of silt, sand and/or clay that extended to the maximum depth explored during the field investigation (i.e., 18 metres below existing ground surface). Clay was generally encountered below a depth of 1.5 metres from ground surface at the locations investigated.

Examination of the CPTu results revealed that the subgrade soils were predominantly loose to compact within the upper sand and/or silt soils, then stiff in the underlying clay. Practical tip refusal was not encountered at the base of the CPTu soundings.

3.2 Groundwater Conditions, Sloughing

Extensive groundwater seepage and sloughing conditions were encountered in saturated sand and/or silt layers/lenses during test drilling. The depths at which groundwater seepage and sloughing conditions were encountered have been shown on Drawing Nos. 12983-2 to 14, inclusive. A summary of the groundwater levels recorded in the piezometers has been presented in Table I.

TABLE I. RECORDED GROUNDWATER LEVELS

Test Hole No.	Piezometer Rim Elevation (metres)	Ground Surface Elevation (metres)	Recorded Groundwater Elevation (metres)	
			May 5, 2017	June 5, 2017
17-1	504.5	503.5	501.5	501.5
17-2	506.5	505.4	501.2	501.6
17-3	505.7	504.5	501.4	501.5

3.5M - 14'
6'
12'
9'

TABLE I. RECORDED GROUNDWATER LEVELS (continued)...

Test Hole No.	Piezometer Rim Elevation (metres)	Ground Surface Elevation (metres)	Recorded Groundwater Elevation (metres)	
			May 5, 2017	June 5, 2017
17-5	509.1	508.0	Dry	Dry
17-6	507.3	506.3	501.4	501.4
17-7	504.8	503.8	498.5	502.3
17-9	507.2	506.2	502.9	501.2
17-10	507.8	506.8	502.0	502.0
17-11	506.6	505.6	501.7	501.7
17-12	508.2	507.1	500.4	503.0
17-12A	508.0	507.0	504.0	502.5

15'
4'
15'
15'
12'
12'
12'
12.7 AVG

Examination of Table I revealed that the groundwater table varied from approximately 1.5 to 6.7 metres below the existing ground surface elevation on May 5 and June 5, 2017. Higher static water levels should be expected during or following spring snowmelt and/or periods of precipitation.

3.3 Cobblestones and Boulders

Cobblestones and/or boulders were not encountered to the full depth explored with our test holes at this site (i.e., 18 metres below existing ground surface).

4.0 LABORATORY ANALYSIS

The soil classification and index tests performed during this investigation consisted of a visual classification of the soil, water contents, Atterberg limits, unit weights, grain size distribution analysis and water soluble sulphate contents.

The results of the soil classification and index tests conducted on representative samples of soil have been plotted on the drill logs alongside the corresponding depths at which the samples were recovered, as shown on Drawing Nos. 12983-2 to 14, inclusive.

The results of the grain size distribution analyses have been shown plotted in Appendix C.

5.0 DESIGN RECOMMENDATIONS

Based on the foregoing outline of soil test results, the following foundation considerations and design recommendations have been presented.

5.1 Design Considerations

The subsurface soil conditions at the site of the proposed Rural Subdivision consisted of organic topsoil overlying variable deposits of silt, sand and/or clay. The soils are considered frost susceptible and the average depth of frost penetration in the Saskatoon, Saskatchewan area is 1.8 metres for heated structures and 2.3 metres for unheated structures.

Groundwater seepage and sloughing conditions were encountered in saturated sand and/or silt layers/lenses during test drilling. The groundwater table appeared to be situated at depths of approximately 1.5 to 6.7 metres below the existing ground surface elevation on May 5 and June 5, 2017. Higher groundwater conditions could be encountered, particularly during or following spring thaw or periods of precipitation.

A shallow foundation system consisting of standard strip or spread footings bearing on undisturbed, naturally occurring sand and/or silt soils above the groundwater table could be considered as a foundation system at this site and should perform satisfactorily. Footings bearing on highly plastic clay will be exposed to potential movements associated with moisture fluctuations in the soil profile. Where highly plastic clay is encountered at the design footing elevation and potential differential foundation movements are not considered acceptable, construction of a pile foundation is recommended.

Construction of a shallow footing foundation below the elevation of the groundwater table will encounter construction difficulties associated with groundwater seepage, sloughing and unstable/softened soil and is not recommended.

Alternately, a deep foundation system consisting of driven, treated timber piles, helical screw piles or driven, open-end steel pipe piles should perform satisfactorily at this site. Drilled, cast-in-place concrete piles were considered as a foundation support and are not recommended due to the extensive groundwater seepage and sloughing conditions anticipated below the groundwater table in saturated sand/silt deposits.

Basement floor slabs based on sand and/or silt should perform satisfactorily. Basement floor slabs based on highly plastic clay will be susceptible to differential movements associated with moisture fluctuation in the soil profile. Where highly plastic clay exists at the floor level, measures should be taken to minimize the effects of differential floor movements by constructing structural elements such as partition walls, staircases, grade beams, columns, etc. independent of the slab. Providing positive drainage alongside the foundation, extending downspouts well away from the building and eliminating irrigation alongside the foundation would serve to minimize the potential for increased soil moisture content adjacent the foundation and potential swelling.

To minimize the potential for groundwater infiltration into a basement, it is recommended that basement floor slabs be constructed at least 750 mm above the groundwater table and a sub-surface drainage system be installed below the floor slab and around the perimeter of the foundation walls. Due to the presence of a shallow groundwater table at the site, some of the lots will need to be built up to allow for the construction of a basement level.

Recommendations have been prepared for site preparation; standard strip and/or spread footings; driven, treated timber piles; helical screw piles; driven, open-end steel pipe piles; limit states resistance factors and serviceability; excavations and dewatering; floor slabs; foundation walls; grade beams; foundation concrete; site classification for seismic site response and access roads.

5.2 Site Preparation

All organic topsoil, loose fill and deleterious materials should be removed from the building, access roads and parking/walkway areas. Staining and root intrusion from the overlying organic material and roots may be encountered during excavation within the subsurface mineral soils. If these conditions are suspected, a representative of the Geotechnical Consultant should inspect the site during excavation to verify the depth of unsuitable soil which should be removed in preparation of the site for construction.

Additional information regarding topsoil composition and soil structure is presented in Appendix D.

The surface of the subgrade should be levelled and compacted to the following minimum density requirements.

- Building Areas - 96 percent of standard Proctor density at optimum moisture content;
- Roadway Areas - 96 percent of standard Proctor density at optimum moisture content;
- Landscape Areas - 90 percent of standard Proctor density at optimum moisture content.

Fill, required to bring the subgrade soil to the design elevation in the construction area, should preferably consist of granular material or non-expansive (i.e. low plastic) fine-grained soil. The on-site sand and/or silt soils (above the elevation of the groundwater table) are considered suitable for use as general subgrade fill across the site. The fill should be placed in thin lifts (maximum 150 mm loose) and compacted to 96 percent of standard Proctor density at optimum moisture content.

The site should be graded to provide positive site drainage away from all structures.

5.3 Standard Strip and/or Spread Footings

The near surface subgrade soil conditions at the subject site consisted of topsoil overlying variable deposits of sand, silt and/or clay. Footings bearing on naturally occurring sand and/or silt soils (above the elevation of the groundwater table) should perform satisfactorily.

Footings bearing on highly plastic clay will be exposed to potential movements associated with moisture fluctuations in the soil profile. Where highly plastic clay is encountered at the design footing elevation and potential differential foundation movements are not considered acceptable, construction of a pile foundation is recommended.

The following minimum recommendations should be incorporated into the design of a footing foundation.

1. For a continually heated dwelling with a basement, the footings should be founded on naturally deposited, undisturbed soil at a minimum depth of 1.2 metres below finished ground surface. Footings for a heated building without a basement should be based at a minimum depth of 1.8 metres below finished grade to provide protection against frost action. Alternately, rigid polystyrene insulation can be utilized to minimize the depth of frost and footing elevation. In this case, a continuous layer of rigid polystyrene insulation should be placed over the exterior face of the foundation wall/grade beam, extending vertically a minimum of 300 mm above grade and laterally a minimum distance of 1.2 metres away from the foundation. The insulation should be a minimum of 50 mm in thickness and should be positively sloped away from the foundation to promote drainage. The lateral section of insulation should be buried a minimum of 300 mm below finished grade.

-
2. Footings in unheated areas should be based at a deeper elevation (i.e., 2.3 metres) to avoid the detrimental impacts of frost.
 3. Footings based on naturally deposited, undisturbed soil may be designed to exert an ultimate bearing pressure of 300 kPa (Ultimate Limit States, ULS). The Serviceability Limit States (SLS) bearing pressure equivalent to 25 mm of footing settlement would be equal to 100 kPa.
 4. A minimum strip footing width of 500 mm is recommended. A minimum dimension of 1,000 mm is recommended for square and rectangular footings.
 5. If the subgrade soil is disturbed during excavation below the design depth, then the disturbed soil should be removed to an undisturbed, level surface. Fill, required to raise the subgrade elevation to the underside of the footings, should be concrete.
 6. Footings should not be constructed on desiccated, frozen or wet subgrade soil. Frost should not be allowed to penetrate beneath the footings prior to, during or after construction.
 7. The finished grade should be landscaped to provide for positive site drainage away from the proposed buildings.

5.4 Driven, Treated Timber Piles

Driven, treated timber piles may be designed on the basis of skin friction only. The ultimate (ULS) and serviceability (SLS) skin friction bearing pressures for driven, treated timber piles have been presented below. Resistance factors to reduce the provided ultimate bearing pressures presented in Table II to values that are suitable for design have been presented in Section 5.7, Limit States Resistance Factors and Serviceability.

TABLE II. SKIN FRICTION BEARING PRESSURES (TIMBER PILES)

Zone (metres)	Skin Friction Bearing Pressure (kPa)	
	ULS	SLS
0 to 2	0	0
Below 2	60	24

Notes:

1. For drop hammers, a minimum drop hammer mass of twice the mass of the pile, but not exceeding five times the mass of the pile, is recommended.
2. A pre-bore diameter of not more than 90% of the pile diameter should be used where required to permit installation through the depth of frost penetration and/or fill.
3. To minimize the potential for frost jacking, driven, treated timber piles should have a minimum embedment length of 6 metres.
4. If the termination criteria is achieved at a depth which is significantly shallower than the design depth, then the pile capacity should be reviewed. Pile driving analyzer (PDA) testing may be required to confirm the pile capacity.
5. A minimum centre-to-centre spacing of not less than three pile diameters is recommended.
6. Timber piles should not be subject to hard driving. The potential problems as a result of hard driving are splitting of the pile, brooming of the pile toe and bowing or breaking of the pile. Pile banding may be required to minimize potential damage during driving. To reduce the potential for damage, driving must be stopped upon satisfying the following termination criteria.

TABLE III. TERMINATION CRITERIA (TIMBER PILES)

Nominal Pile Size mm/No.	Rated Energy Per Hammer Blow (Joules)*	Termination Criteria Hammer Blows for 25 mm Penetration
250/10	25,000 (18,500 ft - lbs)	2
275/11	27,000 (20,000 ft - lbs)	3
300/12	30,000 (22,000 ft - lbs)	3
355/14	35,000 (26,000 ft - lbs)	4

*1 foot - pound - force = 1.356 Joules

7. The structural capacity of each pile should be confirmed by the Structural Engineer to ensure that over-stressing of the pile does not occur.
8. A representative of the Geotechnical Consultant should inspect and document the installation of each driven, treated timber pile.

5.5 Helical Screw Piles

Helical screw piles are installed by rotating a steel pipe, equipped with one or more helix flightings, into the ground. For single helix screw piles, pile capacity is derived from shearing resistance along the pile shaft (i.e., skin friction) as well as end bearing capacity of the helix. For multi-helix piles, pile capacity may be derived from the sum of the shearing resistance along the portion of pile shaft above the uppermost helix and end bearing capacity of each helix. The helical plates should be spaced a minimum of 3 helix diameters apart.

The ultimate (ULS) and serviceability (SLS) skin friction and end bearing pressures for design of screw piles have been presented below. Resistance factors to reduce the provided ultimate bearing pressures to values that are suitable for design have been presented in Section 5.7, Limit States Resistance Factors and Serviceability.

TABLE IV. SKIN FRICTION BEARING PRESSURES (SCREW PILES)

Zone (metres)	Skin Friction Bearing Pressure (kPa)	
	ULS	SLS
0 to 2	0	0
Below 2	25	10

TABLE V. END BEARING PRESSURES (SCREW PILES)

Depth (metres)	End Bearing Pressure (kPa)	
	ULS	SLS
Below 4	700	280

Notes:

1. The minimum embedment depth of the uppermost helix for multi-helix piles should be ≥ 4 metres or $H/D = 5$ (whichever is greater), where H = depth to top helix and D = helix diameter.
2. Single helix screw piles should extend to a minimum depth of 5 metres below grade or $H/D = 5$ (whichever is greater).
3. When determining the compressive skin friction resistance of the pile shaft, the portion of the pile shaft within $1D$ above the uppermost helix should be discounted due to interaction effects between the pile shaft and helix. For piles subject to tensile loads, the zone of zero skin friction should be increased to $2D$ above the uppermost helix.
4. Compressive end bearing capacity may be calculated utilizing the effective soil contact area of the helix (i.e., overall cross-sectional area for the lowest helix, helix area minus shaft area for upper helixes). Piles subject to tensile loads should use the effective area of the helix (i.e., helix area minus shaft) when determining uplift pile capacity.

5. A minimum centre-to-centre pile spacing of 2.5D is recommended.
6. The helical plate shall be normal to the central shaft (within 3 degrees) over its entire length. Multiple helixes (if applicable) should be spaced at increments of the helix pitch to ensure that all helixes travel the same path during installation.
7. Continuous monitoring of the installation torque should be undertaken during installation to determine whether the screw pile has been damaged during installation and to monitor the consistency of the subsurface soils.
8. Screw piles should be designed on the basis of conventional static analysis using the provided bearing pressures presented in Tables IV and V. Installation torque should be used for monitoring purposes only and not to determine pile capacity.
9. A representative of the Geotechnical Consultant should inspect and document the installation of each screw pile on a continuous basis.

5.6 Driven, Open-End Steel Pipe Piles

Driven, open-end steel pipe piles may be designed on the basis of skin friction and end bearing capacity. The ultimate (ULS) and serviceability (SLS) bearing pressures for design of steel pipe piles have been presented below. Resistance factors to reduce the provided ultimate bearing pressures to values that are suitable for design have been presented in Section 5.7, Limit States Resistance Factors and Serviceability.

TABLE VI. SKIN FRICTION BEARING PRESSURES (DRIVEN, PIPE PILES)

Zone (metres)	Skin Friction Bearing Pressure (kPa)	
	ULS	SLS
0 to 2	0	0
2 to 8	45	18
Below 8	60	24

TABLE VII. END BEARING PRESSURES (DRIVEN, PIPE PILES)

Zone (metres)	End Bearing Pressure (kPa)	
	ULS	SLS
Below 6	650	260

Notes:

1. To minimize the potential for frost jacking, driven, open-end steel pipe piles should have a minimum embedment length of 7 metres.
2. The end bearing component of the pile capacity may be determined using the full cross-sectional area of the pile toe (i.e., plugged condition).
3. Piles designed using end-bearing capacity and experiencing heave should, as a minimum, be re-driven within 24 hours of initial drive to the initial embedment depth (or greater).
4. A minimum pile spacing of three times the shaft diameter is recommended.
5. Although not anticipated, if the pile terminates at a depth significantly shallower than the design length, the pile capacity should be reviewed by the Geotechnical Consultant. Pile Driving Analyzer (PDA) testing may be required to confirm the pile capacity.
6. Steel piles should be driven with a hammer of appropriate size and rated energy, depending on the pile design load requirements. The pile-driving hammer should be approved in advance of construction and the required pile set should be determined by dynamic analyses (such as wave equation analyses) for the specified hammer and pile sizes.

-
7. As a guideline, a minimum rated hammer energy of 30 kJ is recommended for small cross-sections and up to 50 kJ for large cross-sections. The maximum driving energy should not exceed 60 J per square cm of steel cross-sectional area to avoid damage to the pile section.
 8. A pre-bore diameter of not more than 90% of the pile diameter should be used where required to permit installation through the depth of frost penetration and/or fill.
 9. Pile driving records should be maintained during driving of all piles and should be assessed by driving analyses to confirm the design capacity of the piles.
 10. Full time inspection by a representative of the Geotechnical Consultant, employed directly by the Owner, is required to confirm the provided bearing capacity.
 11. The installation of each pile and the elevation monitoring of each pile within nine pile diameters which could be affected by the installation of adjacent piles should be documented during construction by a representative of the Geotechnical Consultant. Each pile should be inspected for damage as a result of the driving operations and for the accumulation of water.
 12. After inspection of the pile is complete and upon removal of any accumulated water in the pipe, the pipe should be filled with wet cast (minimum 100 mm slump) 25 MPa concrete. If it is not possible to remove the water from the pipe pile, then the concrete should be placed using a tremie, or an anti-washout admixture could be added to the wet mix concrete to minimize segregation of the concrete in the water.

5.7 Limit States Resistance Factors and Serviceability

Limit states are defined as those conditions under which a structure ceases to fulfill the function for which it was designed (i.e., unsatisfactory performance). In limit states design, two conditions are assessed with respect to performance, these are:

- ultimate limit states (ULS), and
- serviceability limit states (SLS)

Ultimate limit states are concerned with the collapse mechanisms of the structure (i.e., safety), whereas serviceability limit states consider mechanisms that restrict or constrain the intended use, function or occupancy of the structure.

A further discussion of the limit states design method is described in the Canadian Foundation Engineering Manual (CFEM, 2006) and the National Building Code of Canada (NBCC, 2010). As per NBCC - 2010, the following resistance factors may be applied to the ultimate bearing pressures presented in Sections 5.3, 5.4, 5.5 and 5.6 to obtain the factored geotechnical resistance corresponding to ultimate limit states (ULS).

- Shallow foundations:
 - Compressive Resistance, $\Phi = 0.5$
- Deep foundations:
 - Compressive Resistance, $\Phi = 0.4$
 - Tensile Resistance, $\Phi = 0.3$

To satisfy serviceability limit states, a settlement analysis of the foundation must also be evaluated to ensure the structure is not negatively impacted by excessive settlement at the design load.

With respect to Serviceability Limit States (SLS) and footing foundations at this site, the provided SLS bearing capacity presented in Section 5.3 is based on a settlement of 25 mm and typical footing dimensions of 2 metres by 2 metres for spread footings and less than 1 metre for strip footings.

If a lesser settlement is required for the footing foundation and/or larger footing dimension will be constructed, PMEL should re-evaluate the recommended SLS bearing capacity.

With respect to Serviceability Limit States (SLS) and pile foundations, provided the piles are designed using the appropriate resistance factors presented above and good construction practices are followed, the amount of settlement of a deep foundation at the design load will be small and within tolerable limits (typically in the order of 5 to 10 mm).

Driven piles derive the majority of their capacity from skin friction and would undergo less movement at the design load (i.e., 5 to 8 mm) as compared to helical screw piles. Helical screw piles derive a larger portion of carrying capacity in end bearing and would undergo more movement at the design load as compared to predominantly skin friction pile types (i.e., 10 to 15 mm).

Pile design on the basis of ULS or SLS bearing pressures will undergo the same or similar level of performance.

The above is applicable to individual piles and small pile groups. Foundation settlement should be evaluated where large pile groups are employed to carry the foundation load (i.e., breadth of foundation or pile cap is a similar dimension as depth of piles).

5.8 Excavations and Dewatering

Excavations at this site should be made in accordance with current Saskatchewan Labour Occupational Health and Safety (OH&S) Guidelines. The subsurface conditions at this site may be classified as "Type 3" soils (i.e., the excavation sideslopes should be at an angle not steeper than one horizontal to one vertical). The side slopes may need to be flattened where the excavation extends below the groundwater table, particularly where saturated sand and/or silt layers are encountered.

Excavation below the groundwater table in wet sand or silt is not recommended. Temporary shoring and dewatering will be required.

Depending on lateral constraints, excavations at this site may be completed with unbraced, sloped side walls. The stability of the excavation walls will be affected by wetting and drying of the exposed excavation walls, the length of time that the excavation remains open and the consistency and structure (degree of fracturing, slickensiding, etc.) of the subgrade soils. The excavated soil should be removed from the excavation banks (and stockpiled) to minimize potential sloughing of the trench sidewalls due to the soil surcharge loading.

Extensive groundwater seepage and sloughing conditions were encountered below the water table in wet sand/silt deposits during test drilling. The groundwater table appeared to be situated at depths of approximately 1.5 to 6.7 metres below the existing ground surface elevation on May 5 and June 5, 2017. Higher groundwater conditions could be encountered, particularly during or following spring thaw or periods of precipitation.

De-watering should be conducted on an "as required" basis over the time period for which the excavations are left open. A sump (or multiple sumps, if required) should be set up at the deepest excavation points and the floor of the excavation sloped to the sump(s) to handle groundwater seepage and precipitation runoff. A self-actuated sump pump(s) should be operated on a continuous basis and should be discharged well away from the excavations.

The magnitude of dewatering required to provide dry working conditions will depend on the frequency of saturated sand and/or silt layers encountered. As mentioned above, excavation in sand or silt below the water table is not recommended.

5.9 Floor Slabs

5.9.1 At-Grade Slabs

The near surface subgrade soil conditions consisted of topsoil overlying variable deposits of silt, sand and/or clay. Grade supported slabs bearing on silt and/or sand soils should perform satisfactorily. Grade-supported floor slabs based on highly plastic clay soils could potentially undergo some differential movements associated with moisture fluctuations in the soil profile. An increase in the moisture content would result in swelling and heaving, whereas a decrease in the moisture content would result in shrinkage and settlement.

Providing positive drainage alongside the foundation, extending downspouts well away from the building and eliminating irrigation alongside the foundation would serve to minimize the potential for increased soil moisture content adjacent the foundation and potential swelling. The subgrade clay soils should also not be allowed to dry out during construction to minimize shrinkage and subsequent swelling upon wetting.

Since the amount of slab movement depends on many factors (i.e. swelling potential of the clay, existing overburden pressure, existing soil moisture regime, availability of free water, etc.) and is difficult to quantify, where highly plastic clay is encountered, measures should be taken to accommodate potential swelling by constructing structural elements such as partition walls, staircases, grade beams, columns, etc. independent of the slab.

If some differential movements/floor cracking cannot be tolerated, then a structural floor should be constructed. Alternately, overexcavation of the medium plastic clay and replacement with non-expansive soil (i.e., silt or sand) could be considered as an option to minimize potential floor movements.

The following minimum provisions should be incorporated into the design of a conventional, heated, grade-supported, cast-in-place, reinforced concrete slab subject to light loading.

1. Prepare the site in accordance with Section 5.2, Site Preparation. Provide a minimum of 150 mm of granular base fill (i.e., leveling course) beneath the underside of the slab.
2. Level and compact the upper 150 mm of subgrade soil to 96 percent of standard Proctor density at optimum moisture content. Do not allow the subgrade soil to dry out. Cover the prepared subgrade soil with non-expansive fill as soon as practical after preparation.
3. Excavate soft subgrade areas and replace with suitable, non-expansive fill, placed and compacted to 96 percent of standard Proctor density at optimum moisture content.
4. All structural fill placed above the natural soils should be placed and compacted in thin lifts (150 mm maximum) to 98 percent of standard Proctor density at optimum moisture content.
5. Isolate the slab from foundation walls, columns, etc., by means of separation joints.
6. Reinforce the concrete slab and articulate the slab at regular intervals to provide for controlled cracking.
7. Provide positive site drainage away from the proposed Building(s). Extend downspouts at least 3 metres away from the foundation.

8. Floor slabs should not be constructed on desiccated, wet, or frozen subgrade soil or base.
9. Frost should not be allowed to penetrate beneath the floor slab just prior to, during or after construction.

5.9.2 Basement Slabs

The groundwater table appeared to be situated at depths of approximately 1.5 to 6.7 metres below the existing ground surface elevation on May 5 and June 5, 2017. The groundwater table will fluctuate and may be higher in wetter times of the year. For this reason, and to avoid the detrimental impacts of water infiltration into the basement level of the buildings, it is recommended to situate the basement floor a minimum of 0.75 metres above the elevation of the groundwater table and provide a sump pit to collect any free water which may accumulate beneath the floor. A minimum of 200 mm of clean, free-draining granular fill (see gradation requirements below) should be provided beneath the underside of the floor slab to allow any water that accumulates beneath the slab to drain freely into the sump pit.

TABLE VIII. CLEAN, GRANULAR DRAINAGE AGGREGATE

Sieve Designation (mm)	Percent Passing
25.0	100
9.5	50 – 95
5.0	35 – 70
2.0	20 – 45
0.425	0 – 20
0.150	0 – 10
0.071	0 – 3

The surface of the subgrade should be positively graded towards the sump pit. The sump pit should be perforated (and wrapped in filter cloth to prevent clogging) to allow water to drain in from the sub-slab drainage layer.

The provision of weeping tile set in the granular fill could also be considered to convey groundwater to the sump pit if perforating the sump pit is not desirable. Any water collected in the sump pit/weeping tile drainage system (i.e., surface runoff water that infiltrates alongside the foundation walls and/or groundwater) should be directed well away from the Residence.

Separate the slab from the fill by means of a polyethylene vapour barrier. Care should be taken during and following installation to minimize damaging the vapour barrier.

The sub-surface drainage system should incorporate provisions for mitigation of radon gas (i.e., traps in lines entering sump, sealed sump, etc.).

If insulation is to be utilized below the basement floor slab, a minimum of 1 metre of un-insulated space should be provided around the perimeter of the foundation walls to allow heat loss to the underside of the perimeter footing.

5.10 Foundation Walls

Subsurface foundation walls should be designed to resist lateral earth pressure exerted by the backfill as well as the horizontal pressure induced by any surcharge loading. The lateral earth pressure may be calculated on the basis of an equivalent fluid pressure distribution of 9 kN/m^3 for drained conditions (i.e., perforated drainage pipe drainage system and clean, free-draining backfill as discussed below) and 16 kN/m^3 for undrained conditions (i.e., backfill with existing subgrade soils).

A perforated drainage pipe should be installed alongside the foundation walls with the invert elevation at or below the base of the foundation. The perforated drainage pipe should be at least 100 mm in diameter and installed on non-woven geotextile capable of transmitting a flow of not less than 50 litres per second per square metre (ASTM D-4491). The geotextile should be placed on naturally deposited, undisturbed soil or free-draining sand as may be required for leveling.

The geotextile should be used to encapsulate at least 300 mm of clean, granular drainage aggregate above the invert of the drainage pipe. The clean drainage aggregate should meet the aggregate gradation requirements specified in Table VIII. The drainage pipe should be directed to a sump pit and accumulated water discharged in accordance with local regulations.

In the zone 350 mm above the invert of the drainage pipe and extending to within 500 mm of ground surface, clean, free-draining granular material with less than 5 percent material finer than the 0.071 mm sieve size should be used. The uppermost 500 mm should consist of clay or other low permeability material.

5.11 Grade Beams

The grade beams should be reinforced at both top and bottom throughout their entire length. Grade beams should be constructed to allow for a minimum of 100 mm of net void space between the underside of the grade beam and the subgrade soil.

5.12 Foundation Concrete

The results of water soluble sulphate testing on soil samples recovered from the subject site have been summarized in Table IX.

TABLE IX. WATER SOLUBLE SULPHATE TEST RESULTS

Test Hole No.	Depth (m)	Soil Type	Water Soluble Sulphate (%)	Class of Exposure	Degree of Sulphate Exposure
17-10	4.5	Clay	0.017	--	Negligible
17-12	4.5	Sand	<0.010	--	Negligible

An examination of Table IX revealed that the measured sulphate contents varied from less than 0.01 to 0.017 percent, which is considered negligible in terms of potential degree of sulphate attack.

Based on the test results, General Use cement could be used for foundation concrete. However, water soluble sulphate salts (gypsum crystals) were encountered in the subgrade soils during test drilling and the statistical probability of encountering water soluble sulphate salts in the samples tested was low. Higher concentrations (than recorded) of water soluble sulphates at this site should be anticipated. Therefore, it is recommended that sulphate resistant cement should be used for all foundation concrete in contact with the soil. All concrete for this site should be manufactured in accordance with current CSA standards.

It should be recognized that water soluble sulphate salts combined with moist soil conditions or low pH soils, could render the soil highly corrosive to some types of metal water lines, elbows, connectors, etc., in contact with the soil.

5.13 Site Classification for Seismic Site Response

Based on the subgrade soils encountered at this site, the site classification for seismic response, in accordance with Table 4.1.8.4.A of the NBCC (2010), is Site Class D.

5.14 Access Roads

Suitable borrow soils (i.e., sand) exist at the subject site for construction of subdivision roads and parking areas. Silt soils should not be used for access road/parking area construction.

It is anticipated that the subdivision roads and parking areas will be subject to light passenger vehicle to medium truck traffic wheel loading for the most part with some occasional heavy truck traffic wheel loading.

The following minimum recommendations should be incorporated into the design of the asphalt concrete and/or gravel surface structure.

1. Prepare the site in accordance with Section 5.2, Site Preparation.

2. Where soft subgrade conditions are encountered during site preparation, the need for special measures (i.e., overexcavation, geotextile, geogrid, cement stabilization and/or gravel fill) in soft areas must be subject to review by the Geotechnical Consultant during field construction. Based on the actual conditions encountered at the time of construction, the road structure may need to be modified to accommodate the construction equipment and the intended use.
3. As a subgrade support, the CBR (California Bearing Ratio) rating of the compacted subgrade soil should be in the order of 3. Based on the CBR rating, the following pavement structures have been presented.

TABLE X. THICKNESS DESIGN FOR ACCESS ROADS

Pavement/Granular Structure	Heavy Truck Traffic Wheel Loading (5,400 kg) (mm)		Light Truck/Passenger Vehicle Traffic Wheel Loading (1,830 kg) (mm)	
Asphalt Concrete	100	-	65	-
Granular Base (Min CBR = 65)	200	200	150	200
Granular Sub-Base (Min. CBR = 20)	250	450	150	225
Prepared Subgrade	(150)	(150)	(150)	(150)
Geogrid/Geotextile	*	*	*	*
Total Thickness	550	650	365	425

*High strength Geogrid/Geotextile will be required where soft subgrade soils are encountered. Prior to placement the Geotechnical Consultant should review the field conditions. Based on the field conditions, the roadway structure may need to be modified.

4. Subgrade fill, if required, should preferably consist of imported granular soil or the local sand soils. Subgrade fill should be placed in thin lifts (150 mm loose, maximum) and compacted to 96 percent of standard Proctor density at optimum moisture content.
5. All granular fill placed above the subgrade elevation should be placed in thin lifts (150 mm loose) and compacted to 98 percent of standard Proctor density at optimum moisture content. The granular base and sub-base course materials should meet the following aggregate gradation requirements.

TABLE XI. AGGREGATE GRADATION REQUIREMENTS

Grain Size (mm)	Percent Passing	
	Base Course	Sub-Base Course
50.0	–	100
25.0	100	75 – 100
18.0	87 – 100	–
12.5	72 – 93	52 – 100
5.0	45 – 77	30 – 75
2.0	26 – 56	20 – 55
0.900	18 – 39	–
0.400	13 – 26	8 – 30
0.160	7 – 16	–
0.071	6 – 11	3 – 15
Plasticity Index (%)	0 – 6	0 – 6
CBR (min.)	65	25
% Fracture (min.)	50	--

6. Positive surface drainage (2% minimum) is recommended to reduce the potential for moisture infiltration through the pavement structure.
7. Surface water should be prevented from seeping back under the outer edges of the pavement structure.
8. For sand borrow materials, roadway embankment slopes should be no steeper than 3.0 Horizontal to 1.0 Vertical (3H:1V). Similarly, ditch sideslopes should be no steeper than 3H:1V.
9. The roads should be constructed at least 300 mm above adjacent surrounding ground to minimize the accumulation of snow during the winter months.
10. Erosion protection is recommended for all embankment sideslopes. The slopes should be covered with topsoil and seeded to encourage vegetation growth. Alternately, erosion control blankets or hydromulch could be installed. Ditch blocks should be installed within the ditches to minimize soil erosion.

11. Periodic grading will be required to maintain the desired riding surface. Where asphalt pavement is constructed, periodic maintenance (such as crack sealing) will be required.

6.0 LIMITATIONS

The presentation of the summary of the field drill logs and foundation design recommendations has been completed as authorized. Twelve, 150 mm diameter test holes were dry drilled using our truck-mounted, continuous flight auger drill rig. Field drill logs were compiled for the Test Holes during test drilling which, we believe, were representative of the subsurface conditions at the Test Hole locations at the time of test drilling.

Three (3) CPTu piezocone penetration tests were also conducted during the field investigation. The inferred subsoil stratigraphy has been shown on the attached CPTu plots.

Variations in the subsurface conditions from that shown on the drill logs and CPTu plots at locations other than the exact test locations should be anticipated. If conditions should differ from those reported here, then we should be notified immediately in order that we may examine the conditions in the field and reassess our recommendations in the light of any new findings.

The subsurface investigation necessitated the drilling of deep test holes. The test holes were backfilled at the completion of test drilling. Please be advised that some settlement of the backfill materials will occur which may leave a depression or an open hole. It is the responsibility of the client to inspect the site and backfill, as required, to ensure that the ground surface at each Test Hole location is maintained level with the existing grade.

No detectable evidence (odour or staining) of environmentally sensitive materials was detected during the actual time of the field test drilling program. If, on the basis of any knowledge, other than that formally communicated to us, there is reason to suspect that environmentally sensitive materials may exist, then additional test holes should be drilled and samples recovered for chemical analysis.

This report has been prepared for the exclusive use of Mr. Larry Grozell and his agents for specific application to the proposed Rural Subdivision to be constructed along Clarence Avenue South within NE-28-35-5-W3M near Saskatoon, Saskatchewan. It has been prepared in accordance with generally accepted geotechnical engineering practices and no other warranty, express or implied, is made.

Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, is the responsibility of such Third Party. Governing Agencies such as municipal, provincial, or federal agencies having jurisdictions with respect to this development and/or construction of the facilities described herein have full jurisdiction with respect to the described development. Any other unspecified subsequent development would be considered Third Party and would, therefore, require prior review by PMEL. PMEL accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

The acceptance of responsibility for the design/construction recommendations presented in this report is contingent on adequate and/or full time inspection (as required, based on site conditions at the time of construction) by a representative of the Geotechnical Consultant. PMEL will not accept any responsibility on this project for any unsatisfactory performance if adequate and/or full time inspection is not performed by a representative of PMEL.

If this report has been transmitted electronically, it has been digitally signed and secured with personal passwords to lock the document. Due to the possibility of digital modification, only originally signed reports and those reports sent directly by PMEL can be relied upon without fault.

We trust that this report fulfils your requirements for this project. Should you require additional information, please contact us.

P. MACHIBRODA ENGINEERING LTD.



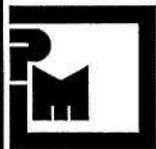
Arjun Paul, M.A.Sc., P.Eng.

Association of Professional Engineers & Geoscientists of Saskatchewan		
CERTIFICATE OF AUTHORIZATION		
P. MACHIBRODA ENGINEERING LTD.		
Number 172		
Permission to Consult held by:		
Discipline	Sk. Reg. No.	Signature
Geotechnical	10461	<i>K. Pardoski</i>
		<u>17-06-09</u>

K. Pardoski

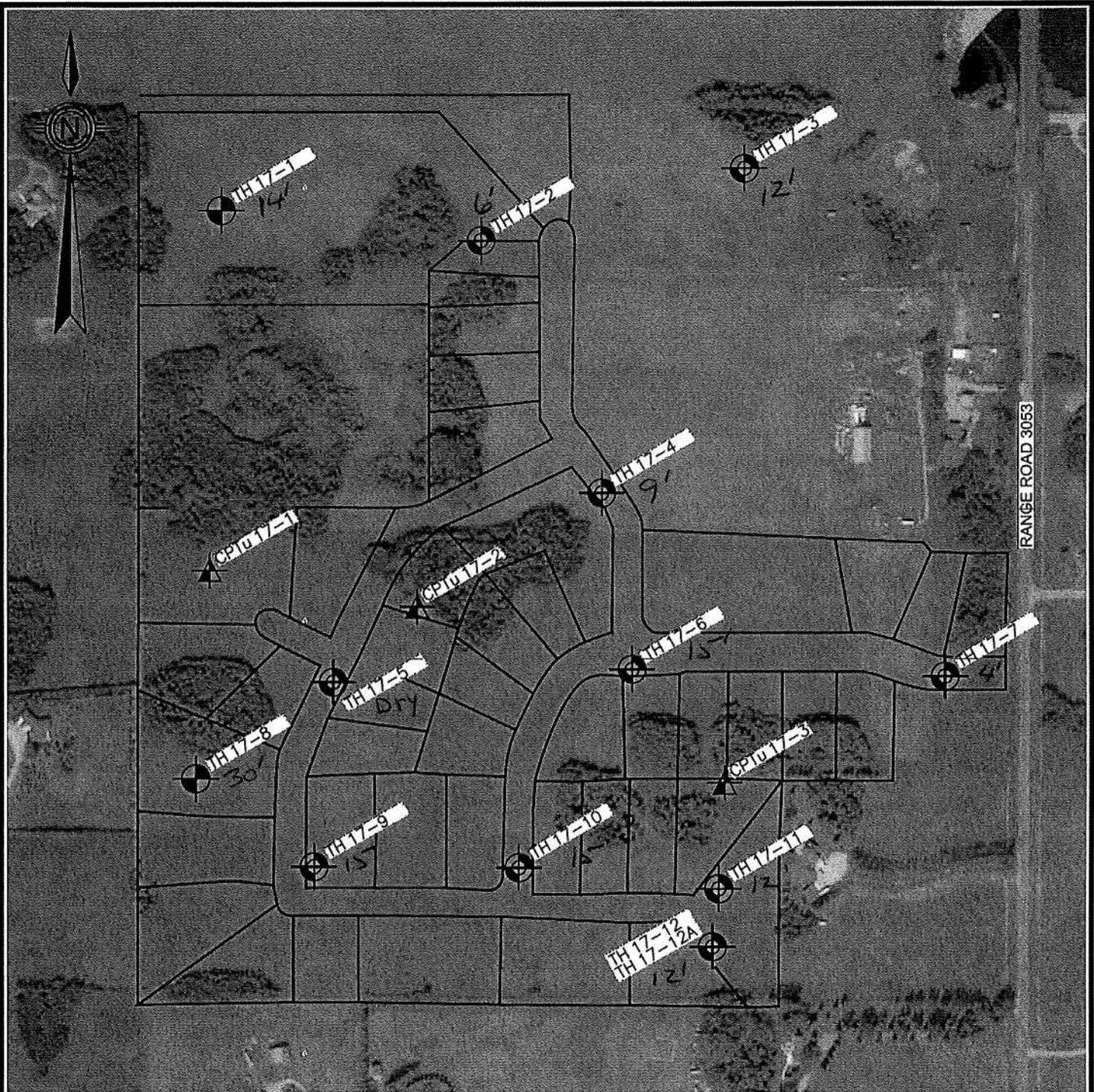
Kelly Pardoski, P. Eng.

AP/KP:



**P. MACHIBRODA
ENGINEERING LTD.
CONSULTING
GEOTECHNICAL/GEOENVIRONMENTAL
ENGINEERS**

DRAWINGS



NOTE:
 1. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.
 2. THIS DRAWING WAS COMPILED FROM GOOGLE EARTH PRO ©2017, IMAGE ©2017 DIGITALGLOBE, (IMAGERY DATE: 8/23/15).

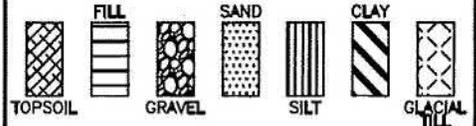
LEGEND	-PMEL TEST HOLE	-PMEL TEST HOLE (PIEZOMETER INSTALLED)	-PMEL PIEZOCONE PENETRATION TEST

<p>CONSULTING GEOENVIRONMENTAL GEOTECHNICAL ENGINEERS</p> <p>P. MACHIBRODA ENGINEERING LTD.</p> <p>806 - 48th STREET EAST SASKATOON, SK S7K 3Y4</p>	DRAWING TITLE: SITE PLAN - TEST HOLE AND PIEZOCONE LOCATIONS		
	PROJECT: PROPOSED RURAL SUBDIVISION NE-28-35-5-W3M, NEAR SASKATOON, SK		
	APPROVED BY: AP	DRAWN BY: SD	DRAWING NUMBER: 12983-1
	DATE: MAY, 2017	SCALE: NOT TO SCALE	

PIEZO. ELEV.= 505.8 ±0.5 m

TEST HOLE 17-1

LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RURAL SUBDIVISION

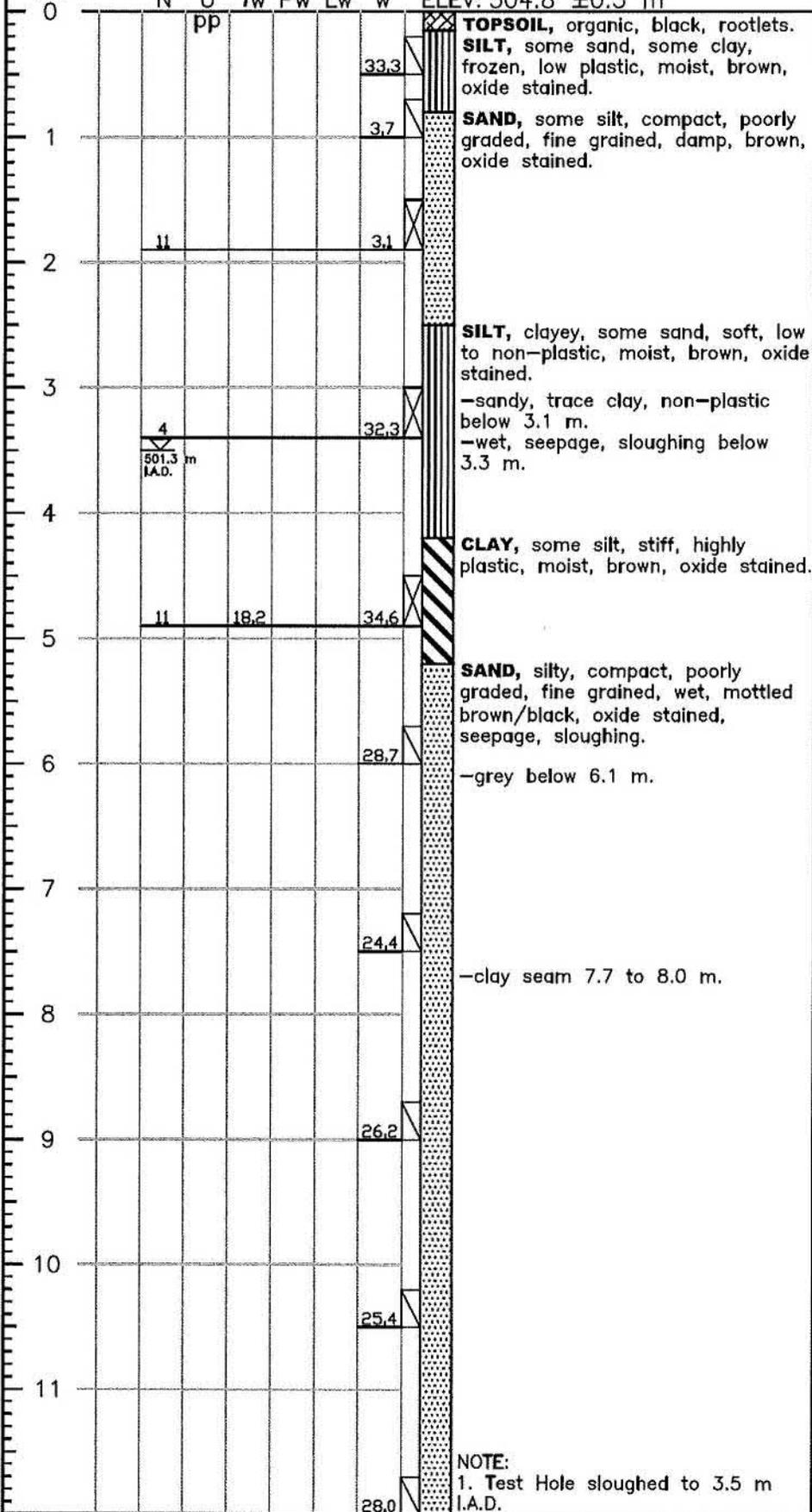
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NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766908 **EASTING:** 386322

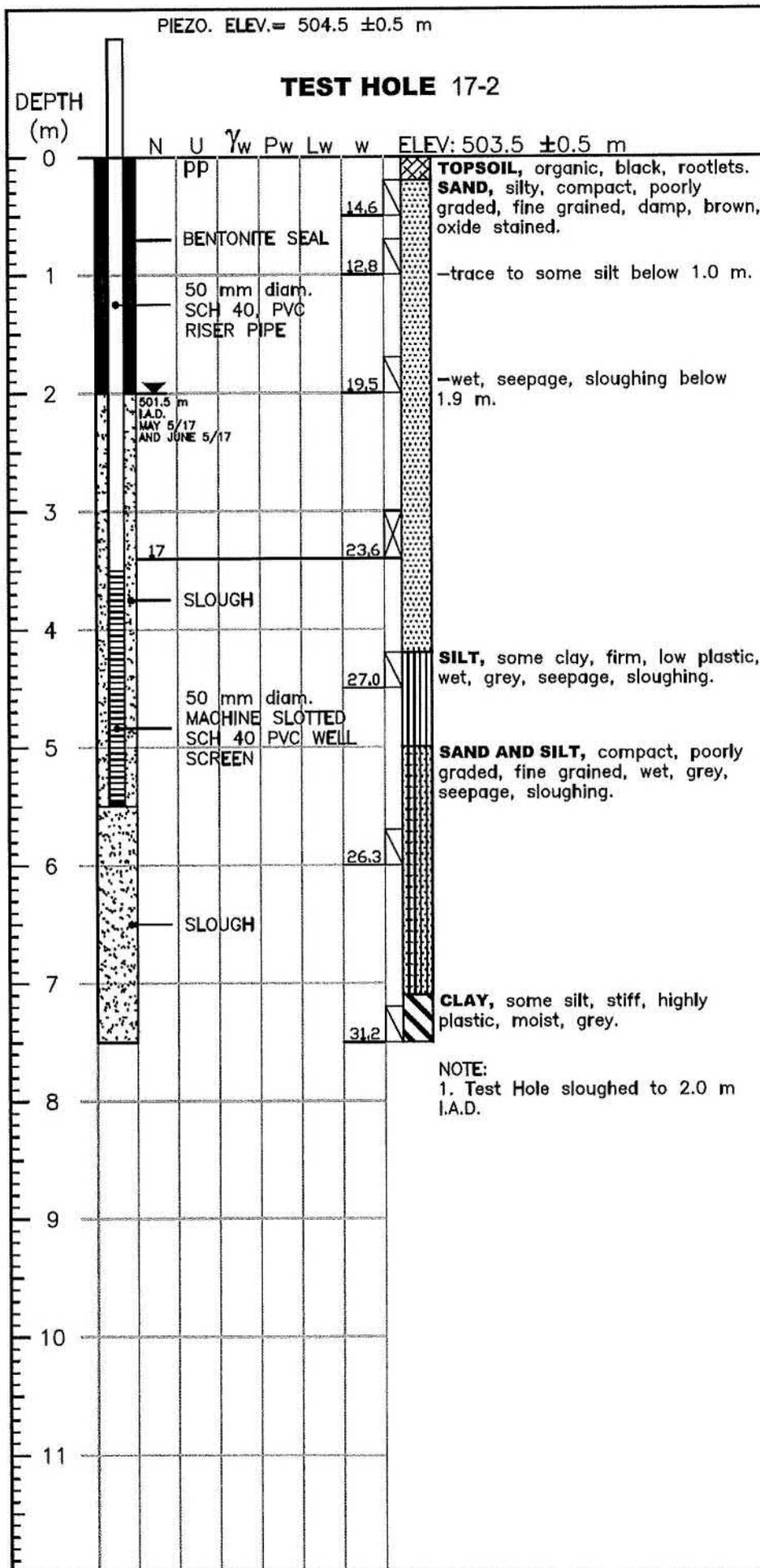
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APR 28/17

DRAWING NUMBER:
12983-2

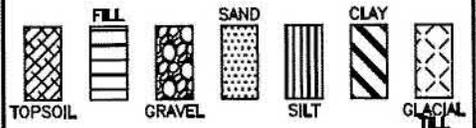
DEPTH (m)



NOTE:
1. Test Hole sloughed to 3.5 m I.A.D.



LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ∇...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ∇...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

PROJECT:

PROPOSED RURAL SUBDIVISION

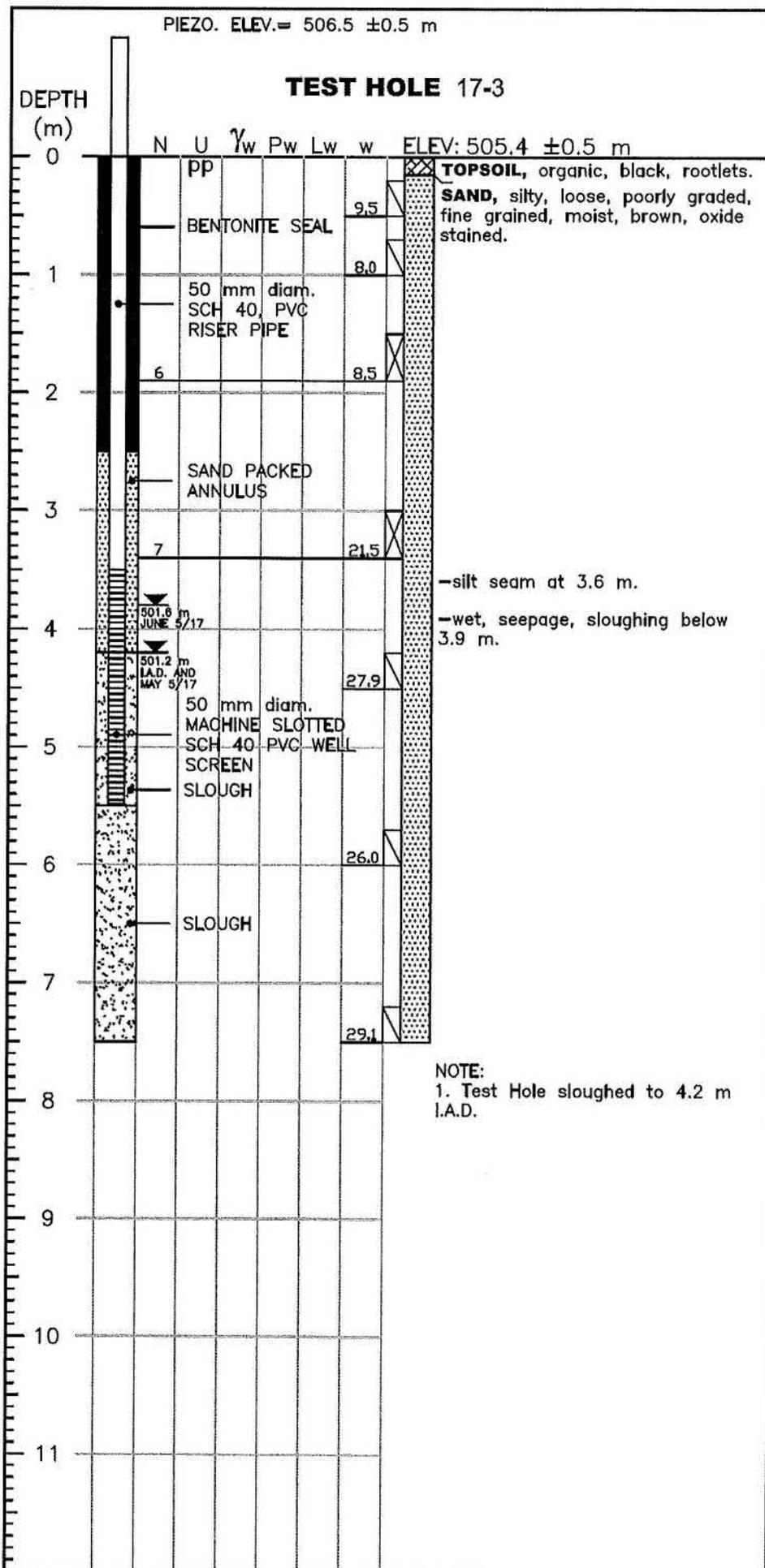
LOCATION:

NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766845 **EASTING:** 386547

DATE DRILLED:
APR 28/17

DRAWING NUMBER:
12983-3



LEGEND:

TOPSOIL	FILL	GRAVEL	SAND	SILT	CLAY	GLACIAL TILL

- w....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
 - Lw...LIQUID LIMIT
 - Pw...PLASTIC LIMIT
 - γ_w ...WET UNIT WEIGHT (kN/m³)
 - U....UNCONFINED COMPRESSIVE STRENGTH (kPa)
 - pp...POCKET PENETROMETER (kg/cm²)
 - N....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
 - SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
 - P200...% PASSING No. 200 SIEVE
 - I.A.D....IMMEDIATELY AFTER DRILLING
 - ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
 - ▼...RECORDED WATER LEVEL (PIEZO)
- | | | |
|-------------|-------------|----------|
| | | |
| SHELBY TUBE | SPLIT SPOON | CUTTINGS |

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

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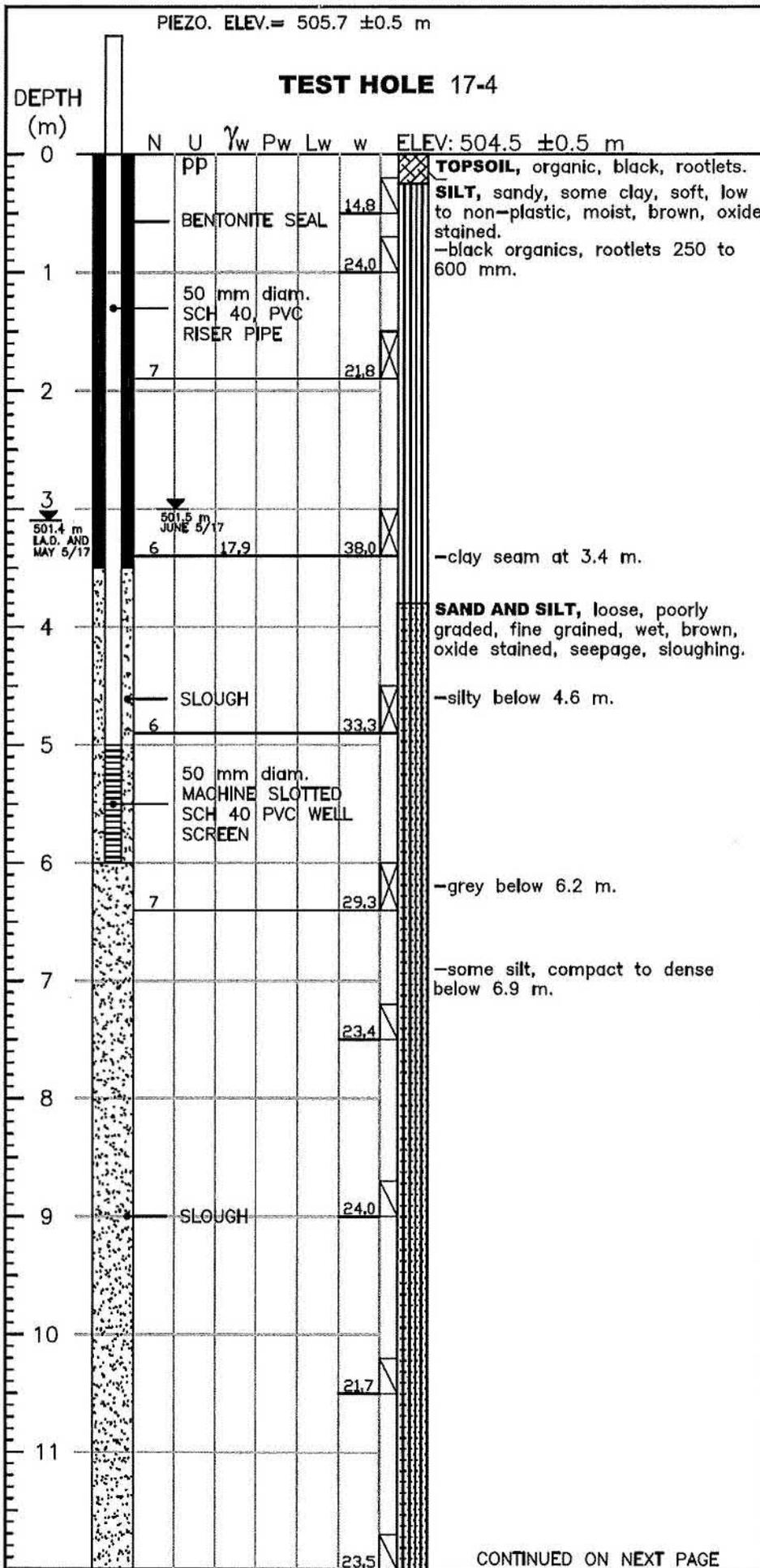
FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766909 **EASTING:** 386786

DATE DRILLED: APR 27/17	DRAWING NUMBER: 12983-4
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LEGEND:

TOPSOIL	FILL	GRAVEL	SAND	SILT	CLAY	GLACIAL FILL

w....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w ...WET UNIT WEIGHT (kN/m³)

U....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm²)

N....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO₄....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

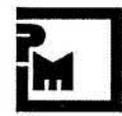
I.A.D....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE	SPLIT SPOON	CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

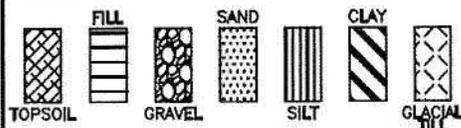
NORTHING: 5766618 **EASTING:** 386657

DATE DRILLED: APR 27/17	DRAWING NUMBER: 12983-5
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CONTINUED ON NEXT PAGE

TEST HOLE 17-4

LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- SPLIT SPOON
- CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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ENGINEERING
LTD.**

**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

PROJECT:

PROPOSED RURAL SUBDIVISION

LOCATION:

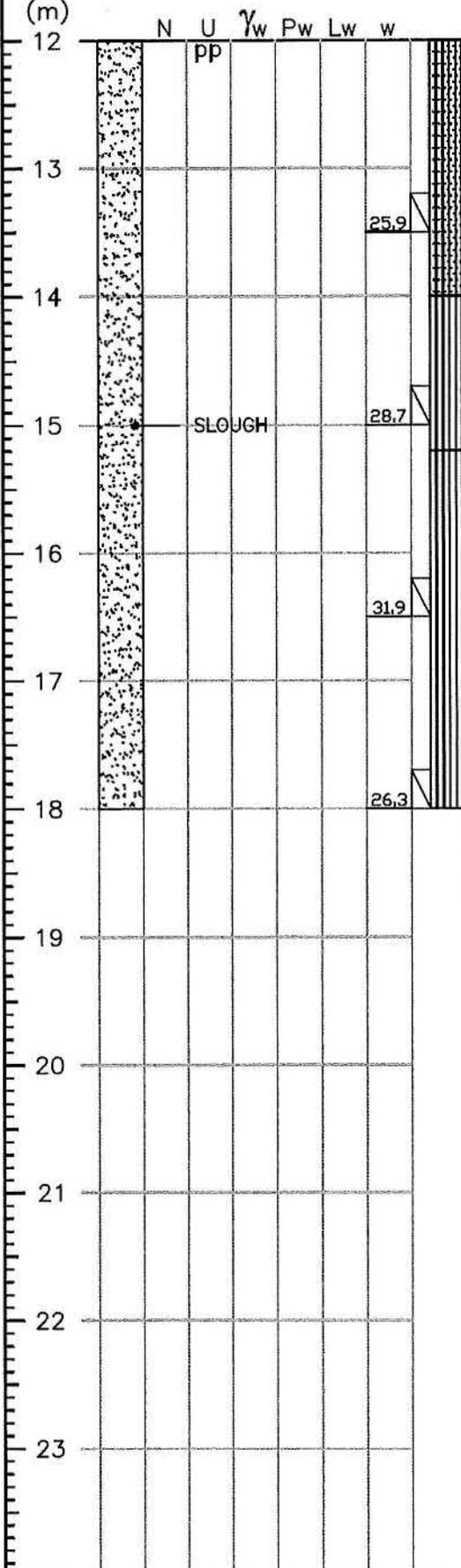
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766618 **EASTING:** 386657

DATE DRILLED:
APR 27/17

DRAWING NUMBER:
12983-5A

DEPTH
(m)

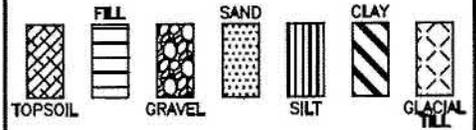


NOTE:
1. Test Hole sloughed to 3.5 m I.A.D.

PIEZO. ELEV.= 509.1 ±0.5 m

TEST HOLE 17-5

LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ∇...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)



LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



**P. MACHIBRODA
ENGINEERING
LTD.**

**FIELD DRILL LOG
AND
SOIL TEST RESULTS**

PROJECT:

PROPOSED RURAL SUBDIVISION

LOCATION:

NE-28-35-5-W3M,
NEAR SASKATOON, SK

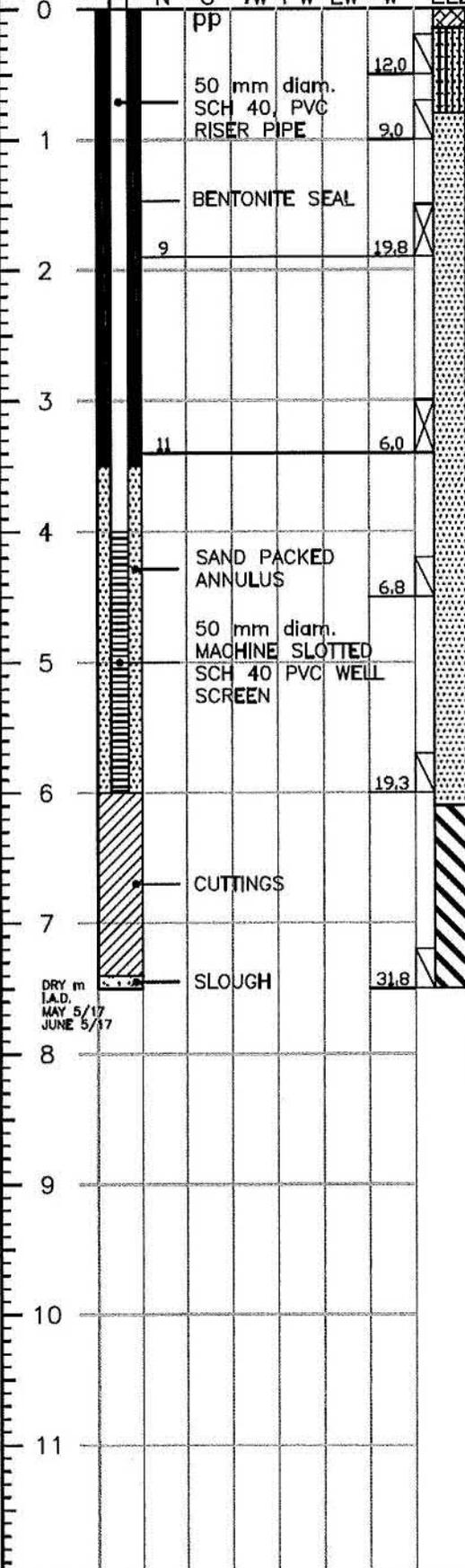
NORTHING: 5766447 **EASTING:** 386413

DATE DRILLED:
APR 26/17

DRAWING NUMBER:
12983-6

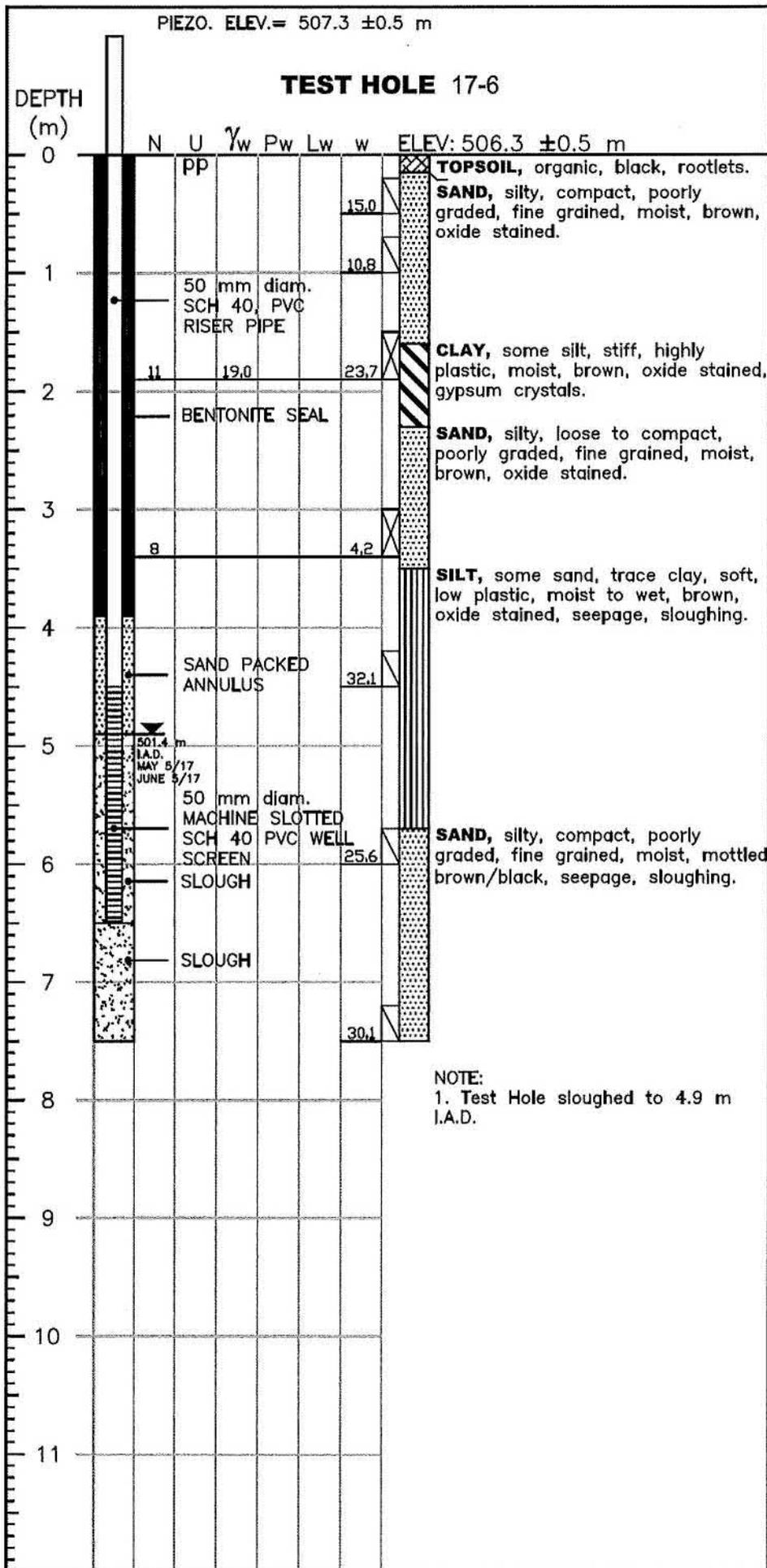
DEPTH (m)

N U γ_w Pw Lw w ELEV: 508.0 ±0.5 m



NOTE:
1. Test Hole sloughed to 7.4 m I.A.D.

DRY m
I.A.D.
MAY 5/17
JUNE 5/17



LEGEND:

TOPSOIL	FILL	GRAVEL	SAND	SILT	CLAY	GLACIAL FILL

w....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
 Lw...LIQUID LIMIT
 Pw...PLASTIC LIMIT
 γ_w ...WET UNIT WEIGHT (kN/m³)
 U....UNCONFINED COMPRESSIVE STRENGTH (kPa)
 pp...POCKET PENETROMETER (kg/cm²)
 N....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
 SO₄....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
 P200...% PASSING No. 200 SIEVE
 I.A.D....IMMEDIATELY AFTER DRILLING
 ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
 ▽...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE	SPLIT SPOON	CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

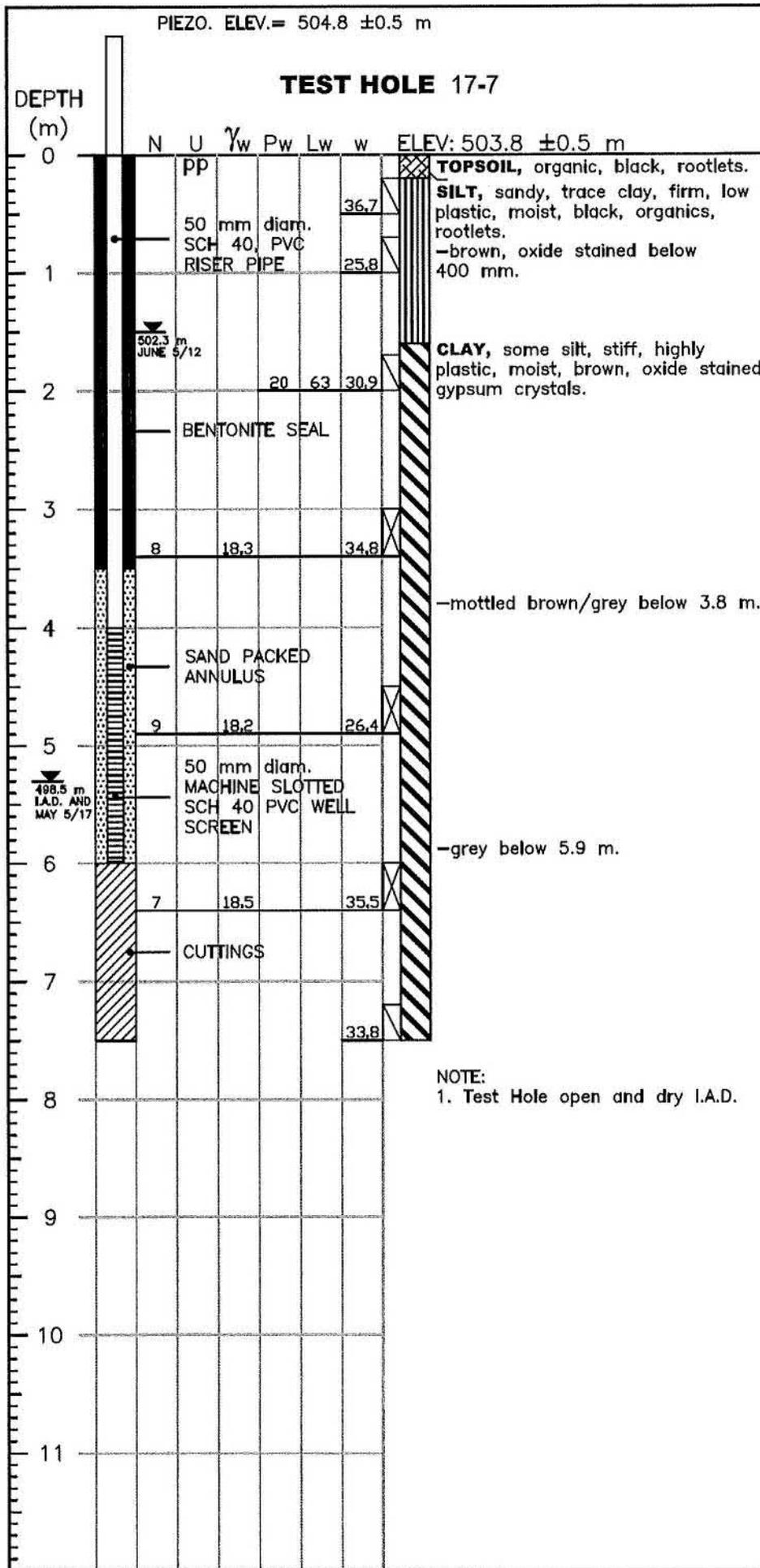
FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766458 **EASTING:** 386685

DATE DRILLED: APR 26/17	DRAWING NUMBER: 12983-7
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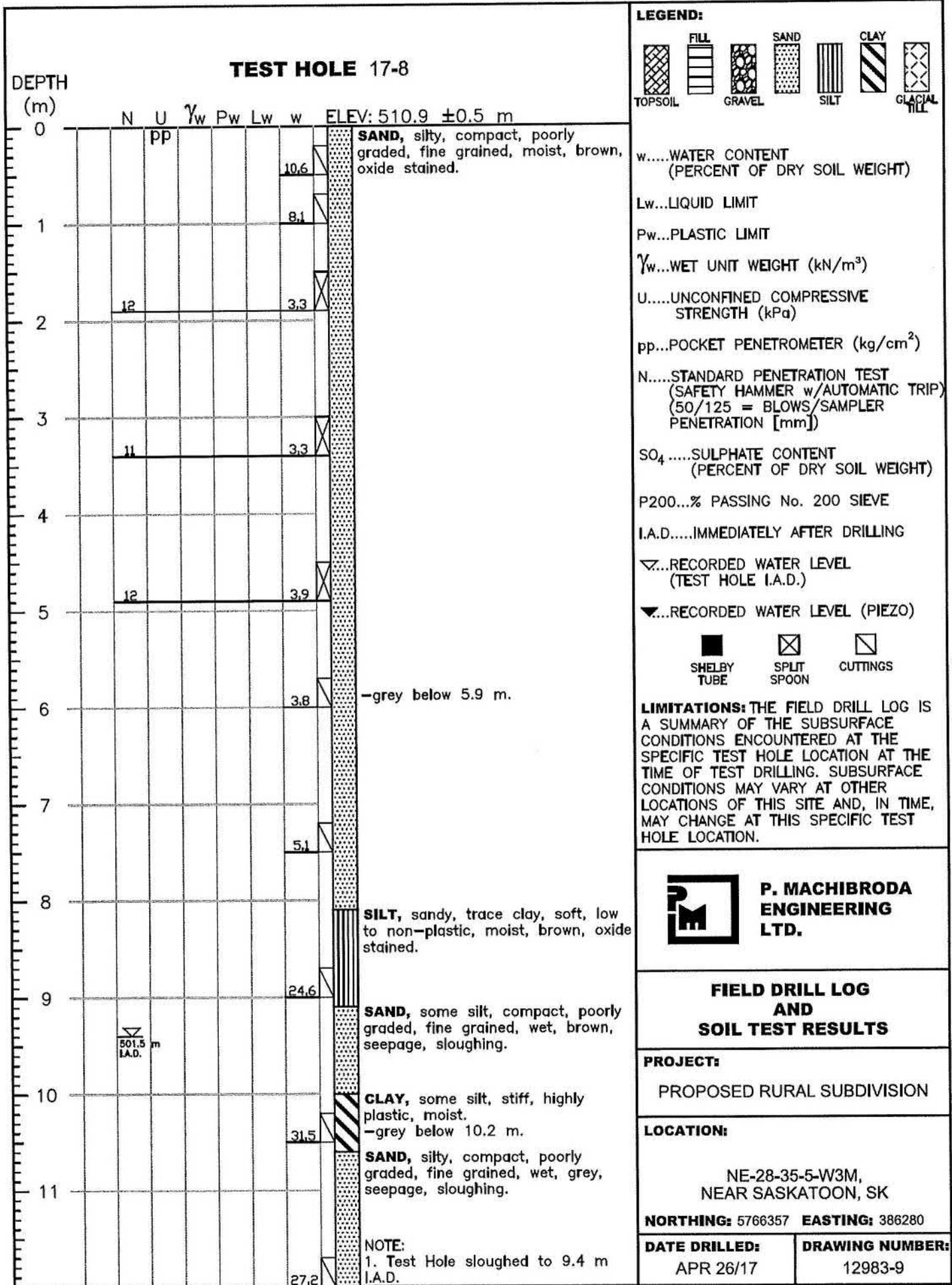
FIELD DRILL LOG AND SOIL TEST RESULTS

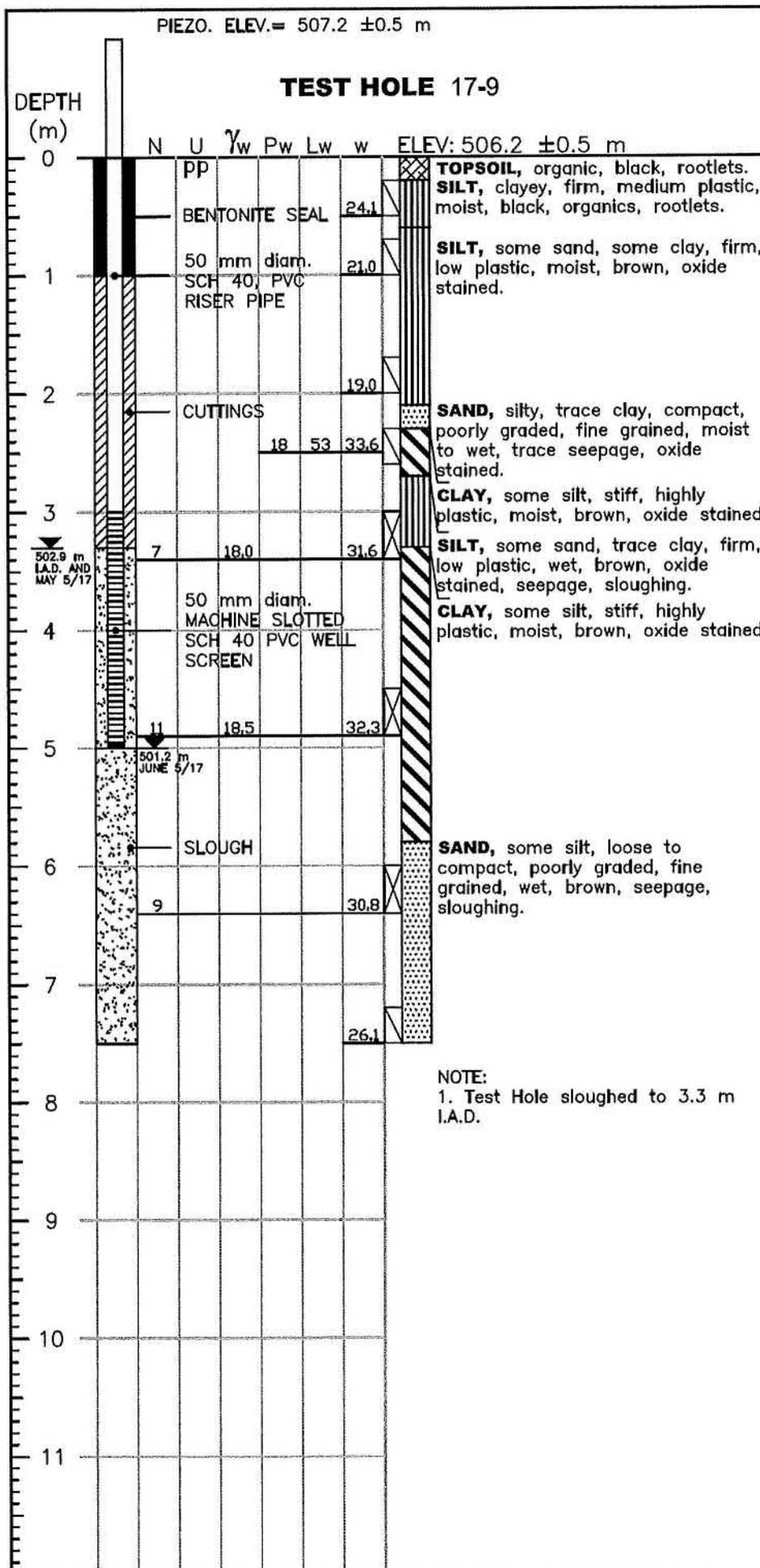
PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766452 **EASTING:** 386968

DATE DRILLED: APR 26/17 **DRAWING NUMBER:** 12983-8





LEGEND:

TOPSOIL	FILL	GRAVEL	SAND	SILT	CLAY	GLACIAL FILL

- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE	SPLIT SPOON	CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

	P. MACHIBRODA ENGINEERING LTD.
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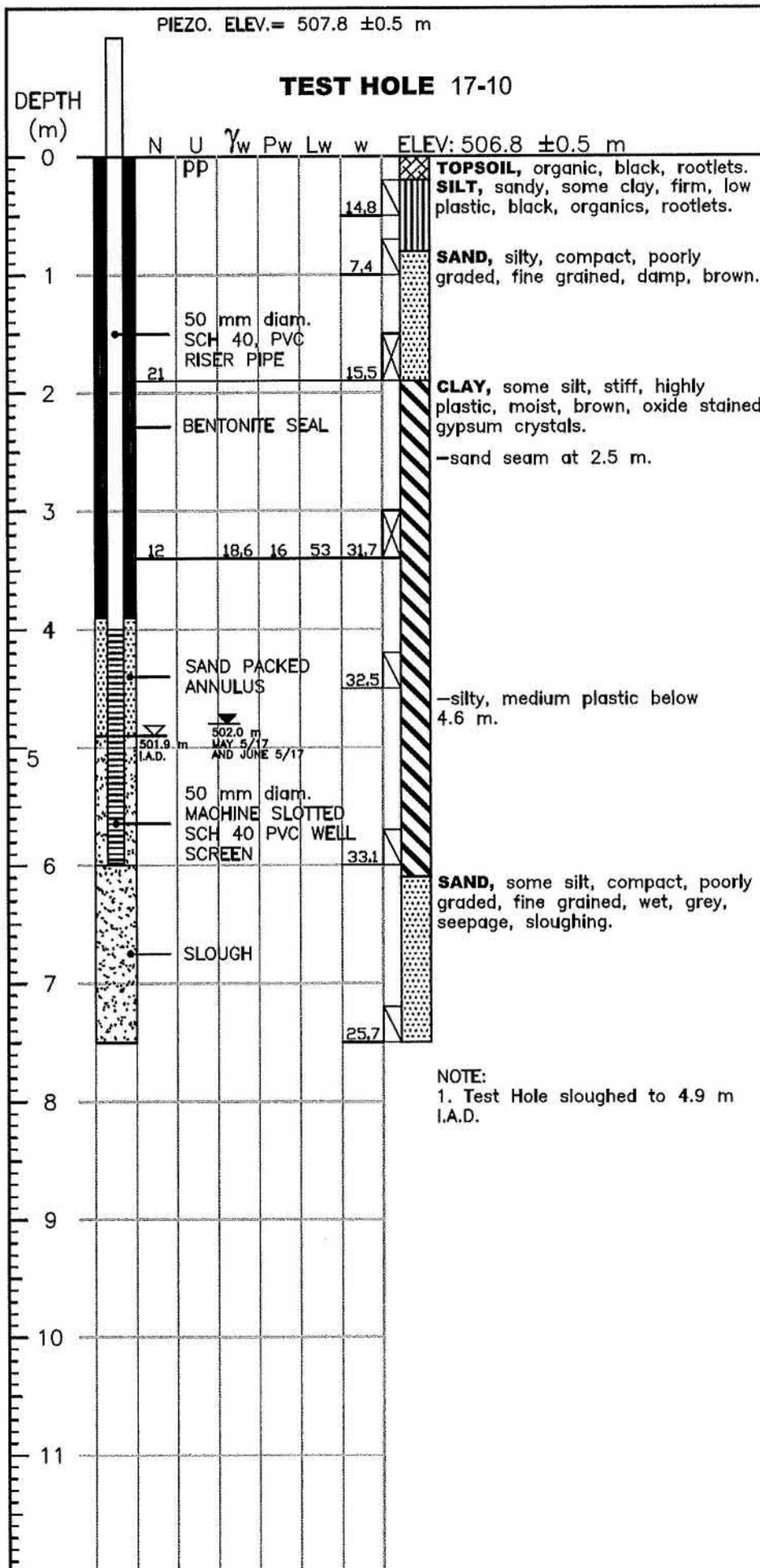
FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766280 **EASTING:** 386396

DATE DRILLED: APR 26/17	DRAWING NUMBER: 12983-10
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LEGEND:

TOPSOIL	FILL	GRAVEL	SAND	SILT	CLAY	GLACIAL FILL

- w....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
 - Lw...LIQUID LIMIT
 - Pw...PLASTIC LIMIT
 - γ_w ...WET UNIT WEIGHT (kN/m³)
 - U....UNCONFINED COMPRESSIVE STRENGTH (kPa)
 - pp...POCKET PENETROMETER (kg/cm²)
 - N....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
 - SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
 - P200...% PASSING No. 200 SIEVE
 - I.A.D....IMMEDIATELY AFTER DRILLING
 - ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
 - ▼...RECORDED WATER LEVEL (PIEZO)
- | | | |
|-------------|-------------|----------|
| | | |
| SHELBY TUBE | SPLIT SPOON | CUTTINGS |

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

	P. MACHIBRODA ENGINEERING LTD.
--	---------------------------------------

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

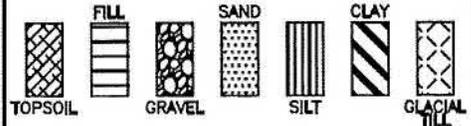
NORTHING: 5766279 **EASTING:** 386581

DATE DRILLED: APR 26/17	DRAWING NUMBER: 12983-11
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PIEZO. ELEV.= 506.6 ±0.5 m

TEST HOLE 17-11

LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ∇...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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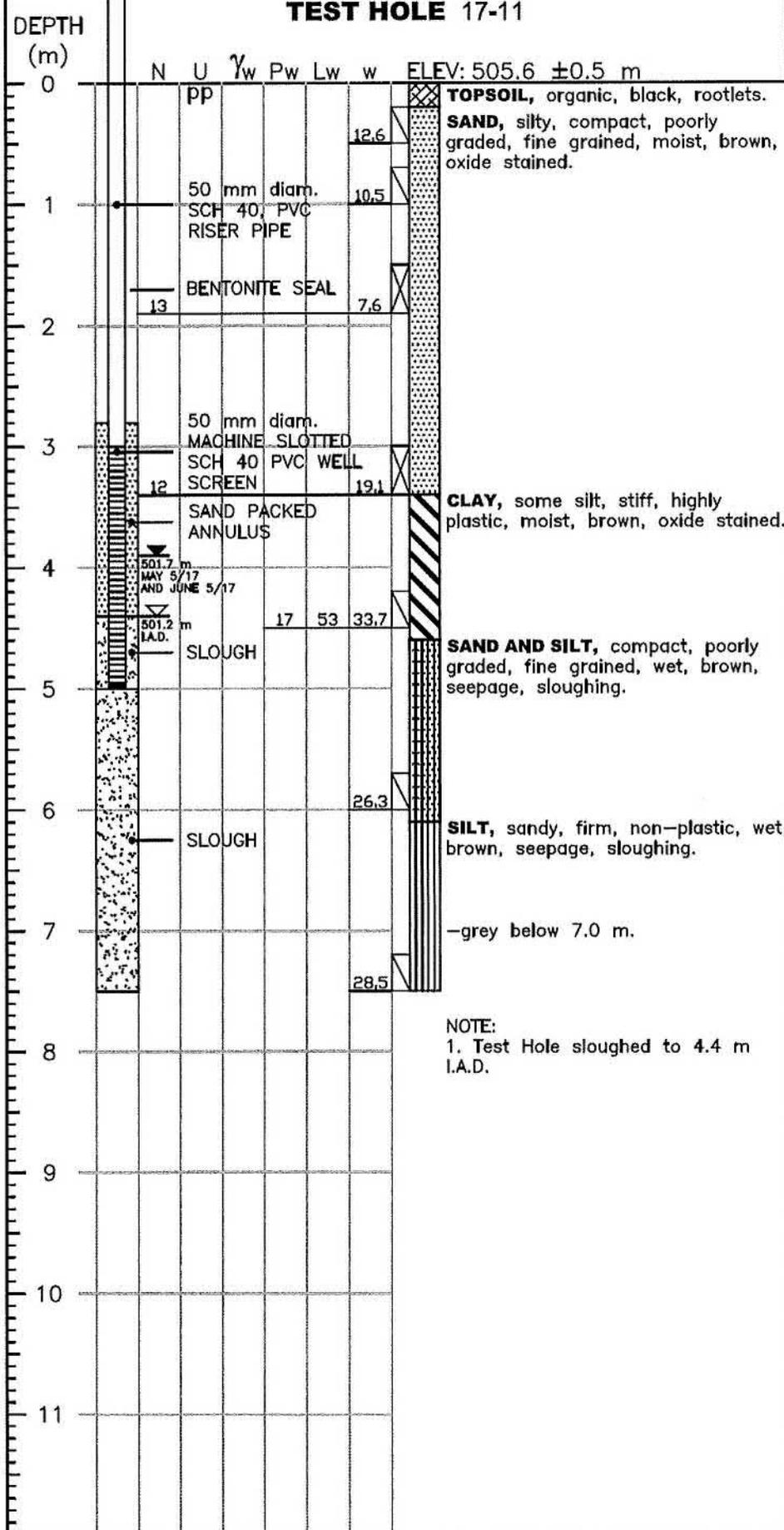
FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766260 **EASTING:** 386763

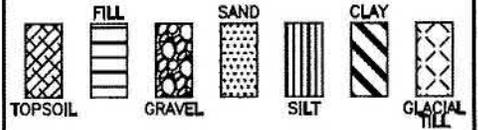
DATE DRILLED: APR 26/17 **DRAWING NUMBER:** 12983-12



NOTE:
1. Test Hole sloughed to 4.4 m I.A.D.

TEST HOLE 17-12

LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



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FIELD DRILL LOG AND SOIL TEST RESULTS

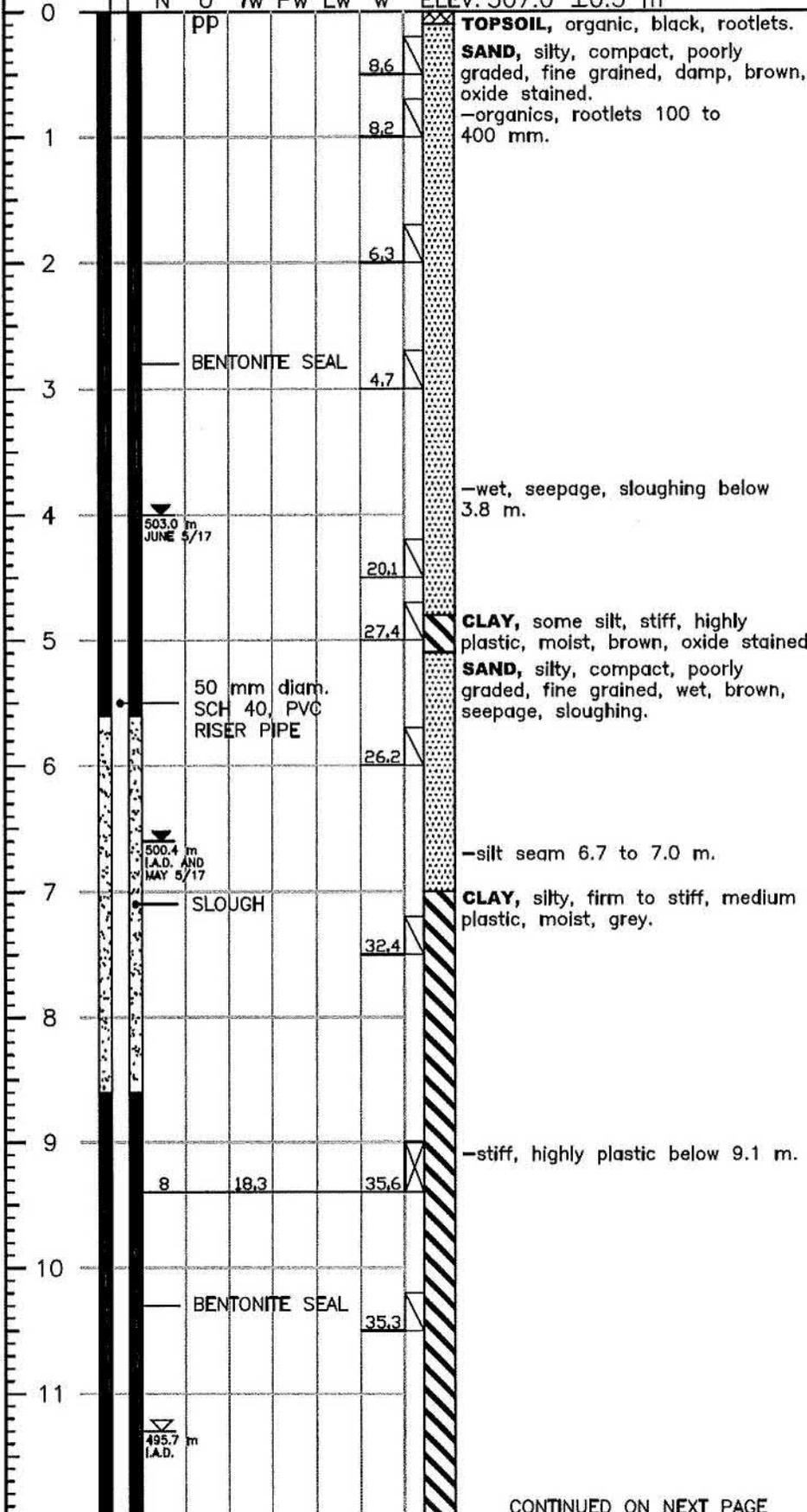
PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766209 **EASTING:** 386758

DATE DRILLED: APR 27/17 **DRAWING NUMBER:** 12983-13

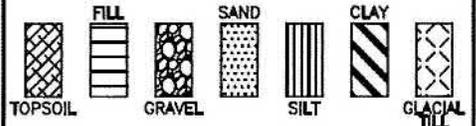
DEPTH (m)



CONTINUED ON NEXT PAGE

TEST HOLE 17-12

LEGEND:



- w....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Lw...LIQUID LIMIT
- Pw...PLASTIC LIMIT
- γ_w ...WET UNIT WEIGHT (kN/m³)
- U....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)
- SHELBY TUBE
- ⊠ SPLIT SPOON
- CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766208 **EASTING:** 386758

DATE DRILLED: APR 27/17 **DRAWING NUMBER:** 12983-13A

DEPTH (m)

DEPTH (m)	N	U	γ_w	Pw	Lw	w
12						
12.0						
12.1						
12.2						
12.3						
12.4						
12.5						
12.6						
12.7						
12.8						
12.9						
13.0						
13.1						
13.2						
13.3						
13.4						
13.5						
13.6						
13.7						
13.8						
13.9						
14.0						
14.1						
14.2						
14.3						
14.4						
14.5						
14.6						
14.7						
14.8						
14.9						
15.0						
15.1						
15.2						
15.3						
15.4						
15.5						
15.6						
15.7						
15.8						
15.9						
16.0						
16.1						
16.2						
16.3						
16.4						
16.5						
16.6						
16.7						
16.8						
16.9						
17.0						
17.1						
17.2						
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17.4						
17.5						
17.6						
17.7						
17.8						
17.9						
18.0						
18.1						
18.2						
18.3						
18.4						
18.5						
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18.7						
18.8						
18.9						
19.0						
19.1						
19.2						
19.3						
19.4						
19.5						
19.6						
19.7						
19.8						
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20.0						
20.1						
20.2						
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21.3						
21.4						
21.5						
21.6						
21.7						
21.8						
21.9						
22.0						
22.1						
22.2						
22.3						
22.4						
22.5						
22.6						
22.7						
22.8						
22.9						
23.0						

CLAY, silty, stiff, highly plastic, moist, grey.

NOTE:
1. Hollow stem auger installed to 9.0 m.
2. Test Hole sloughed to 5.6 m after removing hollow stem and placing bentonite seal.

N U γ_w Pw Lw w

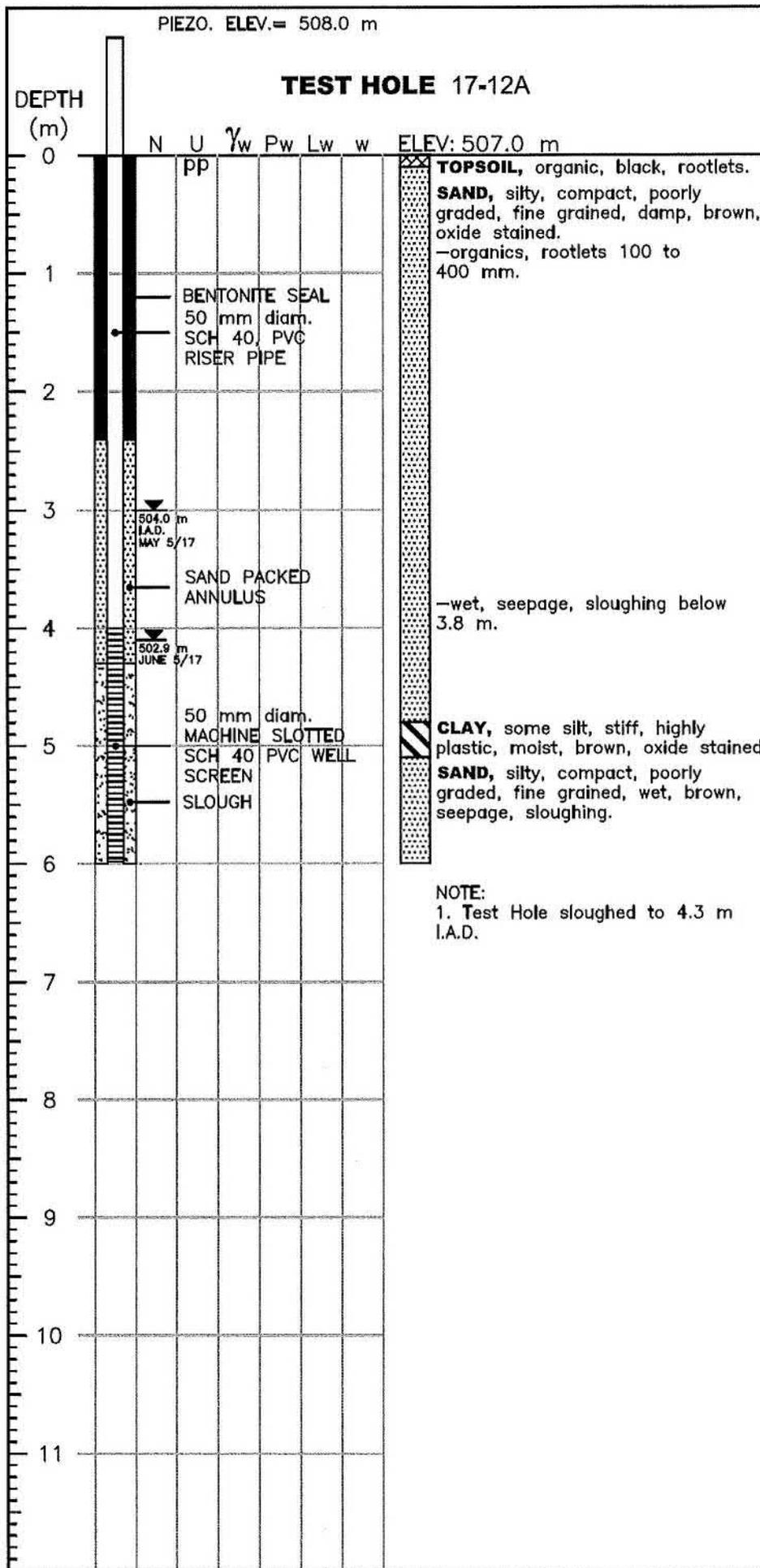
DP BENTONITE SEAL 34.6

8 50 mm diam. SCH 40, PVC RISER PIPE

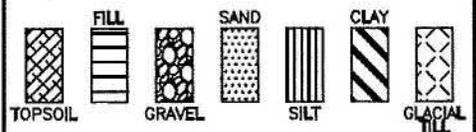
SAND PACKED ANNULUS 31.3

50 mm diam. MACHINE SLOTTED SCH 40 PVC WELL SCREEN

31.3



LEGEND:



- w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- L_w...LIQUID LIMIT
- P_w...PLASTIC LIMIT
- γ_w...WET UNIT WEIGHT (kN/m³)
- U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)
- pp...POCKET PENETROMETER (kg/cm²)
- N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
- SO₄.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- P200...% PASSING No. 200 SIEVE
- I.A.D.....IMMEDIATELY AFTER DRILLING
- ▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)
- ▼...RECORDED WATER LEVEL (PIEZO)



LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.



P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RURAL SUBDIVISION

LOCATION:
NE-28-35-5-W3M,
NEAR SASKATOON, SK

NORTHING: 5766209 **EASTING:** 386758

DATE DRILLED: APR 27/17	DRAWING NUMBER: 12983-14
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APPENDIX A
EXPLANATIONS OF TERMS
ON TEST HOLE LOGS

CLASSIFICATION OF SOILS

Coarse-Grained Soils: Soils containing particles that are visible to the naked eye. They include gravels and sands and are generally referred to as cohesionless or non-cohesive soils. Coarse-grained soils are soils having more than 50 percent of the dry weight larger than particle size 0.080 mm.

Fine-Grained Soils: Soils containing particles that are not visible to the naked eye. They include silts and clays. Fine-grained soils are soils having more than 50 percent of the dry weight smaller than particle size 0.080 mm.

Organic Soils: Soils containing a high natural organic content.

Soil Classification By Particle Size

Clay – particles of size	< 0.002 mm
Silt – particles of size	0.002 – 0.060 mm
Sand – particles of size	0.06 – 2.0 mm
Gravel – particles of size	2.0 – 60 mm
Cobbles – particles of size	60 – 200 mm
Boulders – particles of size	>200 mm

TERMS DESCRIBING CONSISTENCY OR CONDITION

Coarse-grained soils: Described in terms of compactness condition and are often interpreted from the results of a Standard Penetration Test (SPT). The standard penetration test is described as the number of blows, N, required to drive a 51 mm outside diameter (O.D.) split barrel sampler into the soil a distance of 0.3 m (from 0.15 m to 0.45 m) with a 63.5 kg weight having a free fall of 0.76 m.

Compactness Condition	SPT N-Index (blows per 0.3 m)
Very loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	Over 50

Fine-Grained Soils: Classified in relation to undrained shear strength.

Consistency	Undrained Shear Strength (kPa)	N Value (Approximate)	Field Identification
Very Soft	<12	0-2	Easily penetrated several centimetres by the fist.
Soft	12-25	2-4	Easily penetrated several centimetres by the thumb.
Firm	25-50	4-8	Can be penetrated several centimetres by the thumb with moderate effort.
Stiff	50-100	8-15	Readily indented by the thumb, but penetrated only with great effort.
Very Stiff	100-200	15-30	Readily indented by the thumb nail.
Hard	>200	>30	Indented with difficulty by the thumbnail.

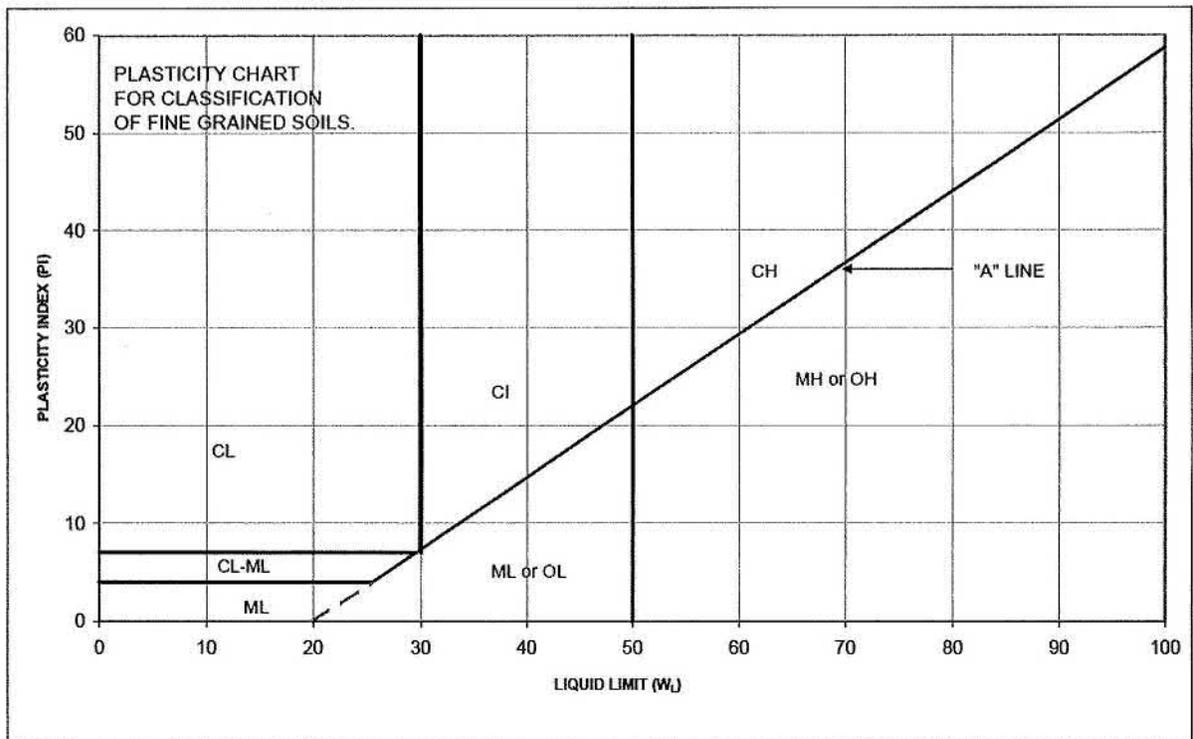
Organic Soils: Readily identified by colour, odour, spongy feel and frequently by fibrous texture.

DESCRIPTIVE TERMS COMMONLY USED TO CHARACTERIZE SOILS

Poorly Graded	- predominance of particles of one grain size.
Well Graded	- having no excess of particles in any size range with no intermediate sizes lacking.
Mottled	- marked with different coloured spots.
Nuggety	- structure consisting of small prismatic cubes.
Laminated	- structure consisting of thin layers of varying colour and texture.
Slickensided	- having inclined planes of weakness that are slick and glossy in appearance.
Fissured	- containing shrinkage cracks.
Fractured	- broken by randomly oriented interconnecting cracks in all 3 dimensions.

SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.)

MAJOR DIVISION		GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
HIGHLY ORGANIC SOILS		Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR AND OFTEN FIBROUS TEXTURE
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS More than half coarse fraction larger than No. 4 sieve size	CLEAN GRAVELS	GW WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES <5% FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$ $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}} = 1 \text{ to } 3$
			GP POORLY-GRADED GRAVELS AND GRAVEL-SAND MIXTURES <5% FINES	NOT MEETING ALL ABOVE REQUIREMENTS FOR GW
		DIRTY GRAVELS	GM SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR $PI < 4$
			GC CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE "A" LINE WITH $PI > 7$
	SANDS More than half coarse fraction smaller than No. 4 sieve size	CLEAN SANDS	SW WELL-GRADED SANDS, GRAVELLY SANDS MIXTURES <5% FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$ $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}} = 1 \text{ to } 3$
			SP POORLY-GRADED SANDS OR GRAVELLY SANDS <5% FINES	NOT MEETING ALL GRADATION REQUIREMENTS FOR SW
		DIRTY SANDS	SM SILTY SANDS, SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR $PI < 4$
			SC CLAYEY SANDS, SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE "A" LINE WITH $PI > 7$
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSING NO. 200 SIEVE SIZE)	SILTS Below "A" line on plasticity chart; negligible organic content	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	$W_L < 50$
		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	$W_L > 50$
	CLAYS Above "A" line on plasticity chart; negligible organic content	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	$W_L < 30$
		CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	$W_L > 30 < 50$
		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	$W_L > 50$
	ORGANIC SILTS & ORGANIC CLAYS Below "A" line on plasticity chart	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	$W_L < 50$
OH		ORGANIC CLAYS OF HIGH PLASTICITY	$W_L > 50$	



APPENDIX B

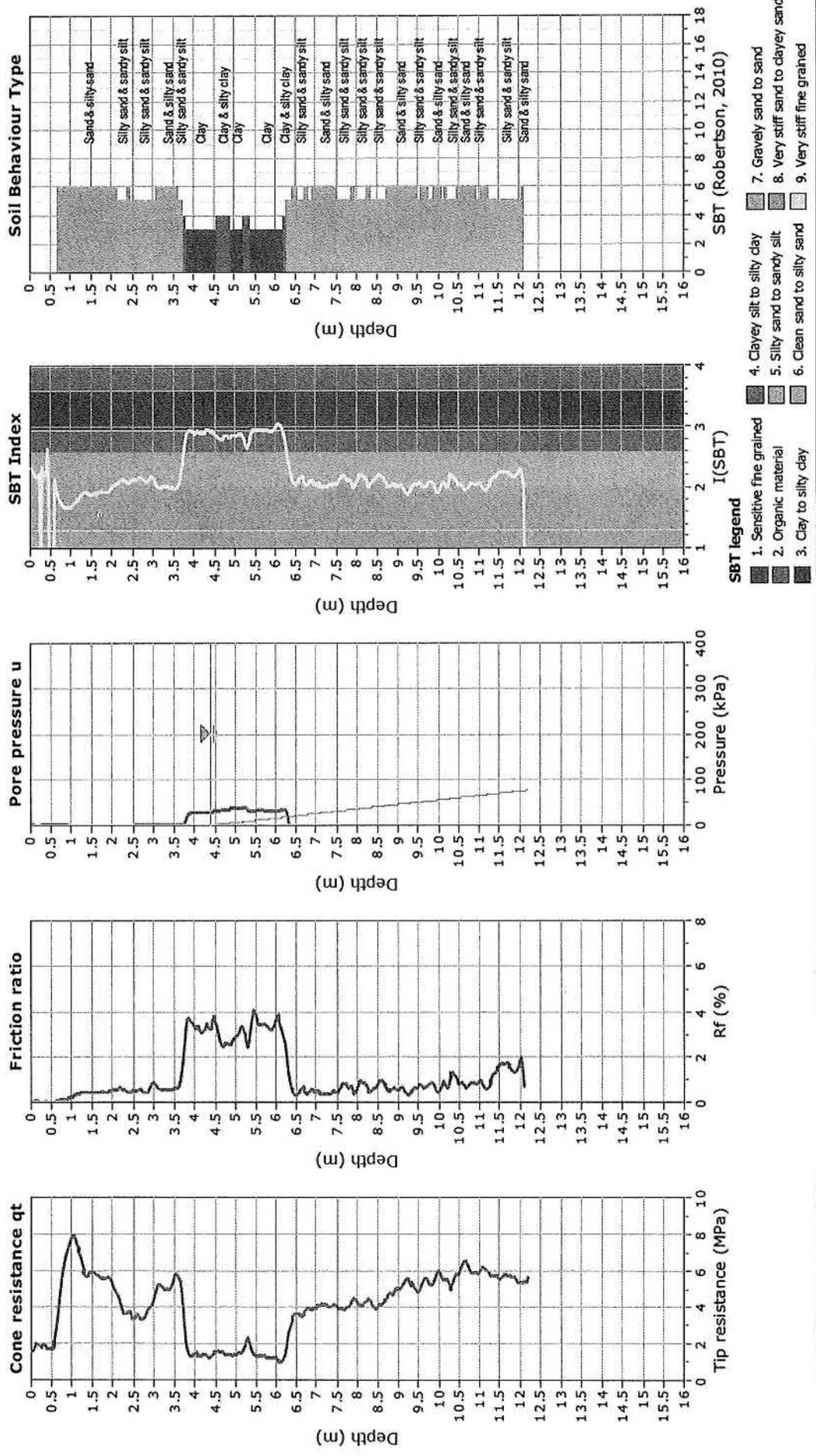
PIEZOCONE PENETRATION PLOTS



P. Machibroda Engineering Ltd.
 806-48th Street East
 Saskatoon, SK S7K 3Y4
<http://www.machibroda.com>

CPT: 17-1
 Total depth: 12.22 m, Date: 4/28/2017
 Surface Elevation: 505.40 m
 Coords: N 5766537, E 386313
 Cone Type: Vertek 15 cm²
 Cone Operator: PMEL

Project: Proposed Rural Subdivision
Location: NE-28-35-5-W3M, Near Saskatoon, SK

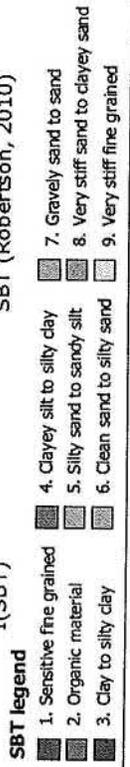
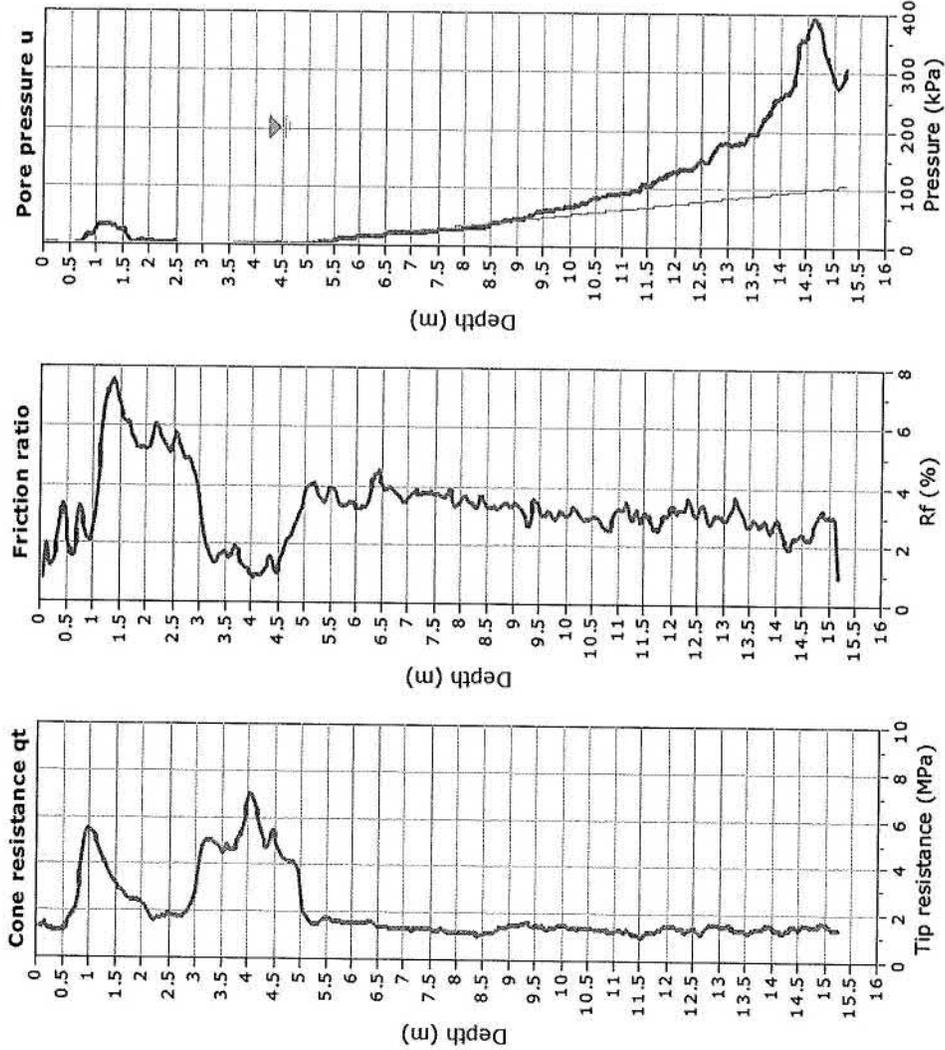




P. Machibroda Engineering Ltd.
 806-48th Street East
 Saskatoon, SK S7K 3Y4
<http://www.machibroda.com>

Project: Proposed Rural Subdivision
Location: NE-28-35-5-W3M, Near Saskatoon, SK

CPT: 17-2
 Total depth: 15.25 m, Date: 4/28/2017
 Surface Elevation: 505.70 m
 Coords: N 5766506, E 386482
 Cone Type: Vertek 15 cm²
 Cone Operator: PMEL

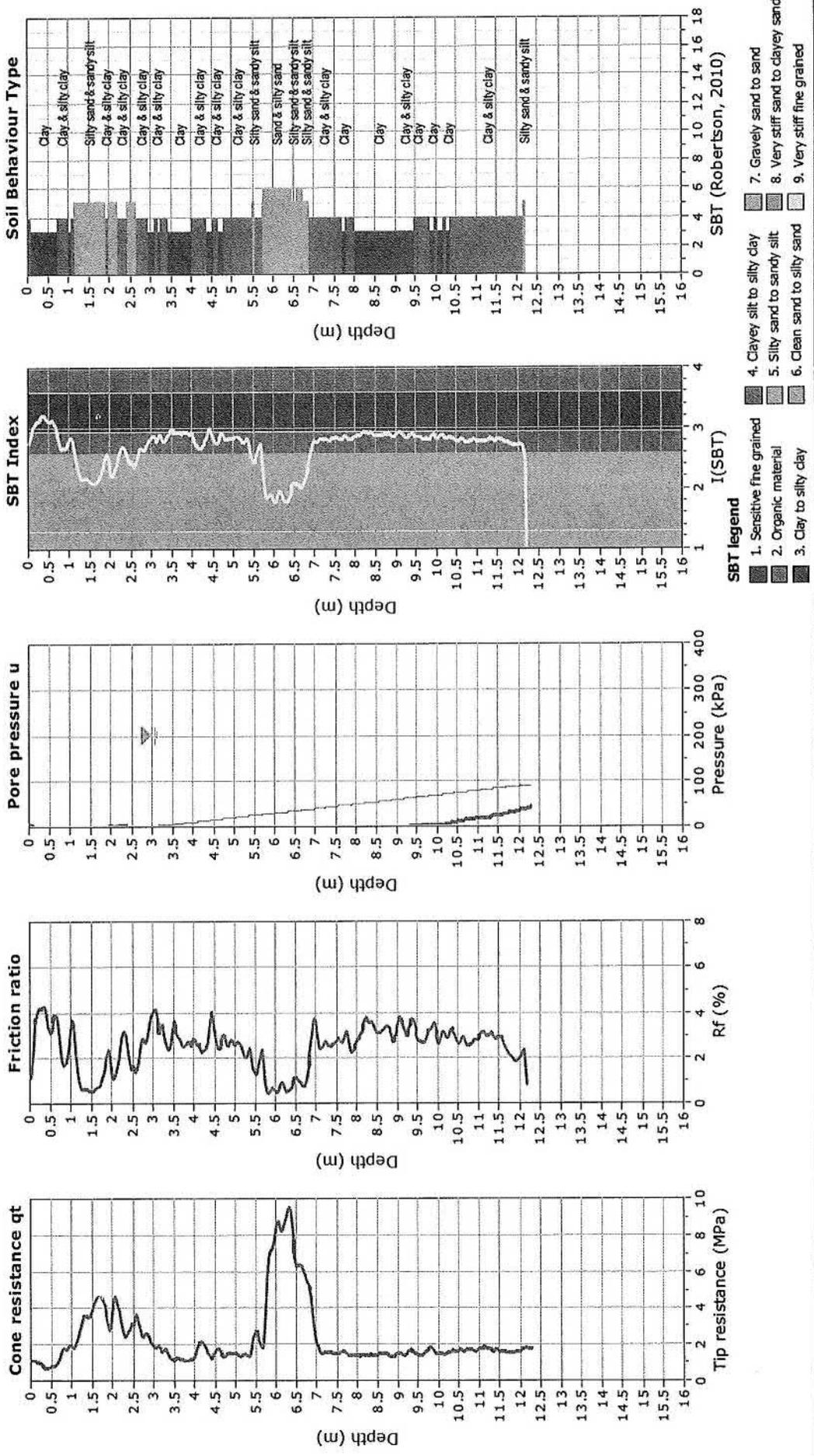




P. Machibroda Engineering Ltd.
 806-48th Street East
 Saskatoon, SK S7K 3Y4
<http://www.machibroda.com>

CPT: 17-3
 Total depth: 12.28 m, Date: 4/28/2017
 Surface Elevation: 504.50 m
 Coords: N 5766349, E 386774
 Cone Type: Vertek 15 cm²
 Cone Operator: PMEL

Project: Proposed Rural Subdivision
Location: NE-28-35-5-W3M, Near Saskatoon, SK



APPENDIX C
GRAIN SIZE DISTRIBUTION
ANALYSIS RESULTS



Project: Proposed Rural Subdivision
 Location: NE-28-35-5-W3M, Near Saskatoon, SK
 Project No.: 12980 / 12983
 Date Tested: May 18, 2017
 Test Hole No.: 17-2
 Sample No.: 99
 Depth (m): 1.0

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.1	100
1"	25.4	100
3/4"	19.1	100
1/2"	12.7	100
3/8"	9.5	100
# 4	4.75	100
# 10	2	100
# 20	0.85	100
# 40	0.425	99.8
#60	0.25	97.8
# 100	0.15	78.3
# 200	0.075	29.0

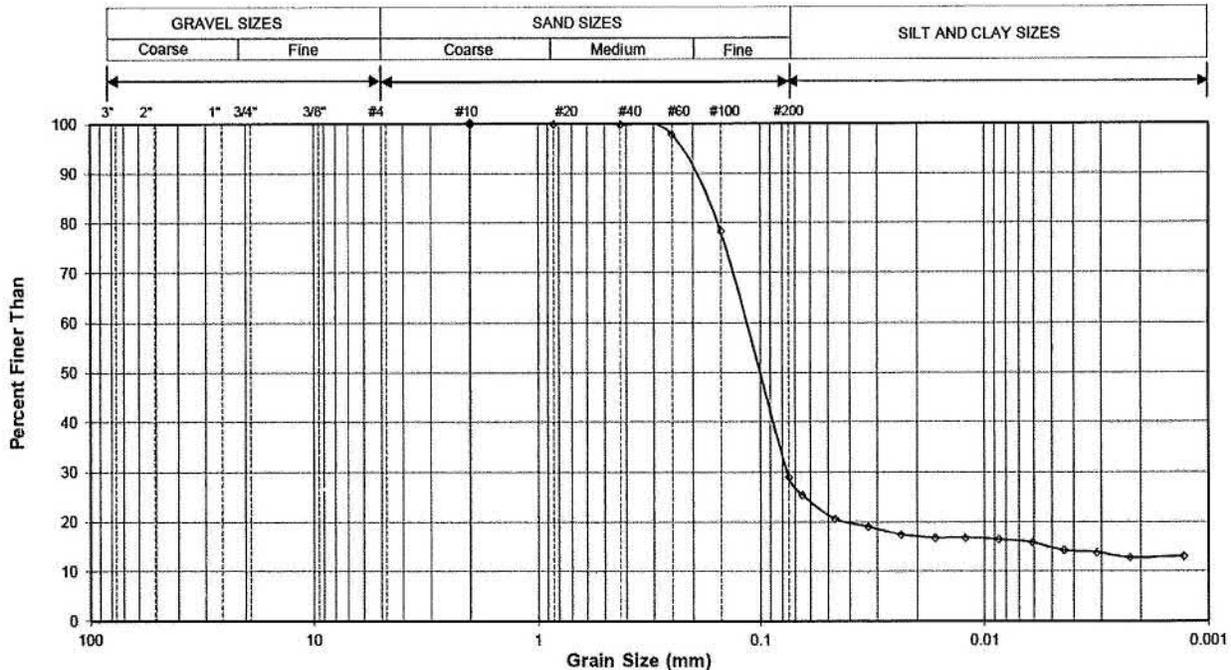
Hydrometer Analysis:

	Diameter mm	% Finer
Dispersing Agent:	0.0652	25.4
<i>Sodium Hexametaphosphate</i>	0.0468	20.6
	0.0332	19.1
	0.0236	17.5
	0.0167	16.8
	0.0122	16.8
	0.0087	16.5
	0.0061	15.9
	0.0044	14.3
	0.0032	13.9
	0.0022	12.8
	0.0013	13.1

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	71	16	13

Remarks:



Drawing No.

Appendix C-1

WE CERTIFY TESTING PROCEDURES ARE IN ACCORDANCE
 WITH ASTM D422 STANDARD
 P. MACHIBRODA ENGINEERING LTD.
 PER *Rudolf Scherwitz*



Project: Proposed Rural Subdivision
 Location: NE-28-35-5-W3M, Near Saskatoon, SK
 Project No.: 12980 / 12983
 Date Tested: May 18, 2017
 Test Hole No.: 17-4
 Sample No.: 55
 Depth (m): 1.0

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.1	100
1"	25.4	100
3/4"	19.1	100
1/2"	12.7	100
3/8"	9.5	100
# 4	4.75	100
# 10	2	100
# 20	0.85	100
# 40	0.425	99.8
#60	0.25	99.1
# 100	0.15	92.2
# 200	0.075	60.0

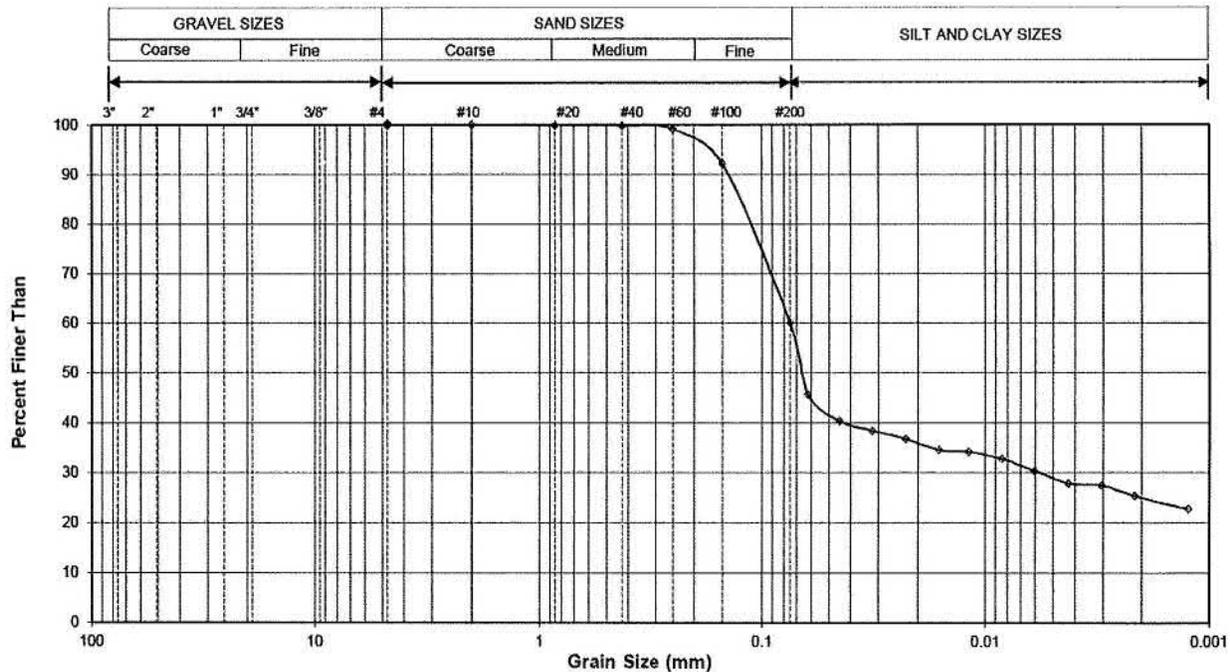
Hydrometer Analysis:

	Diameter mm	% Finer
Dispersing Agent:	0.0622	45.7
Sodium Hexametaphosphate	0.0449	40.3
	0.0319	38.4
	0.0227	36.7
	0.0162	34.5
	0.0119	34.1
	0.0084	32.8
	0.0060	30.3
	0.0043	27.8
	0.0030	27.4
	0.0022	25.3
	0.0013	22.7

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	40	35	25

Remarks:



Drawing No.

Appendix C-2

WE CERTIFY TESTING PROCEDURES ARE IN ACCORDANCE WITH ASTM D422 STANDARD
P. MACHIBRODA ENGINEERING LTD.

PER *Pastern Scherwitz*



Project: Proposed Rural Subdivision
 Location: NE-28-35-5-W3M, Near Saskatoon, SK
 Project No.: 12980 / 12983
 Date Tested: May 18, 2017
 Test Hole No.: 17-5
 Sample No.: 47
 Depth (m): 0.5

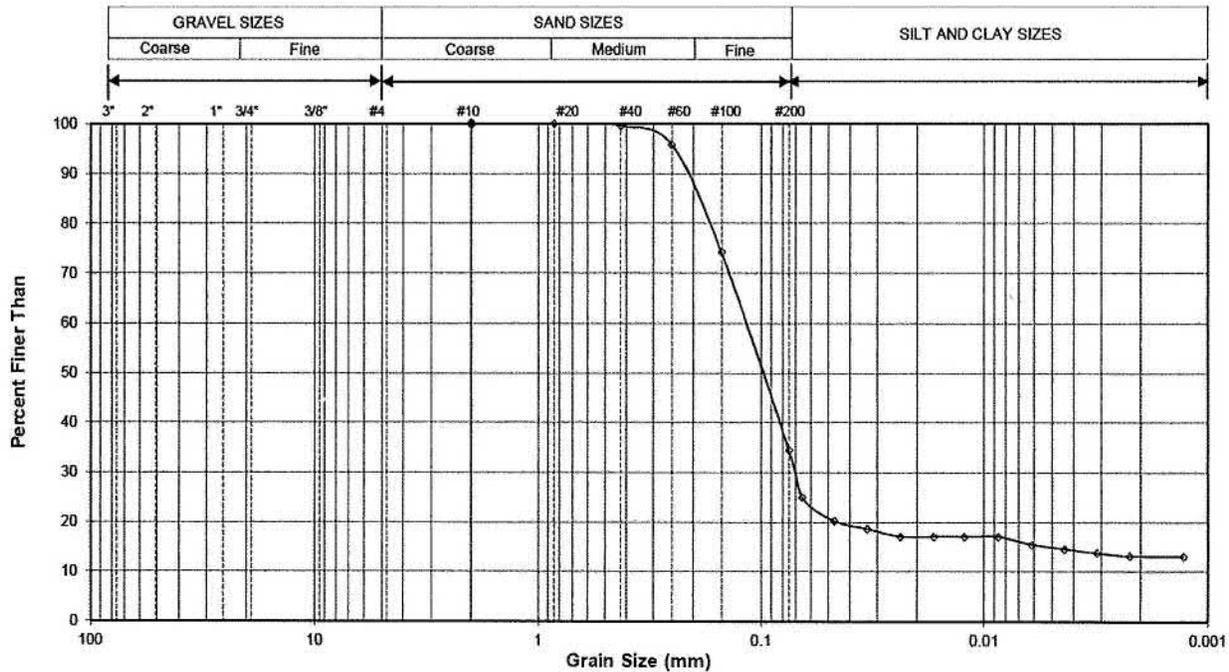
Sieve Analysis:	Sieve	Diameter	%
		mm	Finer
	1.5"	38.1	100
	1"	25.4	100
	3/4"	19.1	100
	1/2"	12.7	100
	3/8"	9.5	100
	# 4	4.75	100
	# 10	2	100
	# 20	0.85	100
	# 40	0.425	99.6
	#60	0.25	95.8
	# 100	0.15	74.2
	# 200	0.075	34.6

Hydrometer Analysis:	Diameter	%
	mm	Finer
Dispersing Agent:	0.0656	25.0
Sodium Hexametaphosphate	0.0471	20.2
	0.0335	18.7
	0.0238	17.1
	0.0168	17.1
	0.0123	17.1
	0.0087	17.1
	0.0062	15.5
	0.0044	14.6
	0.0032	13.8
	0.0022	13.2
	0.0013	13.1

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	65	21	14

Remarks:



Drawing No.
Appendix C-3

WE CERTIFY TESTING PROCEDURES ARE IN ACCORDANCE WITH ASTM D422 STANDARD
 P. MACHIBRODA ENGINEERING LTD.
 PER *Raean Scherwitz*



Project: Proposed Rural Subdivision
 Location: NE-28-35-5-W3M, Near Saskatoon, SK
 Project No.: 12980 / 12983
 Date Tested: May 18, 2017
 Test Hole No.: 17-6
 Sample No.: 42
 Depth (m): 1.5-1.9

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.1	100
1"	25.4	100
3/4"	19.1	100
1/2"	12.7	100
3/8"	9.5	100
# 4	4.75	100
# 10	2	100
# 20	0.85	100
# 40	0.425	99.9
#60	0.25	99.3
# 100	0.15	93.5
# 200	0.075	80.6

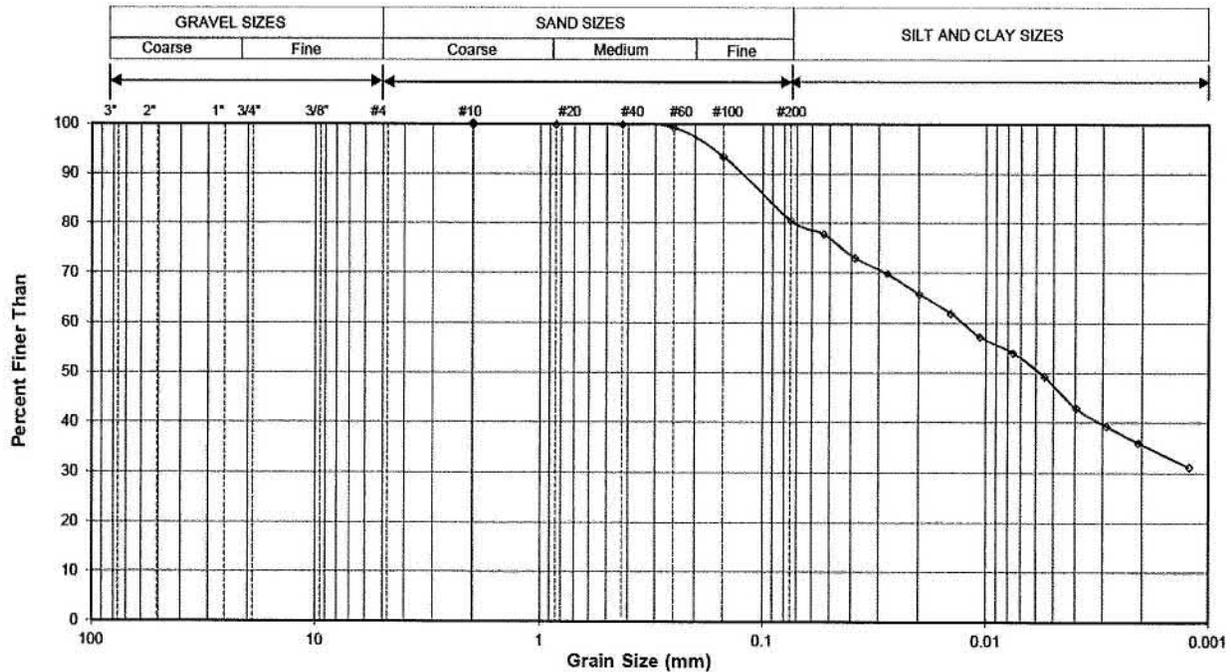
Hydrometer Analysis:

	Diameter mm	% Finer
Dispersing Agent:	0.0533	77.8
Sodium Hexametaphosphate	0.0386	73.1
	0.0277	69.9
	0.0199	65.8
	0.0143	61.9
	0.0106	57.2
	0.0076	54.0
	0.0055	49.2
	0.0040	42.9
	0.0029	39.4
	0.0021	36.0
	0.0012	31.2

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	19	45	36

Remarks:



Drawing No.

Appendix C-4

WE CERTIFY TESTING PROCEDURES ARE IN ACCORDANCE WITH ASTM D422 STANDARD
P. MACHIBRODA ENGINEERING LTD.

PER *Ray Machibroda*



Project: Proposed Rural Subdivision
 Location: NE-28-35-5-W3M, Near Saskatoon, SK
 Project No.: 12980 / 12983
 Date Tested: May 18, 2017
 Test Hole No.: 17-7
 Sample No.: 35
 Depth (m): 2.0

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.1	100
1"	25.4	100
3/4"	19.1	100
1/2"	12.7	100
3/8"	9.5	100
# 4	4.75	100
# 10	2	100
# 20	0.85	100
# 40	0.425	99.6
#60	0.25	99.4
# 100	0.15	98.9
# 200	0.075	97.7

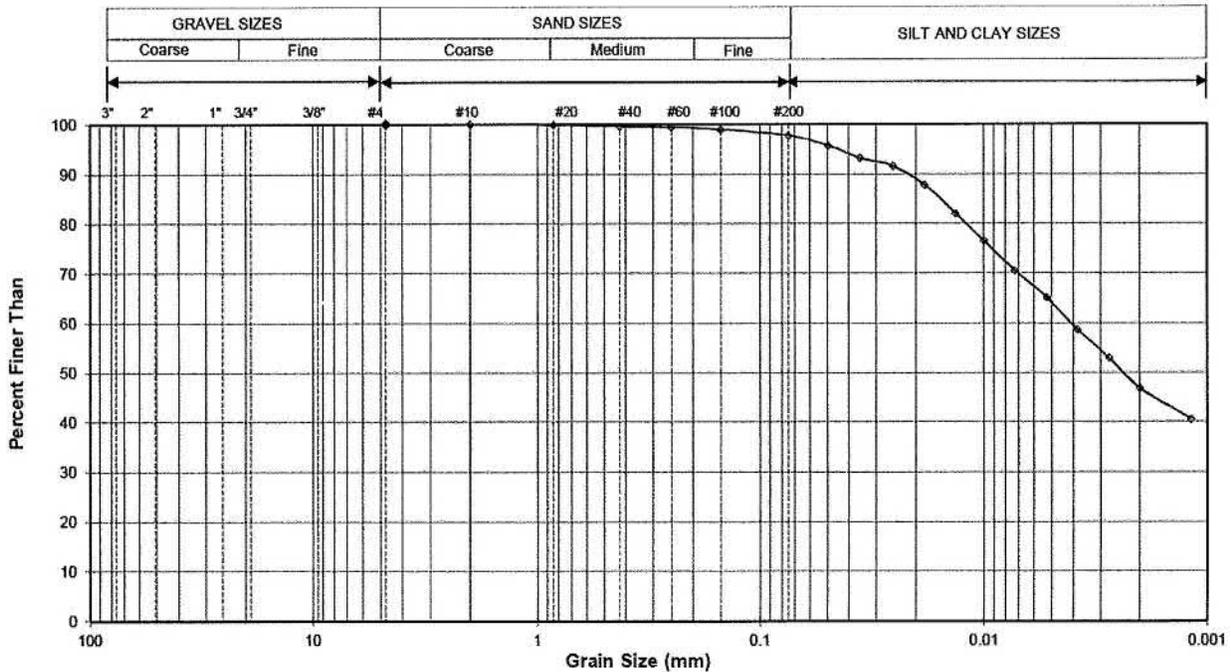
Hydrometer Analysis:

	Diameter mm	% Finer
Dispersing Agent:	0.0496	95.7
<i>Sodium Hexametaphosphate</i>	0.0356	93.2
	0.0254	91.6
	0.0183	87.8
	0.0133	82.1
	0.0100	76.6
	0.0073	70.6
	0.0053	65.2
	0.0038	58.7
	0.0028	53.0
	0.0020	46.9
	0.0012	40.6

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	2	51	47

Remarks:



Drawing No.

Appendix C-5

WE CERTIFY TESTING PROCEDURES ARE IN ACCORDANCE WITH ASTM D422 STANDARD
P. MACHIBRODA ENGINEERING LTD.

PER *Rustem Schorgevitch*



Project: Proposed Rural Subdivision
 Location: NE-28-35-5-W3M, Near Saskatoon, SK
 Project No.: 12980 / 12983
 Date Tested: May 18, 2017
 Test Hole No.: 17-8
 Sample No.: 2
 Depth (m): 1.0

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.1	100
1"	25.4	100
3/4"	19.1	100
1/2"	12.7	100
3/8"	9.5	100
# 4	4.75	100
# 10	2	100
# 20	0.85	100
# 40	0.425	99.7
#60	0.25	97.5
# 100	0.15	75.6
# 200	0.075	26.8

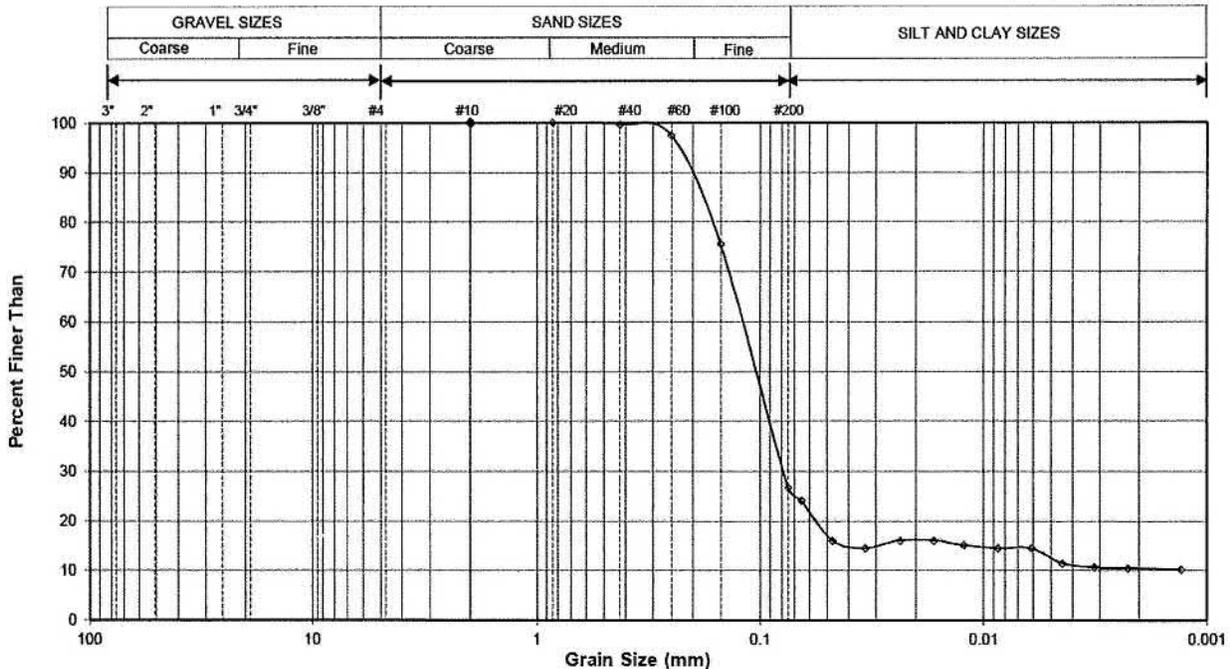
Hydrometer Analysis:

	Diameter mm	% Finer
Dispersing Agent:	0.0653	24.1
<i>Sodium Hexametaphosphate</i>	0.0473	16.1
	0.0336	14.5
	0.0236	16.1
	0.0167	16.1
	0.0122	15.2
	0.0087	14.5
	0.0061	14.5
	0.0045	11.5
	0.0032	10.7
	0.0023	10.5
	0.0013	10.2

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	73	16	11

Remarks:



Drawing No.

Appendix C-6

WE CERTIFY TESTING PROCEDURES ARE IN ACCORDANCE WITH ASTM D422 STANDARD
P. MACHIBRODA ENGINEERING LTD.

PER *Robert Schengweitel*



Project: Proposed Rural Subdivision
 Location: NE-28-35-5-W3M, Near Saskatoon, SK
 Project No.: 12980 / 12983
 Date Tested: May 21, 2017
 Test Hole No.: 17-9
 Sample No.: 11
 Depth (m): 0.5

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.1	100
1"	25.4	100
3/4"	19.1	100
1/2"	12.7	100
3/8"	9.5	100
# 4	4.75	100
# 10	2	100
# 20	0.85	100
# 40	0.425	99.5
#60	0.25	98.0
# 100	0.15	90.0
# 200	0.075	73.6

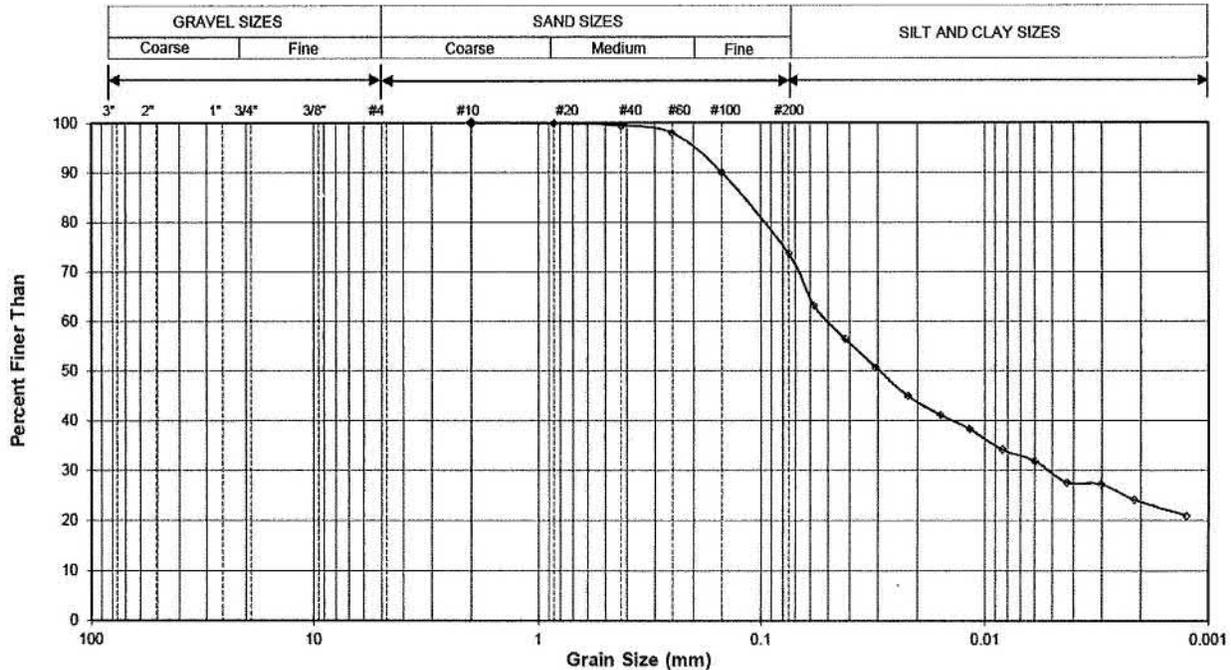
Hydrometer Analysis:

	Diameter mm	% Finer
Dispersing Agent:	0.0578	63.1
<i>Sodium Hexametaphosphate</i>	0.0420	56.4
	0.0307	50.6
	0.0222	44.9
	0.0159	41.1
	0.0117	38.2
	0.0084	34.1
	0.0060	31.8
	0.0043	27.6
	0.0030	27.2
	0.0021	24.1
	0.0013	20.9

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	26	49	25

Remarks:



Drawing No.

Appendix C-7

WE CERTIFY TESTING PROCEDURES ARE IN ACCORDANCE WITH ASTM D422 STANDARD
P. MACHIBRODA ENGINEERING LTD.

PER *Robert Schaefer*



Project: Proposed Rural Subdivision
 Location: NE-28-35-5-W3M, Near Saskatoon, SK
 Project No.: 12980 / 12983
 Date Tested: May 18, 2017
 Test Hole No.: 17-10
 Sample No.: 19
 Depth (m): 0.5

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.1	100
1"	25.4	100
3/4"	19.1	100
1/2"	12.7	100
3/8"	9.5	100
# 4	4.75	100
# 10	2	100
# 20	0.85	100
# 40	0.425	99.7
#60	0.25	97.7
# 100	0.15	84.5
# 200	0.075	49.6

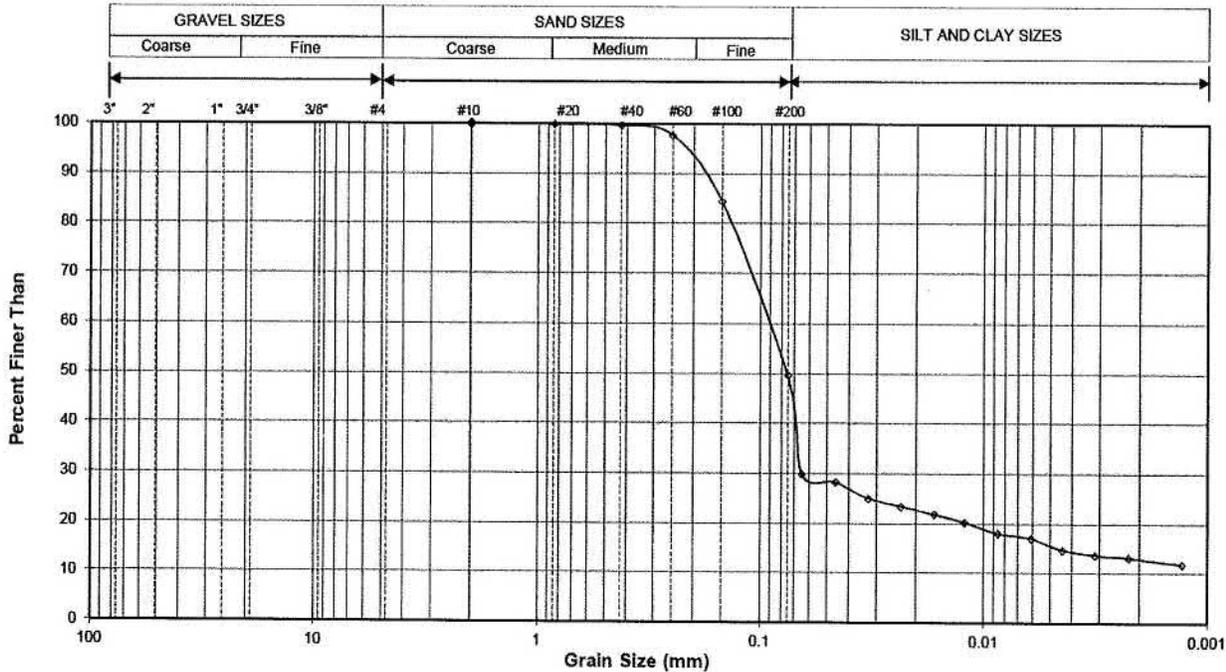
Hydrometer Analysis:

	Diameter mm	% Finer
Dispersing Agent:	0.0646	29.8
Sodium Hexametaphosphate	0.0459	28.2
	0.0328	25.0
	0.0233	23.4
	0.0166	21.8
	0.0122	20.2
	0.0087	18.0
	0.0061	17.1
	0.0044	14.8
	0.0032	13.7
	0.0022	13.2
	0.0013	11.8

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	50	36	14

Remarks:



Drawing No.

Appendix C-8

WE CERTIFY TESTING PROCEDURES ARE IN ACCORDANCE
 WITH ASTM D422 STANDARD
 P. MACHIBRODA ENGINEERING LTD.
 PER *Preston Schenewitz*



Project: Proposed Rural Subdivision
 Location: NE-28-35-5-W3M, Near Saskatoon, SK
 Project No.: 12980 / 12983
 Date Tested: May 18, 2017
 Test Hole No.: 17-12
 Sample No.: 69
 Depth (m): 1.0

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.1	100
1"	25.4	100
3/4"	19.1	100
1/2"	12.7	100
3/8"	9.5	100
# 4	4.75	100
# 10	2	100
# 20	0.85	100
# 40	0.425	99.7
#60	0.25	97.6
# 100	0.15	79.8
# 200	0.075	27.4

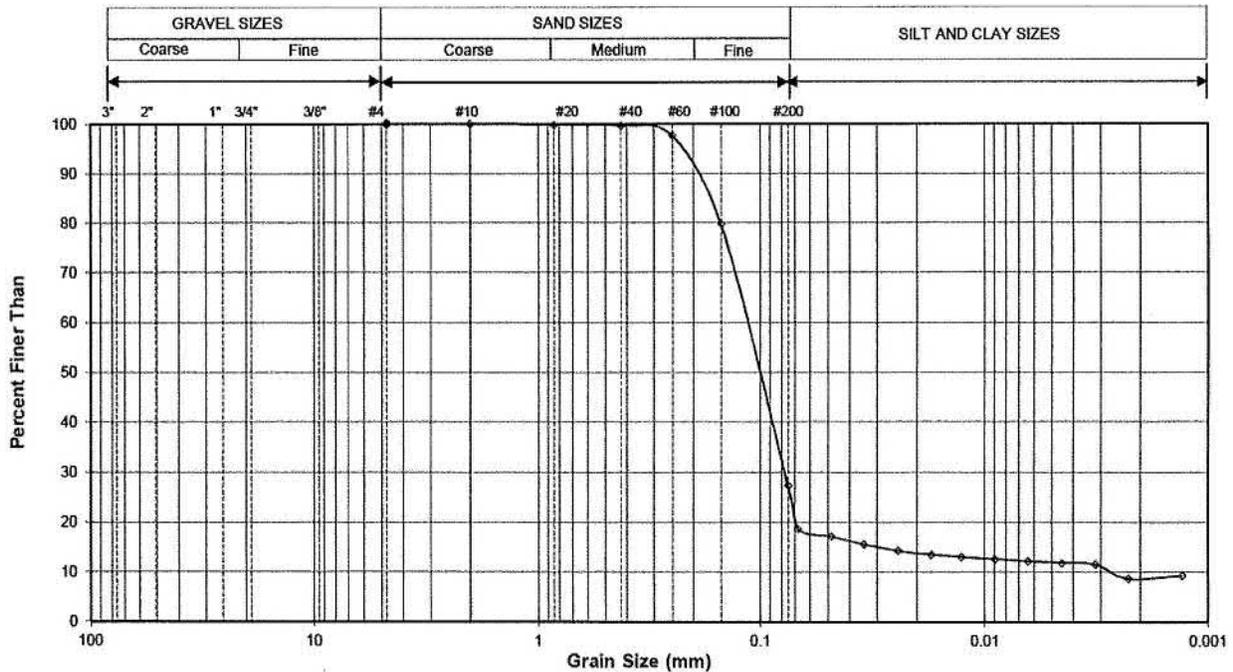
Hydrometer Analysis:

	Diameter mm	% Finer
Dispersing Agent:	0.0681	18.7
<i>Sodium Hexametaphosphate</i>	0.0484	17.1
	0.0344	15.5
	0.0244	14.3
	0.0173	13.5
	0.0127	13.1
	0.0090	12.6
	0.0064	12.2
	0.0045	11.9
	0.0032	11.6
	0.0023	8.7
	0.0013	9.4

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	73	19	8

Remarks:



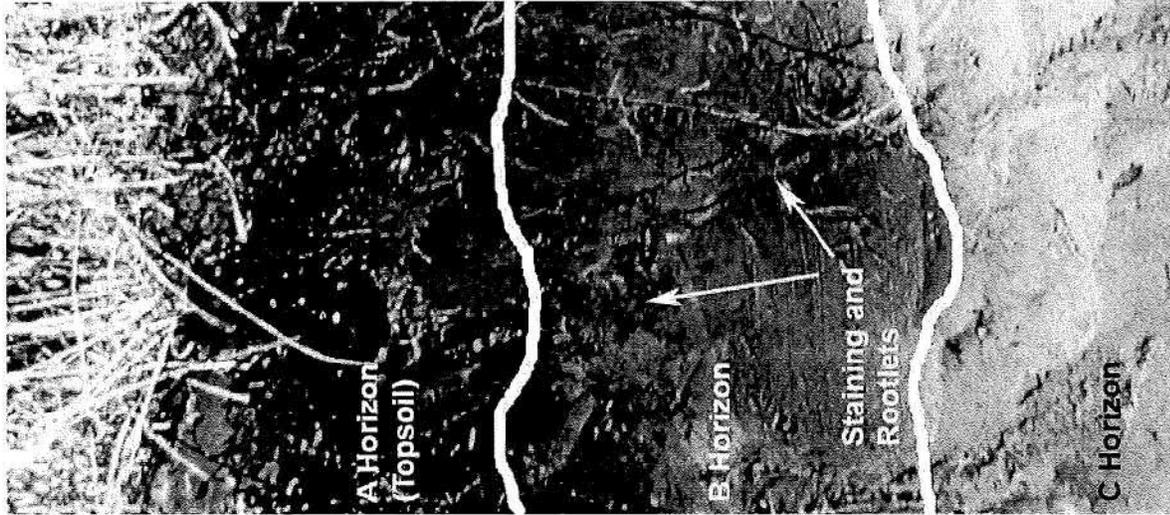
Drawing No.

Appendix C-9

WE CERTIFY TESTING PROCEDURES ARE IN ACCORDANCE WITH ASTM D422 STANDARD
P. MACHIBRODA ENGINEERING LTD.

PER *Ray Machibroda*

APPENDIX D
TOPSOIL, ORGANIC MATTER
AND ORGANICS



A Horizon

The A horizon is the topsoil layer of the soil strata. It is characterized by a build up of organic matter, and a lower unit weight than subsequent layers. The organic matter content of this layer is typically 4-10% by mass.

The colour of this horizon varies from dark black to brown, depending on surface vegetation and climatic conditions.

B Horizon

Typically reddish brown in colour and contains accumulations of matter that have been washed down from the A Horizon. The B horizon is generally composed of clay that has been washed out of the A Horizon, but can also contain iron, calcium and sodium deposits as well.

C Horizon

Unweathered parent soil.

Topsoil is a mixture of mineral soil and organic matter. The organic matter is developed from decaying biological material (leaves, grass, trees, animals, etc.) and contributes to the brown to black colour of the soil. Following the topsoil is the B horizon which is a transition layer, where staining from the overlying topsoil is common. This results in a darker colour of the soil immediately below the organic topsoil layer. Depending on the surface vegetation, rootlets may be present below the depth of topsoil. However it should be recognized that these rootlets are not the same as organic matter in topsoil.

Physically speaking in comparison to mineral soil, topsoil has a significantly lower bulk density and a lower unit weight as compared to the underlying parent soil. This is due to larger pore spaces and non mineral materials in the soil matrix. Along with lower density, topsoil is often spongy and colloidal/fibrous. The following figure is of a typical prairie soil. Each horizon is labelled accordingly to demonstrate a typical soil profile.

Reference

Henry L. 2003. Henry's Handbook of Soil and Water, Henry Perspectives, Saskatoon, SK.

Appendix I: Corman Park Correspondence

Maggie Schwab

From: Cory Boudreau <cboudreau@rmcormanpark.ca>
Sent: Tuesday, April 18, 2017 10:12 AM
To: Maggie Schwab
Subject: RE: Proposed development in the NE-28-35-5 W3M

Hi Maggie,

See the image and information I sent you previously. That information should be accurate still for the development you stated below.

There is an ILO further south but it is outside of the required separation distance.

Thanks,

Cory Boudreau, B.A

Planner I,

R.M. of Corman Park 344

Ph: (306)975-1665 Fax: (306)242-6965



Please consider the environment before printing this e-mail

From: Maggie Schwab [mailto:mschwab@crosbyhanna.ca]
Sent: Thursday, April 13, 2017 1:26 PM
To: Cory Boudreau <cboudreau@rmcormanpark.ca>
Subject: Proposed development in the NE-28-35-5 W3M

Good Morning Cory,

We are working for a Developer who wishes to rezone and subdivide land in the NE-28-35-5 W3M for the purposes of building a multiple-parcel country residential development and possible community care facility.

This development is located near Grasswood, Casa Rio and Riverside Estates and is immediately to the south of the development I sent away to you for review last week. Again, I don't expect there will be any land use conflicts with ILOs, Landfill or Waste Disposal Site, Lagoon, Industrial/Commercial Dev't, or Gravel Deposit. But, I thought I would do my due diligence and check with you to make sure.

If you have any questions, please feel free to email or call me.

Thanks!
Maggie

Maggie Schwab M.A.

CROSBY HANNA & ASSOCIATES

407C 1st Ave N

Saskatoon, SK S7K 1X5

t : 306.665.3441

f : 306.652.9613

e : mschwab@crosbyhanna.ca

www.crosbyhanna.ca

PLEASE CONSIDER THE ENVIRONMENT BEFORE PRINTING.

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Appendix J: Public Consultation

April 24, 2019

Dear Sir or Madam,

The intent of this letter is to inform you of a Public Open House that is scheduled for Wednesday May 15, 2019 regarding a rezoning application that will be submitted to the R.M. of Corman Park for consideration. Ravenswood, a new CR-1 multiple parcel country residential development will include a community centre, senior care and senior housing.

The Development is located at:

- **NE ¼, Section 28, Township 35, Range 5, W3M**

The proposed development is located immediately west of Clarence Avenue, north of the Casa Rio development. We have included a map on the reverse of this letter showing the location of the proposed development (See Map 1).

The Developer wishes to consult with neighbours and receive feedback regarding the proposed development. Following the public consultation, all feedback will be included in a presentation to R.M. Council, in conjunction with the Comprehensive Development Review that is being prepared, where all matters of land use integration, environmental and social considerations, and engineering infrastructure will be addressed.

Ravenswood, a CR-1 application, will feature 41 country residential lots including the existing Community Care Facility serving individuals with challenges. Two of the lots will be dedicated for senior housing and one for a future senior care home. In addition one lot will be allocated as a community centre. This community facility, operated by the non-profit group Light of the Prairies, combined with a sensory walk in the trees will expand the day programming services for people with disabilities. The community centre will also allow an opportunity to invite the broader community to share and connect through common, innovative and creative experiences. A Draft Concept Plan has also been attached to this letter (see Map 2).

The public open house is scheduled for:

- **Wednesday May 15, 2019 from 5:00 to 7:00 PM (come-and-go)
5310 Clarence Avenue**

The open house is a come-and-go event, intended to provide an opportunity for neighbours to discuss potential issues, possible solutions to those issues and to ask general questions. The developers and members of the design team will be present at the open house.



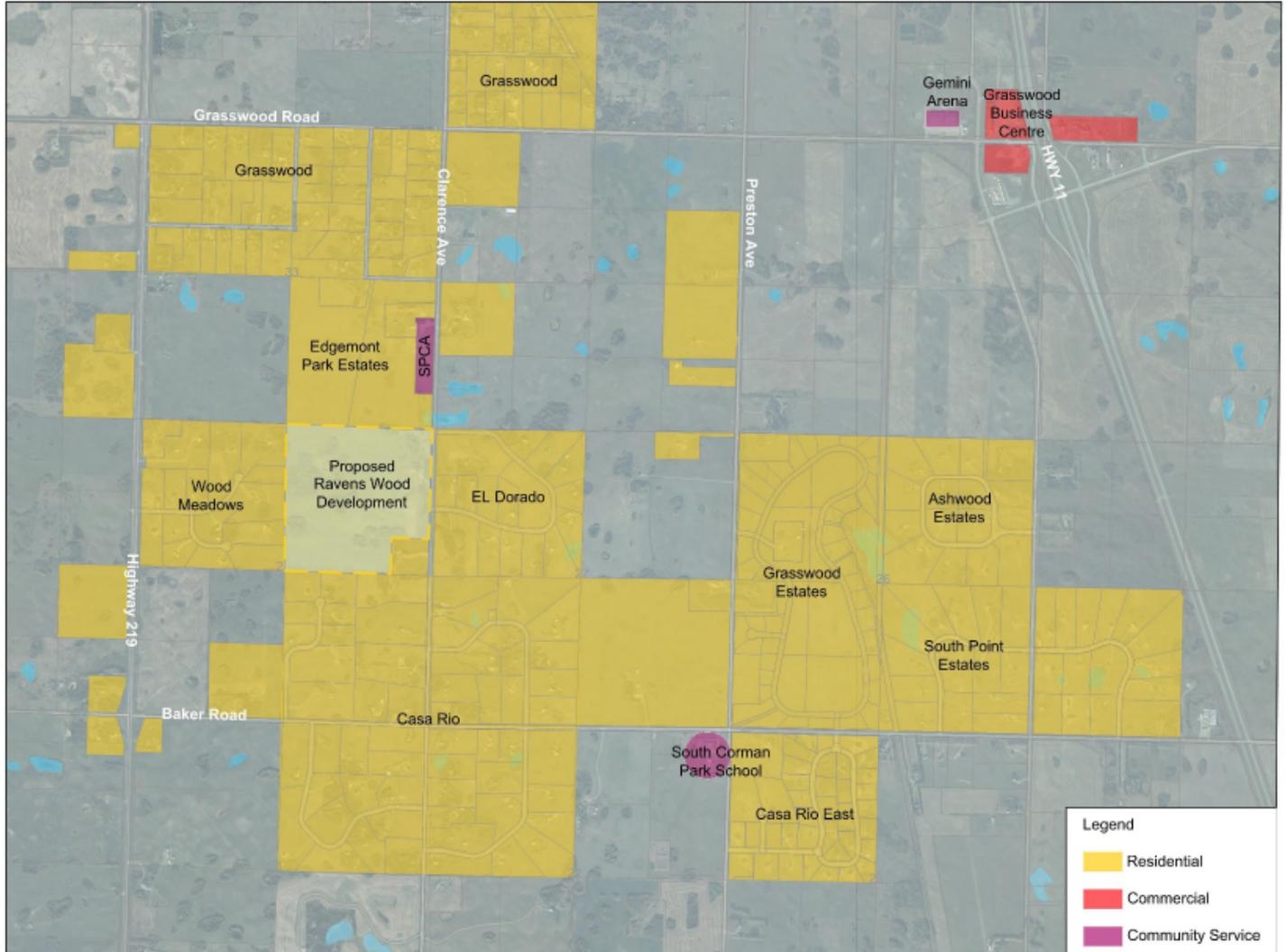
If you are unable to attend the open house, you may provide any comments or concerns via email to Jim Walters by Friday May 31, 2019 to jwalters@crosbyhanna.ca.

We look forward to seeing or hearing from you.

A handwritten signature in blue ink, appearing to read 'J Walters', is placed on a light yellow rectangular background.

Jim Walters, MCIP, RPP
CROSBY HANNA & ASSOCIATES

MAP 1: LOCATION OF PROPOSED DEVELOPMENT



WELCOME

The purpose of this open house is:

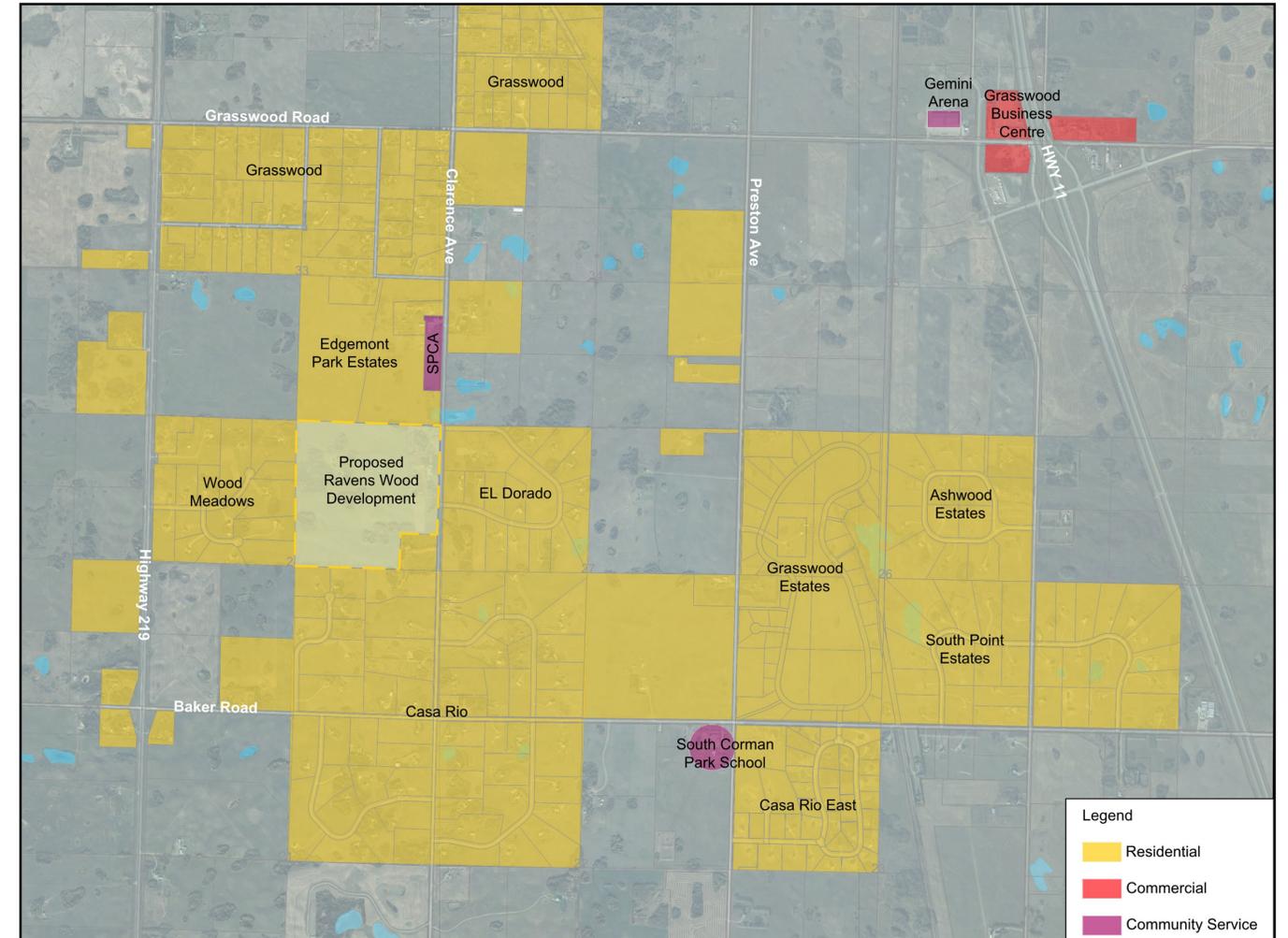
To present residents with information pertaining to a proposed multiparcel country residential development with an expanded community care facility, senior care, and senior housing. The development is located at the NE 1/4 of Section 28, Township 35, Range 5, W3M. This development is known as Ravenswood.

This is an informal, come-and-go event. You are encouraged to review these boards and to raise any questions, comments or concerns you may have to the developer and members of the design team.

Your feedback is very important. Please fill out the feedback form and leave it with us when you're done. It will be important to help us assess community feedback to the proposed development.

The process:

- Following public input, the Developer will submit a Comprehensive Development Review (CDR) and rezoning application to the Council of the RM of Corman Park and a subdivision application to Community Planning.
- The purpose of developing a CDR is to ensure that all engineering, environmental, servicing, and community issues/concerns/priorities are addressed.



Proposed Ravenswood Development

INTRODUCTION TO THE DEVELOPMENT

- **Ravenswood** is a multiparcel country residential development with an expanded community care facility, senior care, and senior housing.
- The proposed development is located on the NE 1/4 Section 28, Township 35, Range 5, W3M, west of Clarence Avenue, north of the Casa Rio development.

Features:

- This development is set apart from other developments in the region for various reasons:
 - Multiple parcel country residential lots range in size from 1.40 acres to 7.17 acres.
 - One lot is being proposed as a Community Care Facility and is intended to provide care to seniors. It will be in addition to the existing group home currently operating as Walter Lane.
 - Two lots are being proposed for senior housing units ranging from market housing to assisted living.
 - One lot is proposed as a Community Centre. It is intended to be inclusive to all and would be operated by the non-profit entity, Light of the Prairies.
 - The centre will complement, as well as expand support for, the existing group home and day programming services that Light of the Prairies currently provides to the disabled community on-site.
 - These facilities will expand on the existing day-programming facilities and activities that are currently being used by the disabled community.



Proposed Ravenswood Development

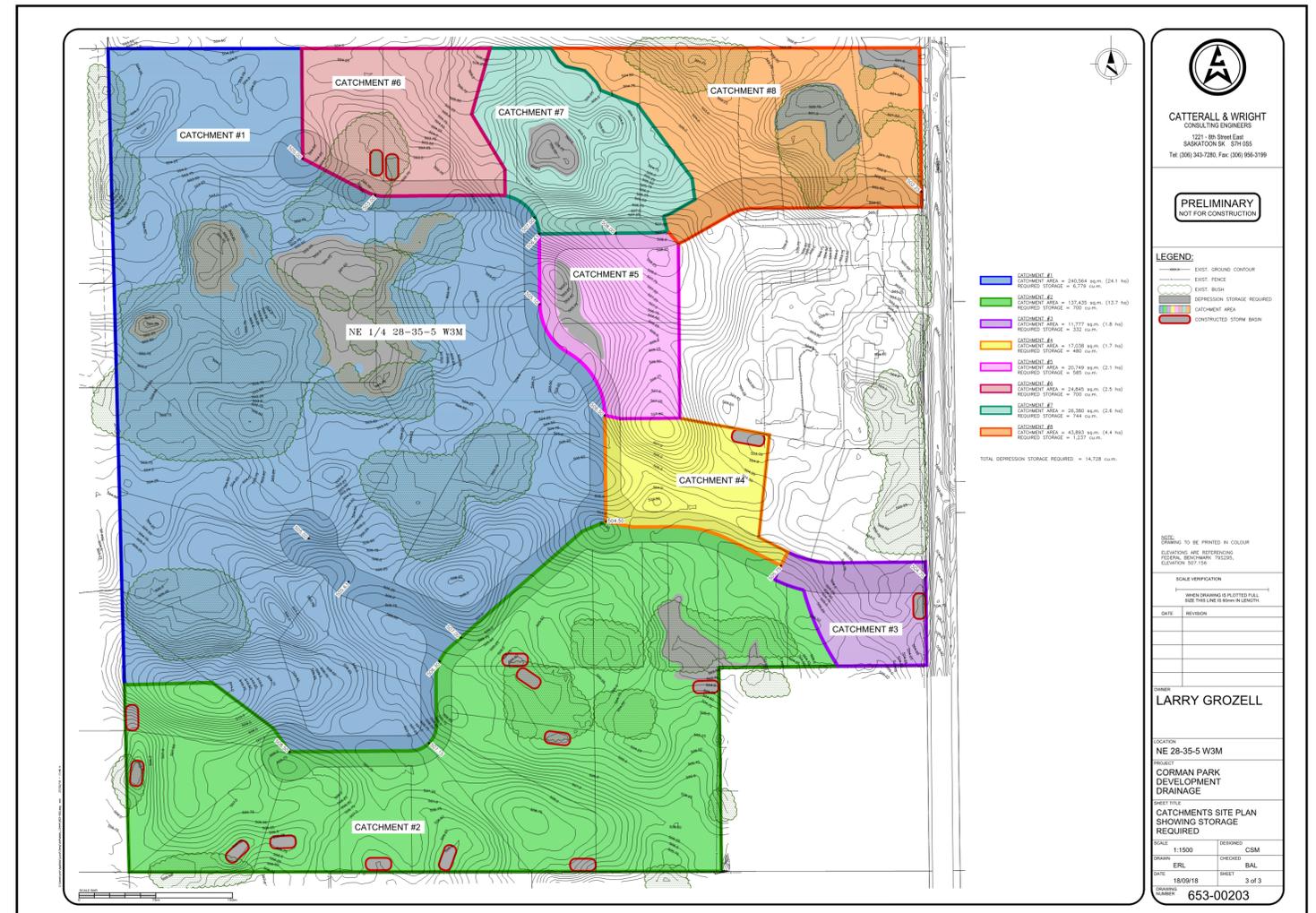
DRAINAGE AND POTABLE WATER

Drainage:

- A comprehensive preliminary grading design was completed by Catterall & Wright Consulting Engineers.
- Pre- and Post-Development runoff conditions were calculated, based on considering the percentage of impervious surfaces for the post-development scenario.
- The existing rolling topography offers significant depression storage for much of the development. Additionally, the sandy soils will assist in accommodating future drainage requirements.
- The drawing to the right illustrates that the storm water storage available to accommodate the 1:100 year storm event by way of existing depression or storage or constructed storm water basins.
- Detailed road and lot grades and Safe Building Elevations will be required during the detailed design phase of the development.

Potable Water:

- Potable Water will be supplied by the Wood Meadows potable water line.



TRAFFIC

Traffic:

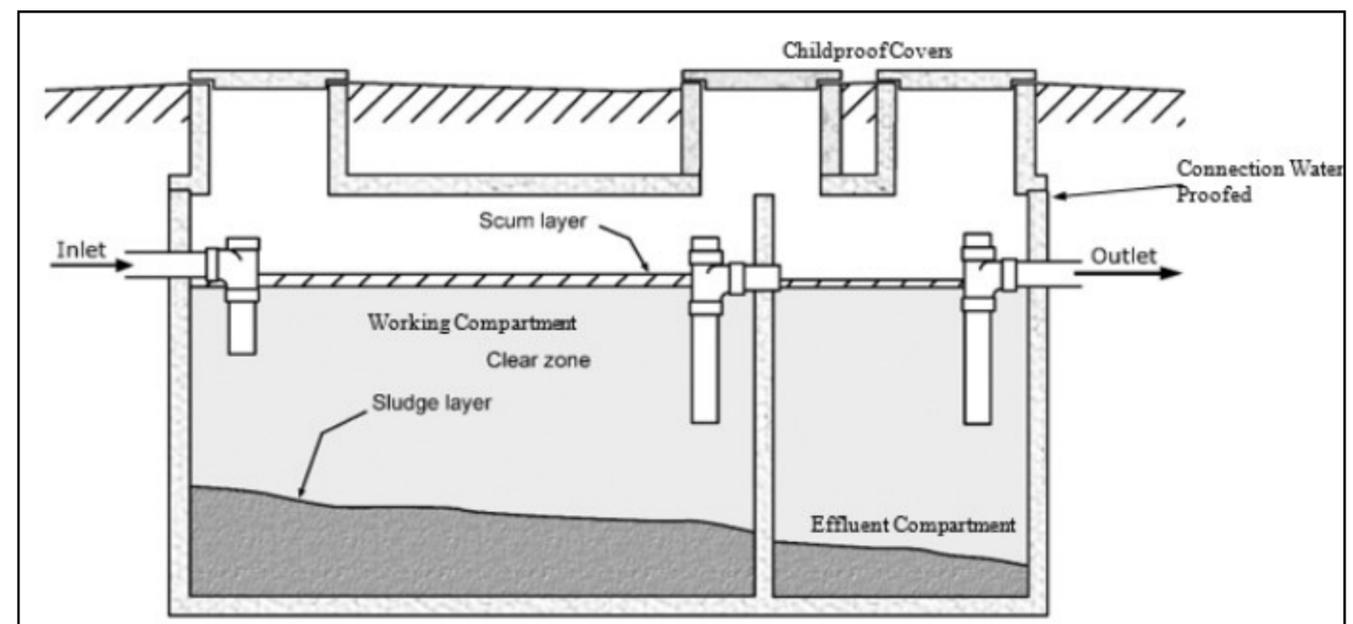
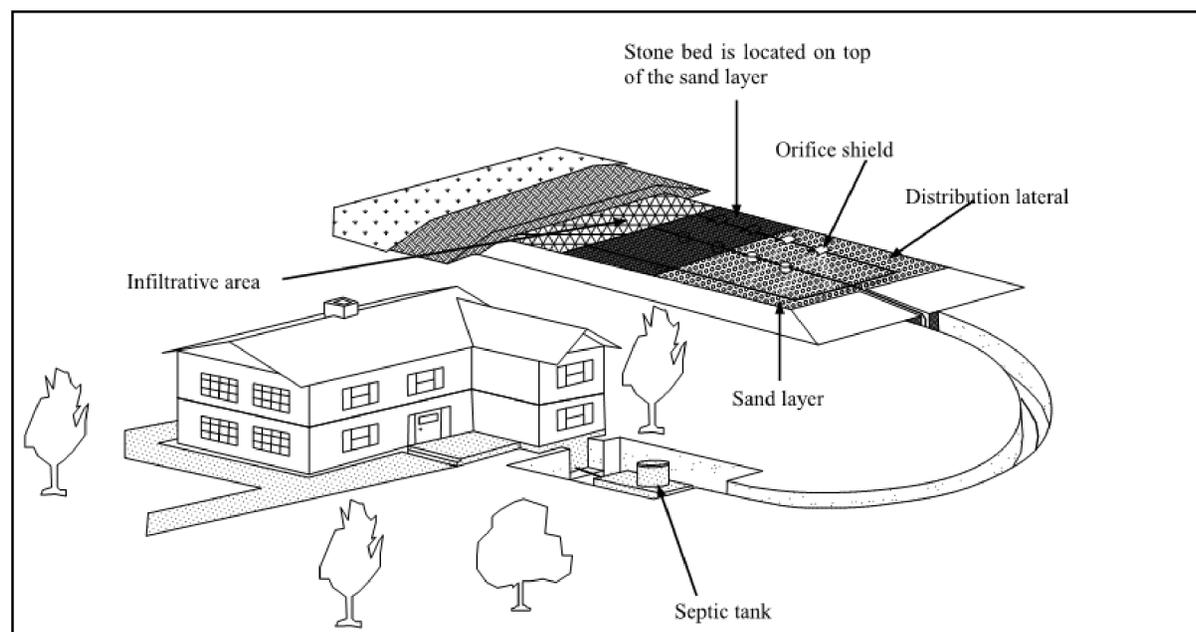
- A Traffic Impact Assessment (TIA) was undertaken in April, 2019 by Catterall & Wright Consulting Engineers.
- Traffic counts undertaken by the neighbouring developers (Edgemont Park Estates) were used, and a 2.0% growth rate was applied to replicate existing traffic conditions.
- Additionally, traffic counts were undertaken at Eldorado Lane South and Clarence Avenue on November 1, 2018 which were also projected to 2019.
- Total forecasted volumes were obtained by combining background traffic growth with new trips associated with the development.
- It was concluded in the TIA that the overall impact of the proposed development is minimal and does not significantly impact the capacity, operations, or safety of the following intersections:
 - Clarence Avenue and North Access
 - Clarence Avenue and South Access
 - Clarence Avenue and Eldorado Lane North
 - Clarence Avenue and Eldorado Lane South



WASTEWATER TREATMENT

Wastewater Treatment

- A geotechnical and hydrogeological investigation were undertaken by P. Machibroda Engineering Limited where existing groundwater and soil conditions were recorded.
- It was concluded, based on a review of soil conditions, groundwater laboratory analysis, and total number of proposed lots, that septic tanks, Type II mounds, and/or chamber systems, are suitable methods of wastewater treatment.
- The Developer will be requiring that site specific soil samples be gathered and groundwater table measured at the proposed septic field locations to determine if each lot is suitable for the proposed treatment system.
- Design and construction of the system will need to be undertaken in accordance with the Saskatchewan Health Authority.



Proposed Ravenswood Development

A Time Line of process

Nov 6th - Completed information packages and delivered to RM for mailing to all neighbours within a 1 mile radius of the subject site with a total of 163 packages to be sent out.

Nov 12th - Received E mail from RM (McClellan) Received input form Nov 14th

Nov 13th - Received E mail from RM (Rumpel) Received input form Nov 19th

Nov 14th - Stanley Bell, adjacent property owner to west, met in person at my home had a 30 minute discussion on the two proposals so he understood what they were about. Discussed types of housing in gated community, what kind of fencing, if any, was involved, Would they have access to trails?

Stan and Maxie came to open house on 21st.

Provided his comments on input sheet received Nov 25th.

Nov 15th - Phone conversation with Ron Schira Wood Meadows resident 373 4268. Comment sheet received Nov 19th

Nov 17th - E mailed an invitation to Sherry Mervold, Division 2 Councillor, to attend the open house and requested any input she had on the proposals as well as input or concerns expressed to her directly from ratepayers in Division 2. Reply e mailed Nov 20th

Nov 19th - Received E mail from RM (Britton) Received e mail Nov 19th
Received E mail from RM (Eyerley) Received e mail Nov 19th

Nov 21st - The public open house was held at the Grasswood Esso Meeting room.

Nov 22nd - At the request of Jim Couch sent out septic information brochure and contact information for Greg Plett from Tanksmart. Received comment sheet Nov 22nd

Nov 27th - 10:30 am telephone discussion with Neil Evans Baker Road Contact number 955 6012
Ok with either proposal. Was verbal - Received Comment sheet Dec 3rd

Nov 27th - Phone conversation with Elwyn Hopkin, Wood Meadows resident, at his request. 477 4798
Comment sheet received Nov 26th

Nov 29th - Deadline given to return input forms in order to meet the RM deadline of Monday Dec 2.
Contacted RM admin by e mail as follow up to see if any comments, other than the ones e mailed had been registered at the RM office.
Collected all input forms

Dec 2nd - Delivered declaration to the R.M. Office.
Will continue to collect late comment sheets
Neil Evans Baker Road received comment form Dec 3/13
Randy Pshebylo 4931 Prairie Lane received comment form Dec 4
Val Zemlak 350 Grasswood Road received comment form Dec 5

Dec 12 - At request of Council sent presentation time to all contacts from public consultation

Dear Neighbour

Re: Country Residential Subdivision Development Proposal

The RM of Corman Park has recently invited landowners interested in developing land to submit new and innovative subdivision proposals for their consideration.

Two different proposals were submitted to the RM of Corman Park to rezone half of the NE 1/4 sec 28 35 5 w3 from its agricultural zoning to Multi-parcel country residential zoning. As part of this process your input is important and requested. Enclosed is an overview and sketch of both proposals for your review as well as a form inviting your comments on each.

Option 1 Design Overview

The design provides a land use mix that combines three distinct housing uses under the umbrella of a Bareland Condominium. Thirty three architecturally controlled single family housing lots approximately one acre in size would form the core. Features would include most of the lots backing onto fully maintained park area or natural linear walking trail areas linking the whole community, green boulevard street separation, cul de sac road layout and an advanced septic system which exceeds current public health standards.

One lot would request councils approval to facilitate a "residential care facility" to provide an opportunity for an organization, such as Cheshire Homes, to duplicate its highly successful new housing option for physically handicapped individuals with spinal cord injuries who are capable of working and living independently with evening attendant care services.

Lot 20, a nine acre lot, is a gated community fashioned after the two gated communities at the Willows in south Saskatoon. With nine acres it would offer a larger land base and less density than the Willows enabling considerably more green space and amenities. Nestled in the rear corner at the very back of the land the gated community would consist of twenty four buildings. Sixteen smaller orchard homes and eight country cottages. The gated community would include amenities such as vegetable garden areas, green house, recreational vehicle storage, plenty of green space, internal walking trails, benches and flower gardens. Concepts of life lease and land lease are being considered within the gated community. Year round property care services would be available through the Homeowner Association.

Option 2 Design Overview

Option two would accommodate twenty eight architecturally controlled single family lots. It will include natural green space with walking trails which will act as a buffer to all existing properties, a cul de sac road design, as well as an advanced septic system which far exceeds current public health standards.

It also includes a request to work with the R.M. Council to create a site specific design on one lot to provide housing options for individuals with spinal cord injuries who are capable of working and living independently with limited care services.

Comments returned prior to November 29, 2013 will be forwarded to the R.M. for consideration on December 2, 2013. A self-addressed envelope has been enclosed for your convenience or you may contact the R.M. directly with your thoughts.

You are also invited to attend a come and go informational meeting to discuss this proposal at 7 P.M. on November 21 at the Grasswood Esso meeting room.

If you wish further clarification or more information please feel free to contact us through E mail at grozell55@gmail.com or speak to us directly by phone at 306 374 2575.

Thank you.

Larry and Joan Grozell
51 Wood Meadows Lane
Corman Park, SK
S7T 1C7

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Victor & Beverley Slusar

Phone number(s) 306-477-4040

Address or Land Description _____

Option 1: Input _____

Option 2: Input _____

General comment or input _____

We have no objections to
either proposal.

Signature(s): B. Slusar

Rec
Nov 15/13

Would you like to be contacted by the applicant: Yes _____ No X

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3

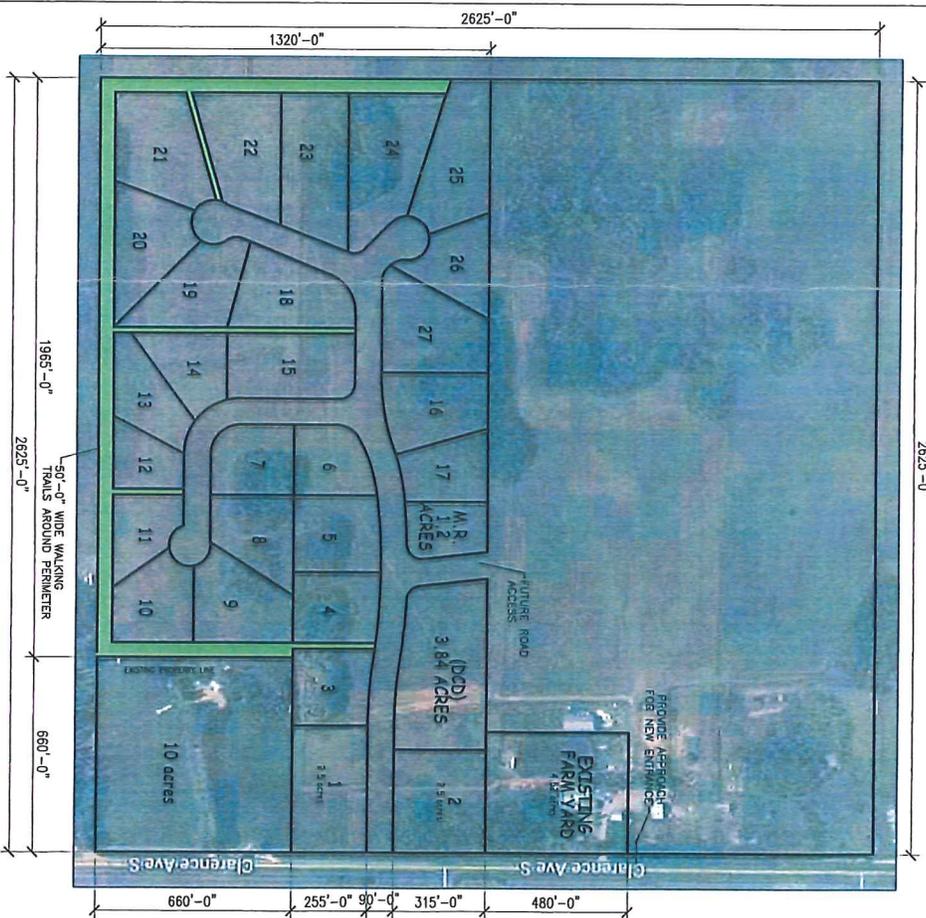


PROPOSED LOT LAYOUT - OPTION 1

LOTS VARY IN SIZE FROM
0.65 ACRES TO 1.8 ACRES

TOTAL AREA: 70 ACRES
GREEN SPACE: 8 ACRES
% OF GREEN SPACE: 11%

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM
1.0 ACRES TO 2.6 ACRES

TOTAL AREA: 70 ACRES
GREEN SPACE: 5 ACRES
% OF GREEN SPACE: 7%

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Roni Carol Schira

Phone number(s) 306 373-4268 306 220-7733

Address or Land Description NW 28 35 5 W3 Lot 2 Blk 1

Option 1: Input

Option 2: Input

General comment or input WE ARE IN FULL SUPPORT OF THE
COUNTRY RESIDENTIAL SUBDIVISION HARRY AND
JOAN ARE PROPOSING. OPTION 1 OR 2, EITHER
IS FINE.

Signature(s): [Signature]
Carol Schira

Rec'd 12/19/13

Would you like to be contacted by the applicant: Yes _____ No

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 1

LOTS VARY IN SIZE FROM 0.55 ACRES TO 1.8 ACRES
 TOTAL AREA: 70 ACRES
 GREEN SPACE: 8 ACRES
 % OF GREEN SPACE: 11%

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM 1.0 ACRES TO 2.6 ACRES
 TOTAL AREA: 70 ACRES
 GREEN SPACE: 5 ACRES
 % OF GREEN SPACE: 7%



Larry Grozell <grozell55@gmail.com>

Information letter

2 messages

Larry Grozell <grozell55@gmail.com>
To: Schira01@yourlink.ca

Thu, Dec 12, 2013 at 11:49 AM

Good Morning Ron and Carol

I am sending this letter out to contacts in the public consultation process to pass on information at the request of council. .

December 12 2013

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

I have been requested by Council to present a brief overview of the project and a summary of the public consultation results on December 18th at 11:45 am.

Council has indicated this is an open council meeting and invites contacts from the public consultation process to sit in and observe the discussion from the gallery. It should be noted that Council also indicated that it is not a public hearing or forum in which the gallery will be invited to speak.

Thank you for your time.

Larry and Joan Grozell

Ron Schira <Schira01@yourlink.ca>
To: Larry Grozell <grozell55@gmail.com>
Cc: carolschira@sasktel.net

Thu, Dec 12, 2013 at 3:15 PM

Hi Larry and Joan,

We will not be able to attend as we are leaving for Fernie on the 18th to visit Landon and Brittany. Hope it all goes well and let us know if there is anything we can do to help.

R & C

[Quoted text hidden]

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Klark Ito Tammy Just

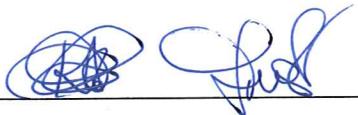
Phone number(s) 306-244-5576

Address or Land Description 31 Wood Meadows Lane.

Option 1: Input _____

Option 2: Input _____

General comment or input _____

Signature(s): 

Would you like to be contacted by the applicant: Yes _____ No X

Rec
Nov 19/13

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3

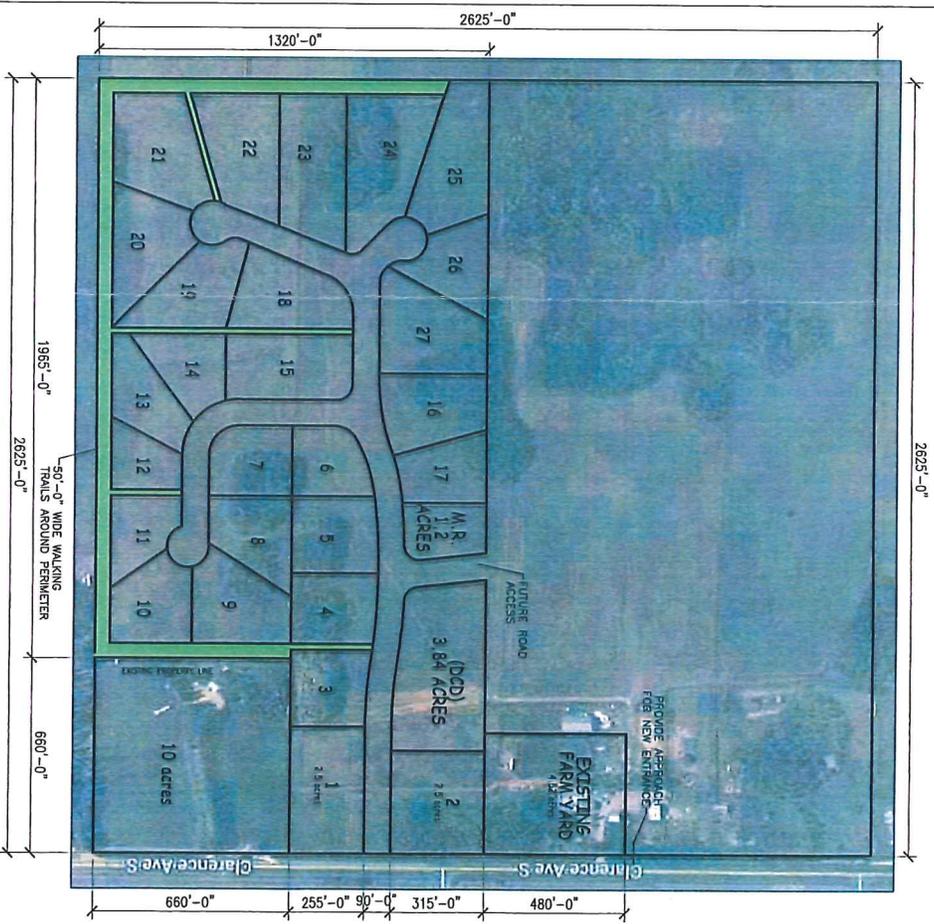


PROPOSED LOT LAYOUT - OPTION 1

LOTS VARY IN SIZE FROM
0.65 ACRES TO 1.8 ACRES

TOTAL AREA: 70 ACRES
GREEN SPACE: 8 ACRES
% OF GREEN SPACE: 11%

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM
1.0 ACRES TO 2.6 ACRES

TOTAL AREA: 70 ACRES
GREEN SPACE: 5 ACRES
% OF GREEN SPACE: 7%



Larry Grozell < grozell55@gmail.com >

Information letter

1 message

Larry Grozell < grozell55@gmail.com >

Thu, Dec 12, 2013 at 11:47 AM

To: Klark's Trenching <klarkstrenching@sasktel.net>

Good Morning Klark and Tammy

I am sending this letter out to contacts in the public consultation process to pass on information at the request of council. .

December 12 2013

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

I have been requested by Council to present a brief overview of the project and a summary of the public consultation results on December 18th at 11:45 am.

Council has indicated this is an open council meeting and invites contacts from the public consultation process to sit in and observe the discussion from the gallery. It should be noted that Council also indicated that it is not a public hearing or forum in which the gallery will be invited to speak.

Thank you for your time.

Larry and Joan Grozell

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Danielle Gibson

Phone number(s) 306-260-3880

Address or Land Description 90 Woodmeadows Place

Option 1: Input _____

Option 2: Input I would choose this. I didn't move out here to live like in the city. I don't like the smaller lot sizes that's not why I want to live on an acreage. Tell Corman Park that Larry LOL. Thanks

General comment or input _____

Signature(s): [Signature]

Would you like to be contacted by the applicant: Yes _____ No _____

Rec
DDW 12/13

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 1

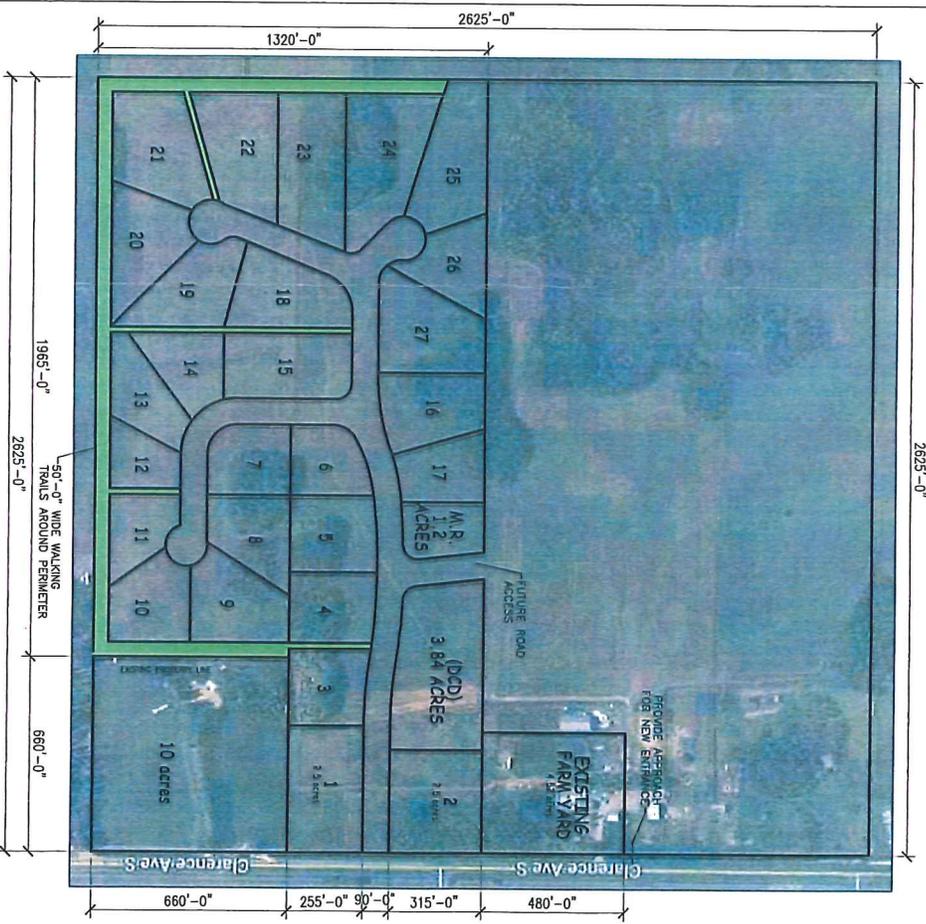
LOTS VARY IN SIZE FROM 0.65 ACRES TO 1.8 ACRES

TOTAL AREA: 70 ACRES

GREEN SPACE: 8 ACRES

% OF GREEN SPACE: 11%

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM 1.0 ACRES TO 2.6 ACRES

TOTAL AREA: 70 ACRES

GREEN SPACE: 5 ACRES

% OF GREEN SPACE: 7%



Larry Grozell <grozell55@gmail.com>

Information letter

1 message

Larry Grozell <grozell55@gmail.com>
To: Danielle Robson <drosatiuk@hotmail.com>

Thu, Dec 12, 2013 at 11:35 AM

Good Morning Danielle

I am sending this letter out to contacts in the public consultation process to pass on information at the request of council.

December 12 2013

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

I have been requested by Council to present a brief overview of the project and a summary of the public consultation results on December 18th at 11:45 am.

Council has indicated this is an open council meeting and invites contacts from the public consultation process to sit in and observe the discussion from the gallery. It should be noted that Council also indicated that it is not a public hearing or forum in which the gallery will be invited to speak.

Thank you for your time.

Larry and Joan Grozell

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Dan + Nicolle Rawdyk

Phone number(s) 306.221.1656 306.227.8480

Address or Land Description 41 Wood Meadows Lane

Option 1: Input _____

Option 2: Input We favor option 2 for the added green space/lot.

However, option 1 provides some unique housing opportunities. Either option sounds great. It would definitely add value to country residential living.

General comment or input We suggest connecting the development to the existing Wood Meadows area by way of walking trails to bring the community together and offer better outdoor walking/running/cross country skiing area rather than the highway or crossing through fields.

Signature(s): [Signature]
[Signature]

Rec 20/13

Would you like to be contacted by the applicant: Yes _____ No _____

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3

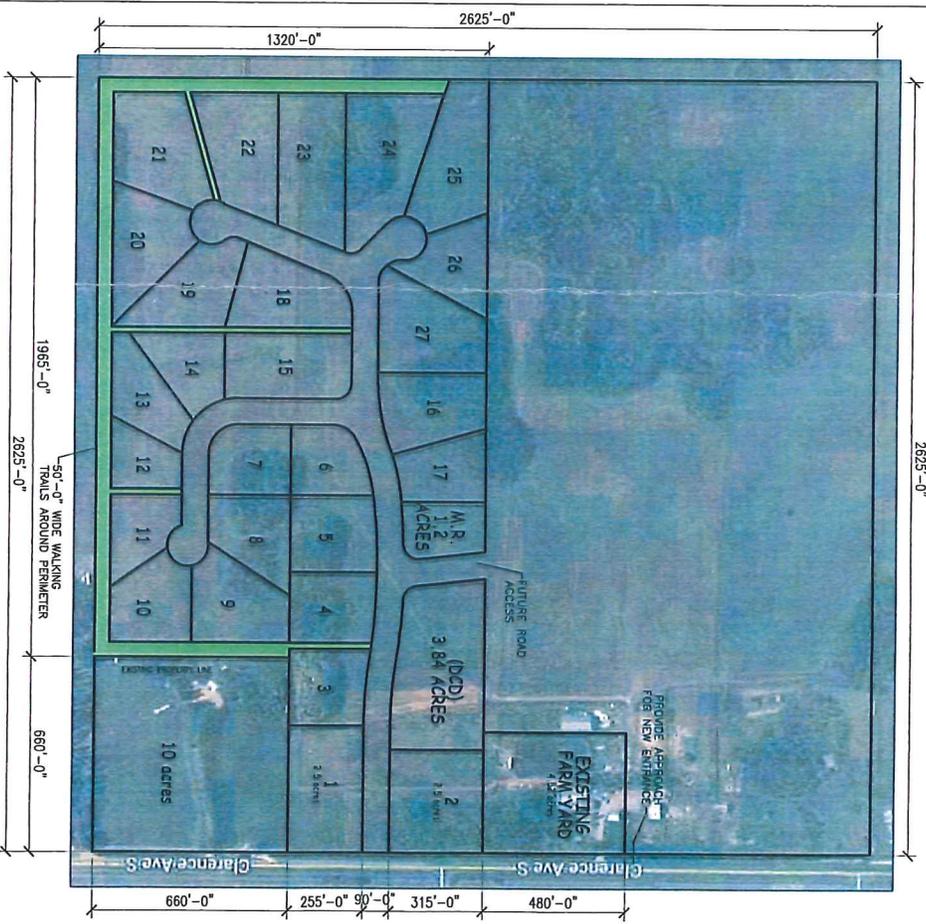


PROPOSED LOT LAYOUT - OPTION 1

LOTS VARY IN SIZE FROM
0.65 ACRES TO 1.8 ACRES

TOTAL AREA: 70 ACRES
GREEN SPACE: 8 ACRES
% OF GREEN SPACE: 11%

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM
1.0 ACRES TO 2.6 ACRES

TOTAL AREA: 70 ACRES
GREEN SPACE: 5 ACRES
% OF GREEN SPACE: 7%



Larry Grozell < grozell55@gmail.com >

Information

1 message

Larry Grozell < grozell55@gmail.com >

Thu, Dec 12, 2013 at 11:28 AM

To: Nicolle Rawlyk <Nicolle@weareunique.com>

Good Morning to the Rawlyk's

I am sending this letter out to contacts in the public consultation process to pass on information at the request of council. .

December 12 2013

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

I have been requested by Council to present a brief overview of the project and a summary of the public consultation results on December 18th at 11:45 am.

Council has indicated this is an open council meeting and invites contacts from the public consultation process to sit in and observe the discussion from the gallery. It should be noted that Council also indicated that it is not a public hearing or forum in which the gallery will be invited to speak.

Thank you for your time.

Larry and Joan Grozell

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) JAMES & CHARLENE Couch

Phone number(s) 306-477-0913 306-321-2813 (cell)

Address or Land Description 80 Wood Meadows place, Cornman Park, STIC7

Option 1: Input The green space in this option is much more appealing than option #2. Even though you note a superior septic system I am very concerned on ground water quality around the new high density acreage development. here lots are not large. New developments like this, across 219 acre Baker Road are very large numbers in small area.

Option 2: Input Have same concern with ground water.

General comment or input _____

We have lots in Wood Meadows that are much larger than these. Our personal ground water well is not useable for household purposes due to nitrate loading (we have city water for house). would like more info on superior septic system)

Signature(s): Jim Couch
Charlene Couch

rec 22/11/13

Would you like to be contacted by the applicant: Yes No

Larry:
If you have website for septic system proposed please forward
THKS Jim Couch

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3

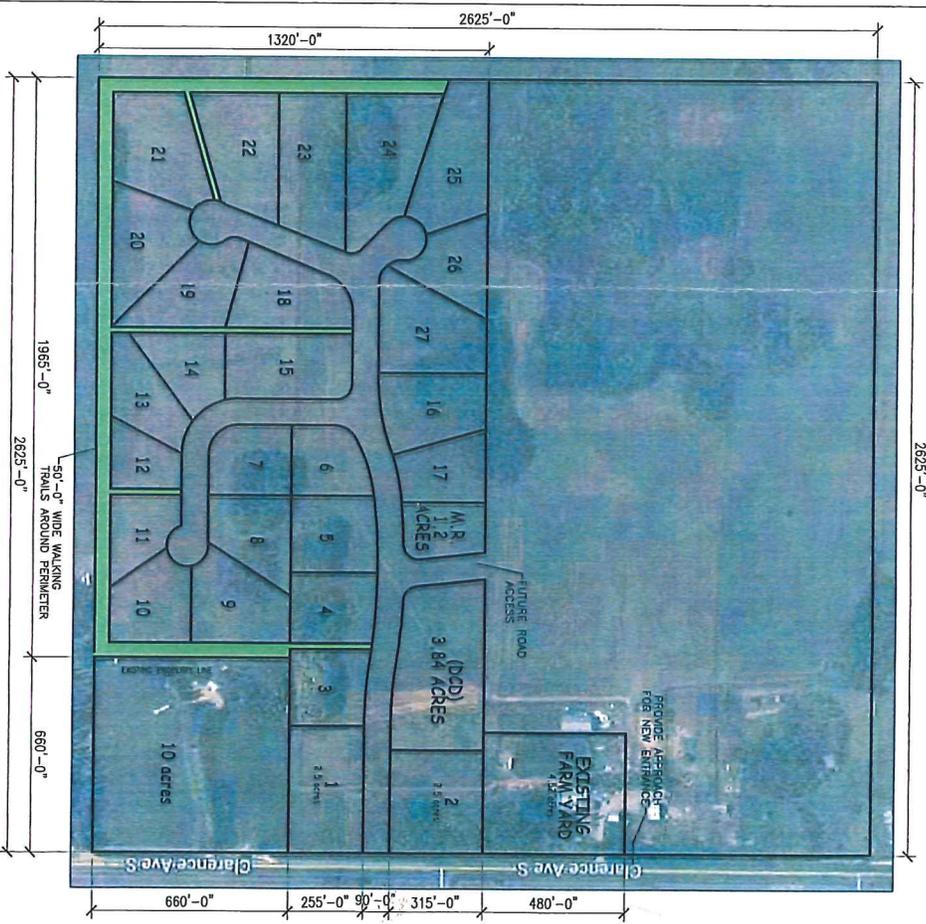


PROPOSED LOT LAYOUT - OPTION 1

LOTS VARY IN SIZE FROM
0.65 ACRES TO 1.8 ACRES

TOTAL AREA: 70 ACRES
GREEN SPACE: 8 ACRES
% OF GREEN SPACE: 11%

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM
1.0 ACRES TO 2.6 ACRES

TOTAL AREA: 70 ACRES
GREEN SPACE: 5 ACRES
% OF GREEN SPACE: 7%



Larry Grozell < grozell55@gmail.com >

information letter

1 message

Larry Grozell < grozell55@gmail.com >

Thu, Dec 12, 2013 at 11:52 AM

To: Couch.j.c@sasktel.net

Good Morning to the Couch's

I am sending this letter out to contacts in the public consultation process to pass on information at the request of council. .

December 12 2013

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

I have been requested by Council to present a brief overview of the project and a summary of the public consultation results on December 18th at 11:45 am.

Council has indicated this is an open council meeting and invites contacts from the public consultation process to sit in and observe the discussion from the gallery. It should be noted that Council also indicated that it is not a public hearing or forum in which the gallery will be invited to speak.

Thank you for your time.

Larry and Joan Grozell



Larry Grozell < grozell55@gmail.com >

septic

2 messages

Larry Grozell < grozell55@gmail.com >
To: Couch.j.c@sasktel.net

Fri, Nov 22, 2013 at 3:41 PM

Hi Jim

I will send you the information I have with the suppliers contact information. Should you want to see anything else please let me know.

Thank you for taking the time to fill out the input form.

Larry

couch01@sasktel.net < couch01@sasktel.net >
Reply-To: couch.j.c@sasktel.net
To: Larry Grozell < grozell55@gmail.com >

Sat, Nov 23, 2013 at 3:04 PM

Thanks Larry appreciate that.

Jim

[Quoted text hidden]

[Quoted text hidden]

*info Package + Contact
information sent
Nov 22/13*



Larry Grozell < grozell55@gmail.com >

information letter

2 messages

Larry Grozell < grozell55@gmail.com >

Thu, Dec 12, 2013 at 11:52 AM

To: Couch.j.c@sasktel.net

Good Morning to the Couch's

I am sending this letter out to contacts in the public consultation process to pass on information at the request of council. .

December 12 2013

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

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Thank you for your time.

Larry and Joan Grozell

couch.j.c@sasktel.net < couch.j.c@sasktel.net >

Thu, Dec 12, 2013 at 3:34 PM

To: Larry Grozell <grozell55@gmail.com>

Larry

Thanks for the invite, unfortunately I have a commitment.

The info you sent me on septic system was useful. I do view it as a superior system compared to the ones we have.

Good luck with your project.

Jim

Sent from my iPhone

[Quoted text hidden]

grozell55@gmail.co...

Error checking mail for groz@sasktel.net. Details Dismiss

Gmail

More

5 of 48

COMPOSE

Advanced Concrete Coring - www.neskor.ca - Professional Concrete Cutting & Coring Services

Why this ad?

Inbox (3)
Starred
Important
Sent Mail

Sign into chat

Search people...

- Bev Jutras
- Brad Hamilton
- Dean Blatz
- Kim Thiessen
- Roy & Mina Grozell
- Roy Taylor
- Sarah & Mitchell
- couch.j.c
- Hopkin@yourlink.ca
- Klark's Trenching

information letter

Inbox x

Larry Grozell Good Morning to the Couch's I am sending this Dec 12 (2 days ago) ☆

couch.j.c@sasktel.net Dec 12 (2 days ago) ☆

to me

Larry

Thanks for the invite, unfortunately I have a commitment.
The info you sent me on septic system was useful. I do view it as a superior system compared to the ones we have.
Good luck with your project.
Jim

Sent from my iPhone

Click here to Reply or Forward

couch.j.c

couch.j.c@sasktel.net

Show details

Ads

Eco-Clean Hardwood floors
Remove scratches & bring shine back Save 30% till Jan 1/14.
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Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Stanley & Maxine Bell

Phone number(s) (306) 664-3571 cell (306) 381-8720

Address or Land Description 38 Wood Meadows Lane, Corman Park

Option 1: Input NOT sure about this option as it is quite high density for rural development

Option 2: Input Our preference is option 2 as we feel

option 1 would ~~be~~ not retain a rural feeling and it would look too much like a city development

We like greenspace and walking paths in the plan. We also like the idea of a foot/bike path from Wood Meadows Lane culdesac.

General comment or input Our first reaction is we like our quiet rural setting and view. Having said that, we realize that development happens and we would be okay with it.

Signature(s): Stanley Bell

Would you like to be contacted by the applicant: Yes No

Rec
Nov. 25th



Larry Grozell < grozell55@gmail.com>

Information letter

1 message

Larry Grozell < grozell55@gmail.com>

Thu, Dec 12, 2013 at 11:53 AM

To: Maxine Bell <maxineandstan@gmail.com>

Good Morning to the Bell's

I am sending this letter out to contacts in the public consultation process to pass on information at the request of council. .

December 12 2013

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

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Thank you for your time.

Larry and Joan Grozell

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) EE HOPKIN & JO-ANNE R. DILLON

Phone number(s) (306) 477 4798

Address or Land Description 65 Wood Meadow Place, Cornman Park.

Option 1: Input _____

OK

Option 2: Input _____

OK

General comment or input _____

Both conceptual proposals would work along Clarence
and we support the development.

Signature(s): EE Hopkin
ms JRDillon

Would you like to be contacted by the applicant: Yes No _____

REC 26th
Called By
spoke on phone Nov 27th

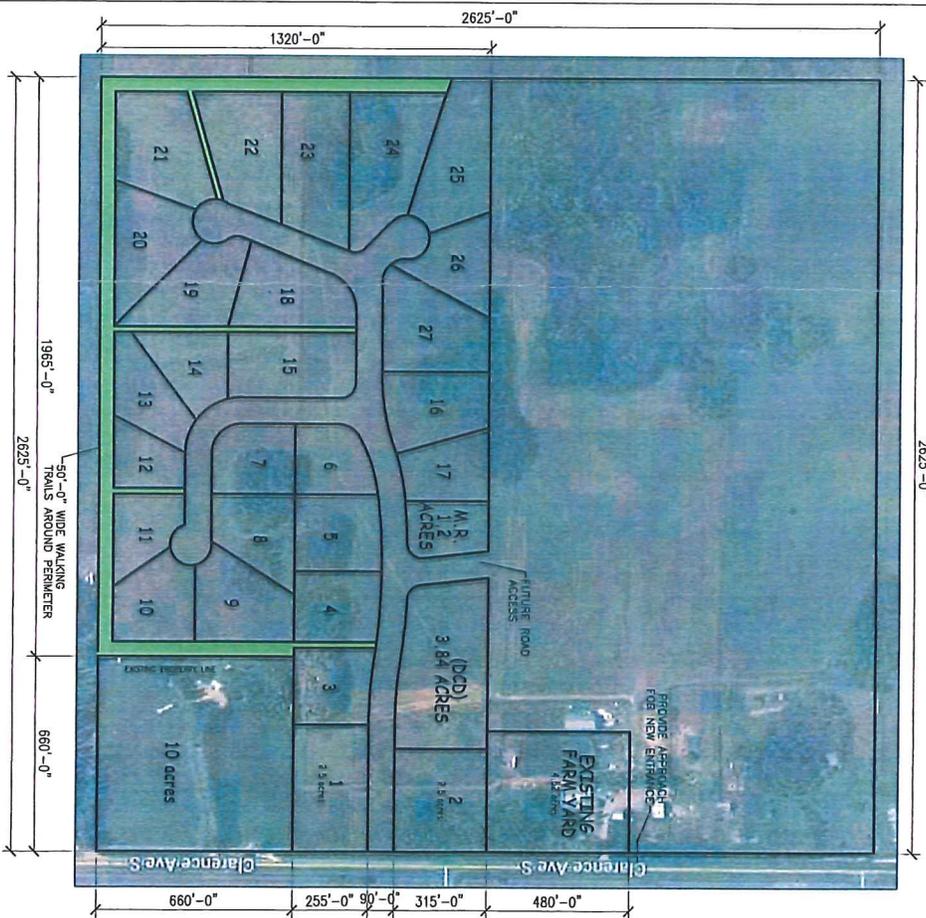
PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 1

LOTS VARY IN SIZE FROM
0.55 ACRES TO 1.8 ACRES
TOTAL AREA: 70 ACRES
GREEN SPACE: 8 ACRES
% OF GREEN SPACE: 11%

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM
1.0 ACRES TO 2.6 ACRES
TOTAL AREA: 70 ACRES
GREEN SPACE: 5 ACRES
% OF GREEN SPACE: 7%



Larry Grozell < grozell55@gmail.com >

Information letter

1 message

Larry Grozell < grozell55@gmail.com >
To: "Hopkin@yourlink.ca" < hopkin@yourlink.ca >

Thu, Dec 12, 2013 at 11:57 AM

Good Morning Elwyn and Jo-Anne

I am sending this letter out to contacts in the public consultation process to pass on information at the request of council. .

December 12 2013

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

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Thank you for your time.

Larry and Joan Grozell

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) CHRIS & MICHELLE CHULHANIYA

Phone number(s) 306 374 2626

Address or Land Description 95 Eldorado Lane

Option 1: Input _____

Option 2: Input _____

General comment or input - see attached letter -

Signature(s): 

Would you like to be contacted by the applicant: Yes _____ No X

*Rec
Nov 29/13*

To Whom It May Concern

As our community is growing, we would support any development that would result in a controlled and aesthetically pleasing process. The rural municipality of Corman Park needs to consider the current situation in regards to acreages surrounding the City of Saskatoon. Except for developments such as Casa Rio and Wood Meadows (to the south), the small acreages dotting the perimeter of the city generally lack architectural controls — in fact too many are unsightly. It is time the R.M. consider the building of 'communities' (rather than 'one-shot' acreage approvals) that are reflective of the beautiful developments being built around the cities of Calgary and Edmonton. Time to put the Saskatoon area (Corman Park) on the map!

Please consider this our support of this particular development — so long as there are assurances of architectural controls.

Michelle Chuhaniak - M. Chuhaniak
Chris Chuhaniak - C. Chuhaniak

95 Eldorado Lane
Casa Rio
306 374 2626

Received
Nov 29/13

December 12 2013

Mr. and Mrs. Chuhaniuk
95 Eldorado Lane
Casa Rio, SK
S7T 1B8

Dear Chris and Michelle

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

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Thank you for your time.

Larry and Joan Grozell

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Neil & Yvette Evans

Phone number(s) 955 6012

Address or Land Description 875 BAKER Rd E, CASARIO

Option 1: Input I'm in favor of either option 1

or option 2. Both

will enhance the neighborhood.

Option 2: Input _____

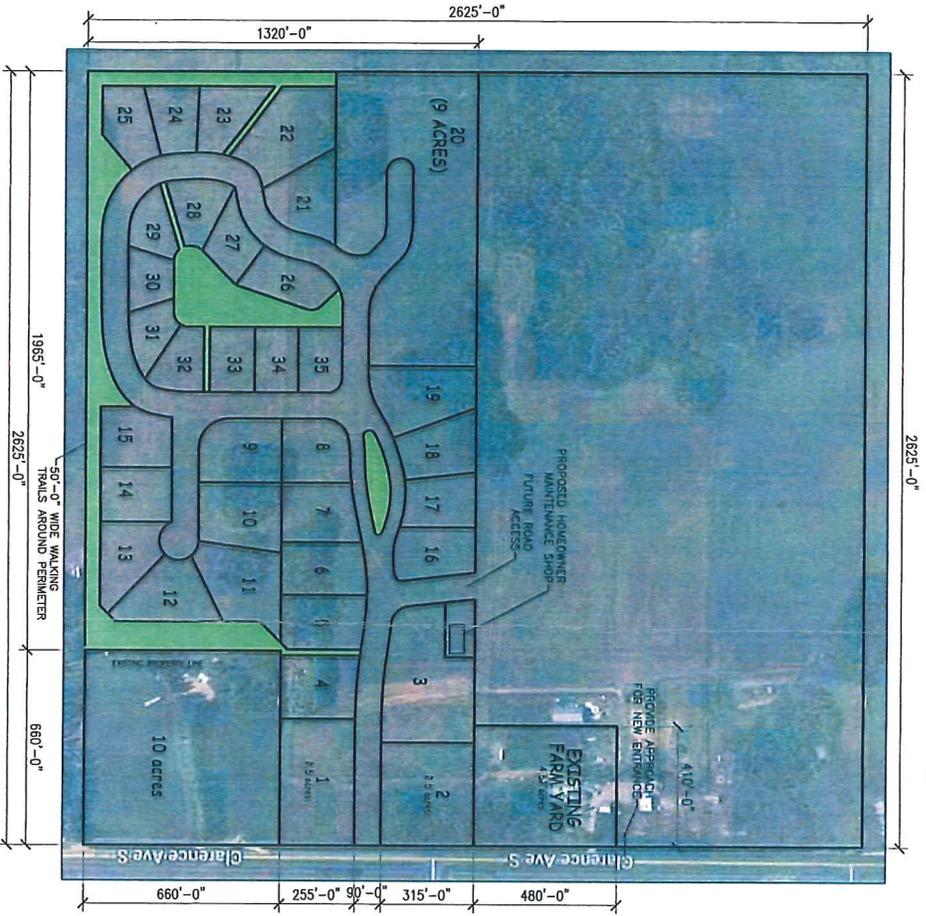
General comment or input _____

Signature(s): 

Rec Dec 3

Would you like to be contacted by the applicant: Yes No

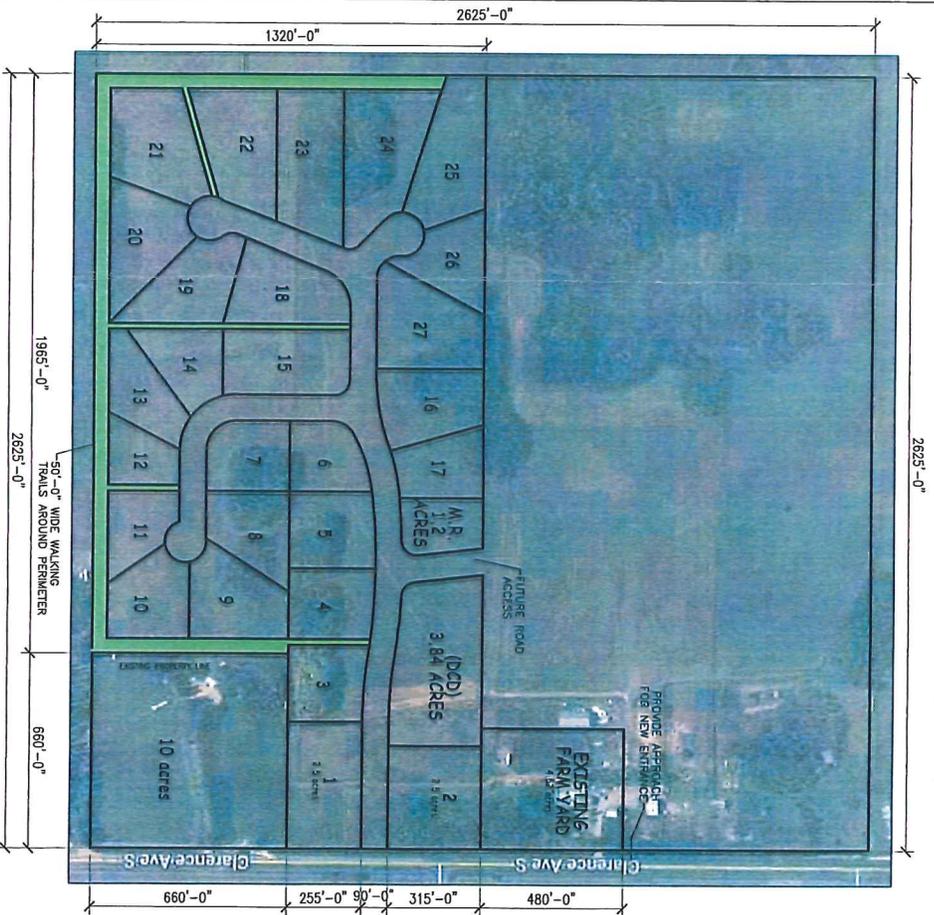
**PROPOSED SUBDIVISION FOR
NE - SECTION 28, TOWNSHIP 35, R5, W.3**



PROPOSED LOT LAYOUT - OPTION 1

LOTS VARY IN SIZE FROM
0.65 ACRES TO 1.8 ACRES
TOTAL AREA: 70 ACRES
GREEN SPACE: 8 ACRES
% OF GREEN SPACE: 11%

**PROPOSED SUBDIVISION FOR
NE - SECTION 28, TOWNSHIP 35, R5, W.3**



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM
1.0 ACRES TO 2.6 ACRES
TOTAL AREA: 70 ACRES
GREEN SPACE: 5 ACRES
% OF GREEN SPACE: 7%

December 12 2013

Mr. and Mrs. Evans
875 Baker Road E
Casa Rio, SK
S7T 1B5

Dear Neil and Yvette

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

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Thank you for your time.

Larry and Joan Grozell

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) RANDY PSHEBYLO

Phone number(s) 306.241.3714

Address or Land Description 4931 PRAIRIE LANE - GRASSWOOD

Option 1: Input AS DISCUSSED IN THE OPEN HOUSE
THIS APPEARS TO BE A MORE ATTRACTIVE
OPTION; I APPRECIATE THE LOCAL
MAINTENANCE IS SELF FUNDING;
WIN-WIN FOR RM & RESIDENTS.

Option 2: Input _____

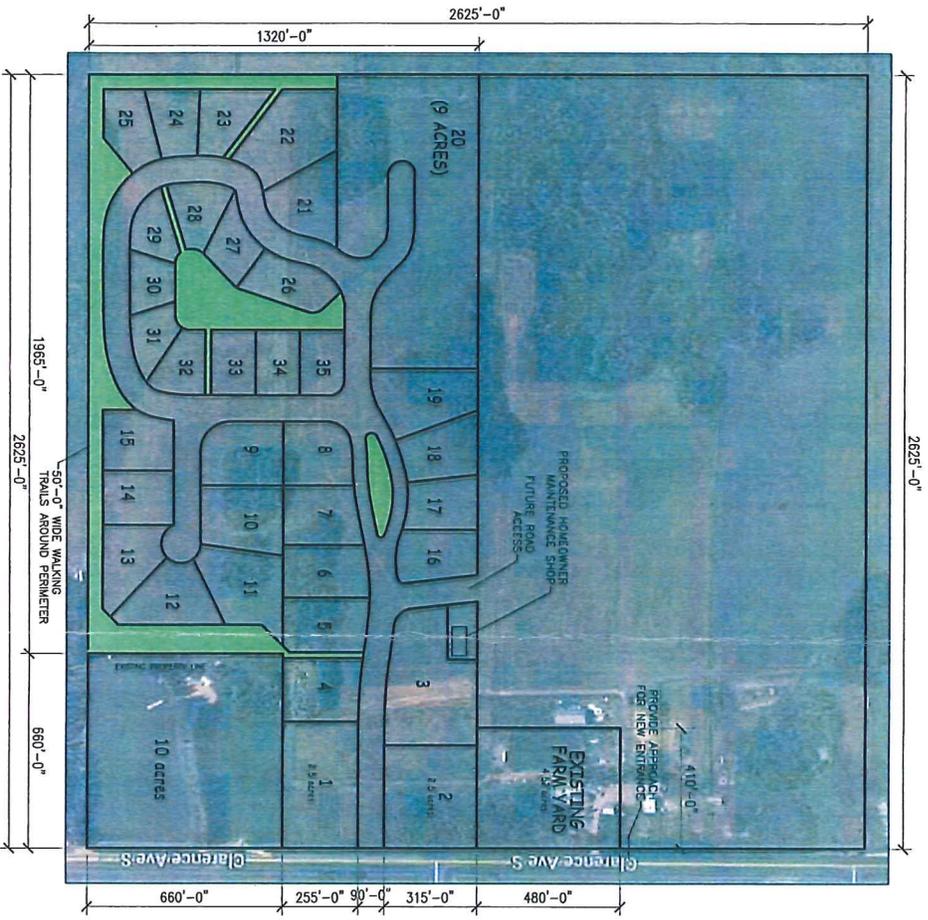
General comment or input WHETHER OR NOT THIS IS
APPROVED, CLARENCE AVENUE & GRASSWOOD
ROAD WILL NEED PROPER ~~SEWER~~ SHOULDER
AND SURFACE RECONSTRUCTION

Signature(s): R Pshebylo

rec Dec 4th

Would you like to be contacted by the applicant: Yes _____ No _____
ALREADY MET.

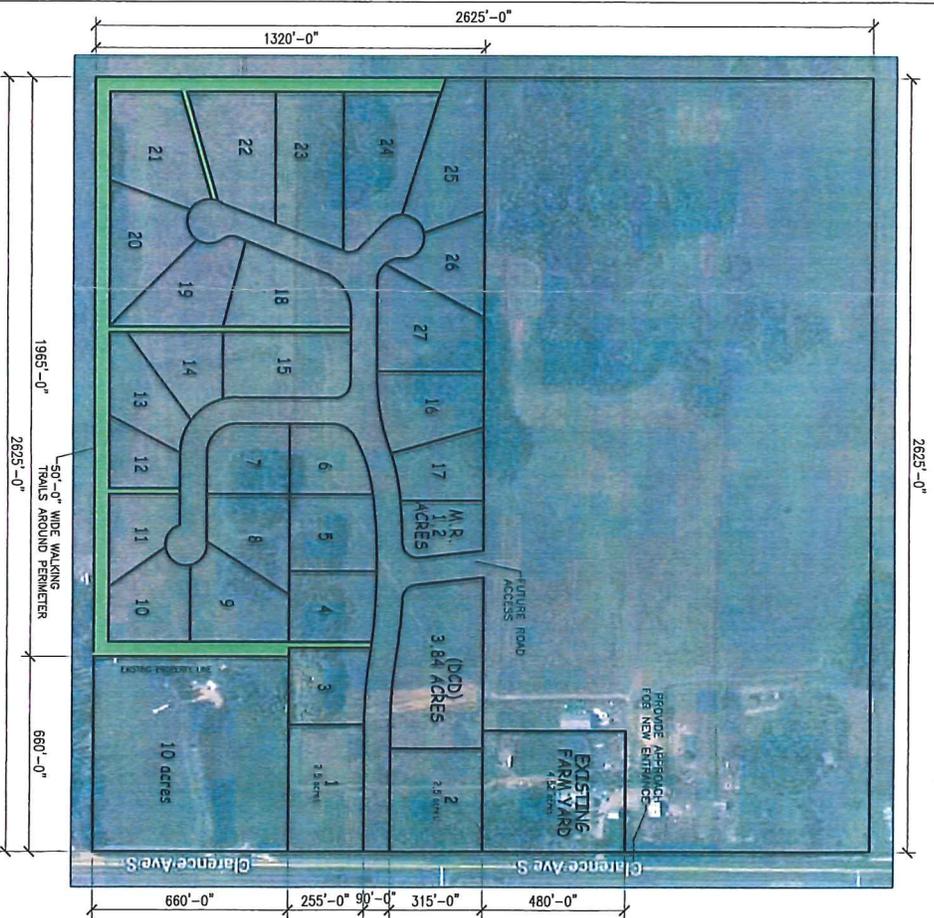
PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 1

LOTS VARY IN SIZE FROM
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% OF GREEN SPACE: 11%

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM
1.0 ACRES TO 2.6 ACRES
TOTAL AREA: 70 ACRES
GREEN SPACE: 5 ACRES
% OF GREEN SPACE: 7%

December 12 2013

Mr. Randy Pshebylo
4931 Prairie Lane
Grasswood, SK
S7T 1A7

Dear Randy

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

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Thank you for your time.

Larry and Joan Grozell

Nov 24/13

Rec
Dec 5

Harry & Joan Brozell

I fully support your proposition to gain approval for a Care Home.

We have been trying to get permission to subdivide 9.2 acres & have not received approval as we are on paper 9.2 but yet they say we have on 9.10 because of road allowance. Your parcels range from 1 acre to more. Should you be granted permission for these size or parcels I believe we may be successful in subdividing ours at some point.

I am in favor of your proposal for the housing development.

Urgent
350 Grasswood Rd E
Grasswood

December 12 2013

Mrs Val Zemlak
350 Grasswood Road
Grasswood, SK
S7T 1A6

Dear Val

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

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Thank you for your time.

Larry and Joan Grozell

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Robert + Karen McClean

Phone number(s) 249-4630

Address or Land Description 83 Eldorado Lane

Option 1: Input disagree with the small lot size / higher density multifamily dwellings

~~should not~~ are not consistent with the nature of this community and should not be permitted.

I do not support the inclusion of gated communities in this area.

pertains to both options

Option 2: Input as above. I have no disagreement with the location of group homes in this community PROVIDED

they maintain the character + intent of the community - that is: they are consistent in physical structure / size, occupancy + housing intensity / property size with the existing single family dwellings in the area + the ORIGINAL zoning

General comment or input We disagree with the continued erosion of

the nature of this community converting to higher density housing. This community is valued for the larger lot size allowing for lower density + supporting wild life. + many residents choose this area specifically because of the zoning that supports this type of life.

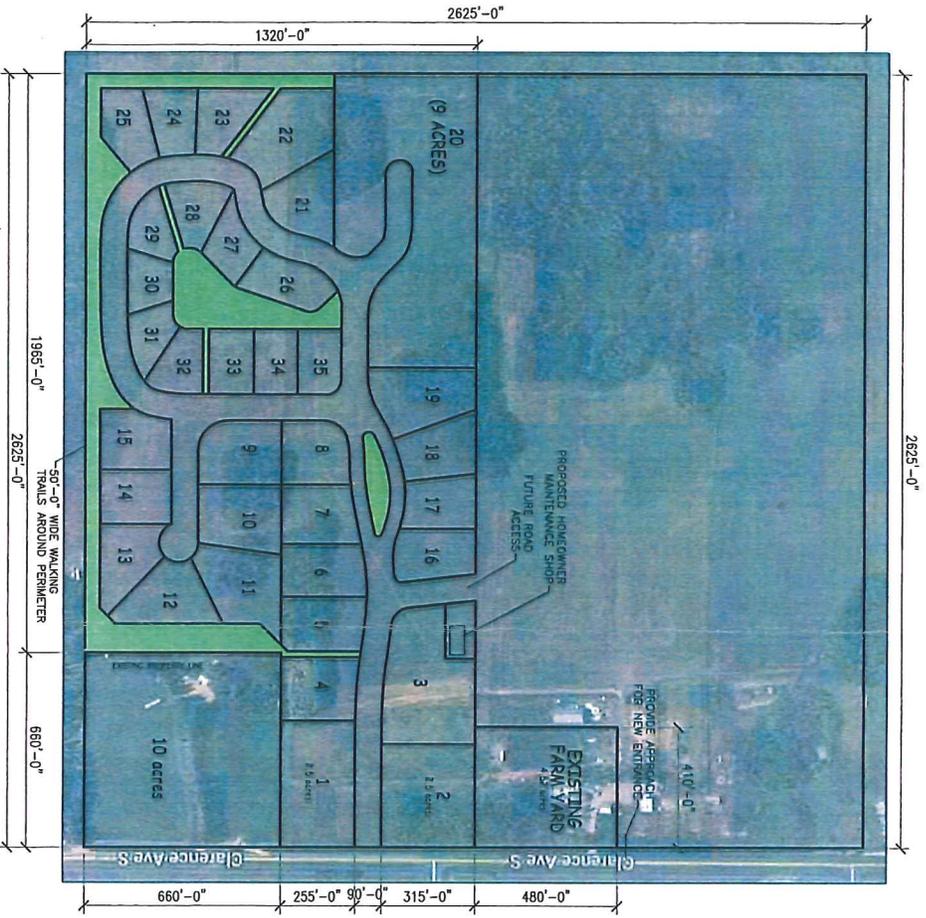
Signature(s): Karen McClean
Robert J. McClean

Would you like to be contacted by the applicant: Yes No

cc: R.M. Corman Park.

*Rec email new 12/13
Rec new 14/13*

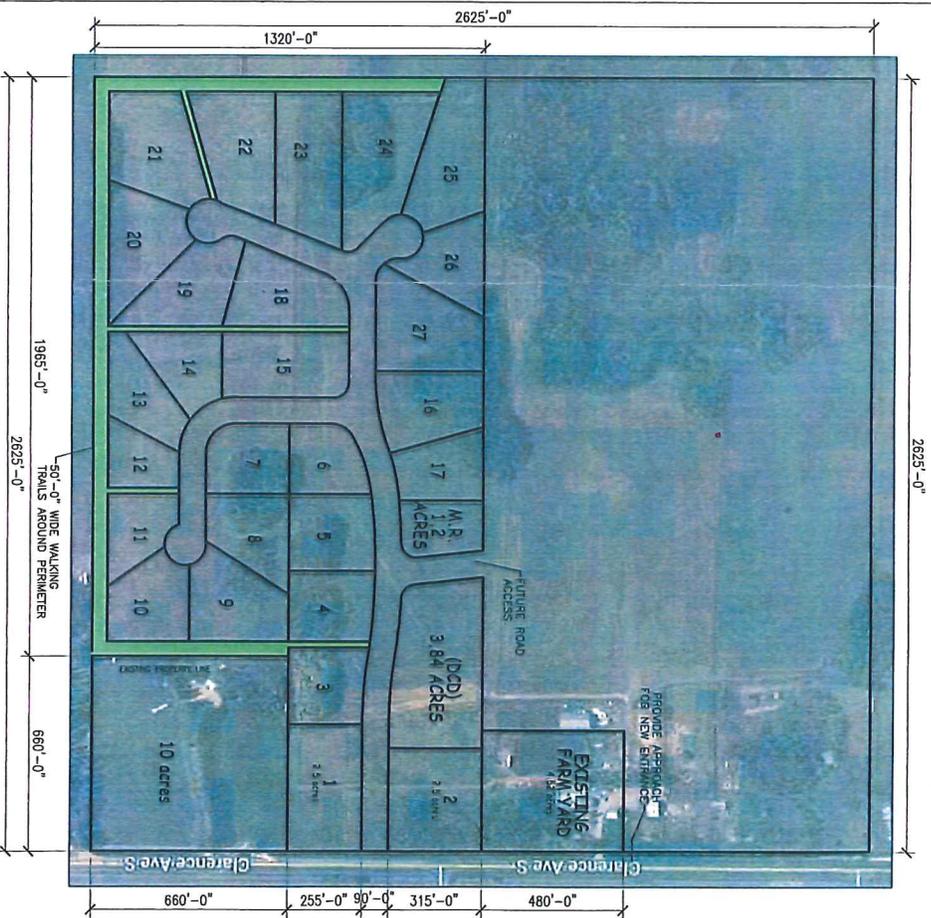
PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 1

LOTS VARY IN SIZE FROM
0.65 ACRES TO 1.8 ACRES
TOTAL AREA: 70 ACRES
GREEN SPACE: 8 ACRES
% OF GREEN SPACE: 11%

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM
1.0 ACRES TO 2.6 ACRES
TOTAL AREA: 70 ACRES
GREEN SPACE: 5 ACRES
% OF GREEN SPACE: 7%

December 12 2013

Mr. and Mrs. McClean
83 Eldorado Lane
Casa Rio, SK
S7T 1B8

Dear Robert and Karen

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

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Thank you for your time.

Larry and Joan Grozell

fax 242-8965

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Deen + Stephanie Zumpel

Phone number(s) _____

Address or Land Description 52 Coe Rd W

Option 1: Input No! Too much traffic.
Not enough infrastructure for more
population/development. Peace + quiet
+ country living.

Option 2: Input No! Too much traffic.
Not enough infrastructure for more
development. We want peace and
quiet & country living.

General comment or input No more development! We
moved out here to live in the
country not a suburb!! Enough
development. Stop please.

Signature(s):
[Signature]
Zumpel

Rec via email
11/19/13

Would you like to be contacted by the applicant: Yes No

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 1

LOTS VARY IN SIZE FROM 0.65 ACRES TO 1.8 ACRES

TOTAL AREA: 70 ACRES

GREEN SPACE: 8 ACRES

% OF GREEN SPACE: 11%

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM 1.0 ACRES TO 2.6 ACRES

TOTAL AREA: 70 ACRES

GREEN SPACE: 5 ACRES

% OF GREEN SPACE: 7%

December 12 2013

Mr. and Mrs. Rumpel
52 Casa Rio Lane
Casa Rio, SK
S7T 1B6

Dear Dean and Stephenie

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

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Thank you for your time.

Larry and Joan Grozell



Larry Grozell <grozell55@gmail.com>

FW: Larry and Joan Grozell

1 message

Rebecca Row <rrow@rmcormanpark.ca>
To: grozell55@gmail.com

Tue, Nov 19, 2013 at 4:26 PM

FYI

From: Extra Clean [mailto:extra.clean@sasktel.net]
Sent: Tuesday, November 19, 2013 4:11 PM
To: rrow@rmcormanpark.ca
Cc: m344@rmcormanpark.ca
Subject: Larry and Joan Grozell

Hello Rebecca:

Just a short note to say we do not want to see any further development in Casa Rio Area.

Including the two separate purposed developments of Larry and Joan Grozell Subdivision for NE-
Section 28, Township 35, R5, W.3

Thank you,

Chris and Linda Eyerley

Spam
Not spam
Forget previous vote



Larry Grozell < grozell55@gmail.com >

Information letter

1 message

Larry Grozell < grozell55@gmail.com >

Thu, Dec 12, 2013 at 11:45 AM

To: extra.clean@sasktel.net

I am sending this letter out to contacts in the public consultation process to pass on information at the request of council. .

December 12 2013

Mr. and Mrs. Eyerley

Dear Chris and Linda

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

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Thank you for your time.

Larry and Joan Grozell

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Tim Britton and Sae Britton

Phone number(s) 306 222 1647

Address or Land Description 285 Parklands Rd, Grasswood SK

Option 1: Input Far to dense with close to 60 houses

on 70 acres

- like the idea of a residential care facility.
- Would prefer to see a reasonable amount of lots, such as possibly 14 ~~lots~~ small lots with 28 acres of green space and trails.

Option 2: Input _____

Option 2 is also still to dense for the area. ~~once~~ Once again I would recommend a maximum of 14 small lots with lots of trails + green space.

- Like the idea of a residential ~~development~~ ^{Care facility}

General comment or input This area already has lots of development with bigger acreages that allow for privacy. I would prefer not to have this concentration of development.

I would be more supportive of a development of a maximum of 14 ~~plots~~ lots with lots of trails + green space for the residence.

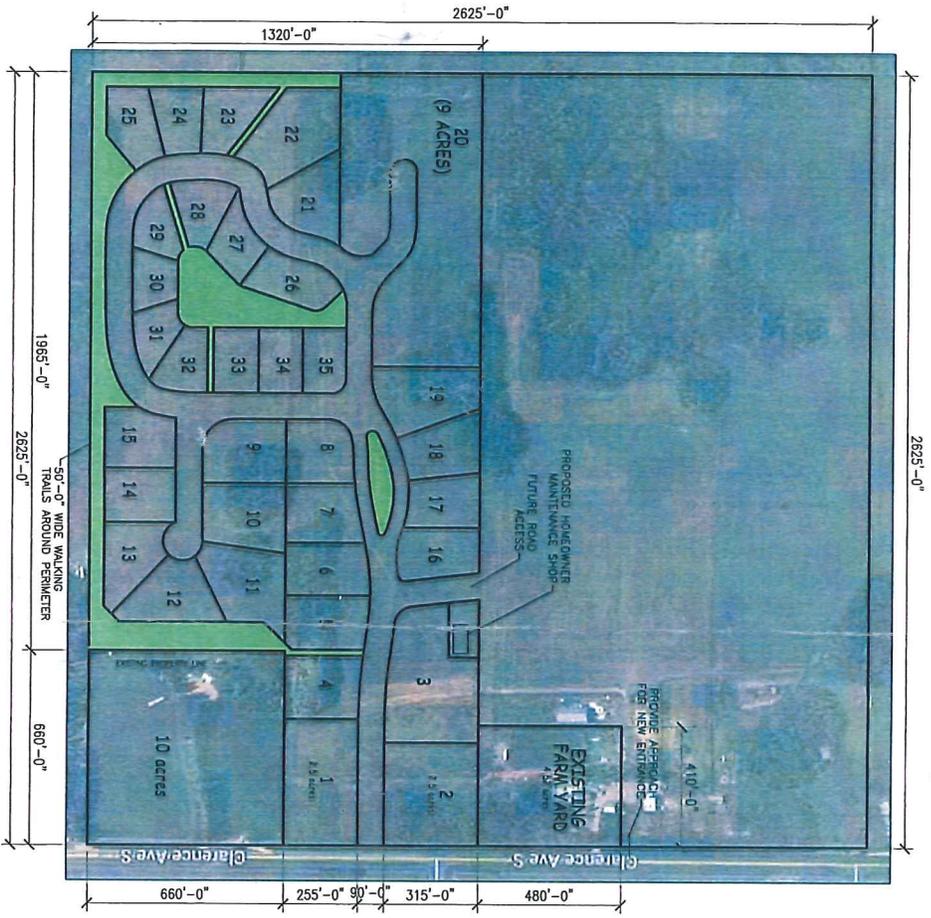
Signature(s): Tim Britton

Would you like to be contacted by the applicant: Yes _____ No _____

the applicant can contact me if they want to.

Like the idea of a residential care facility.

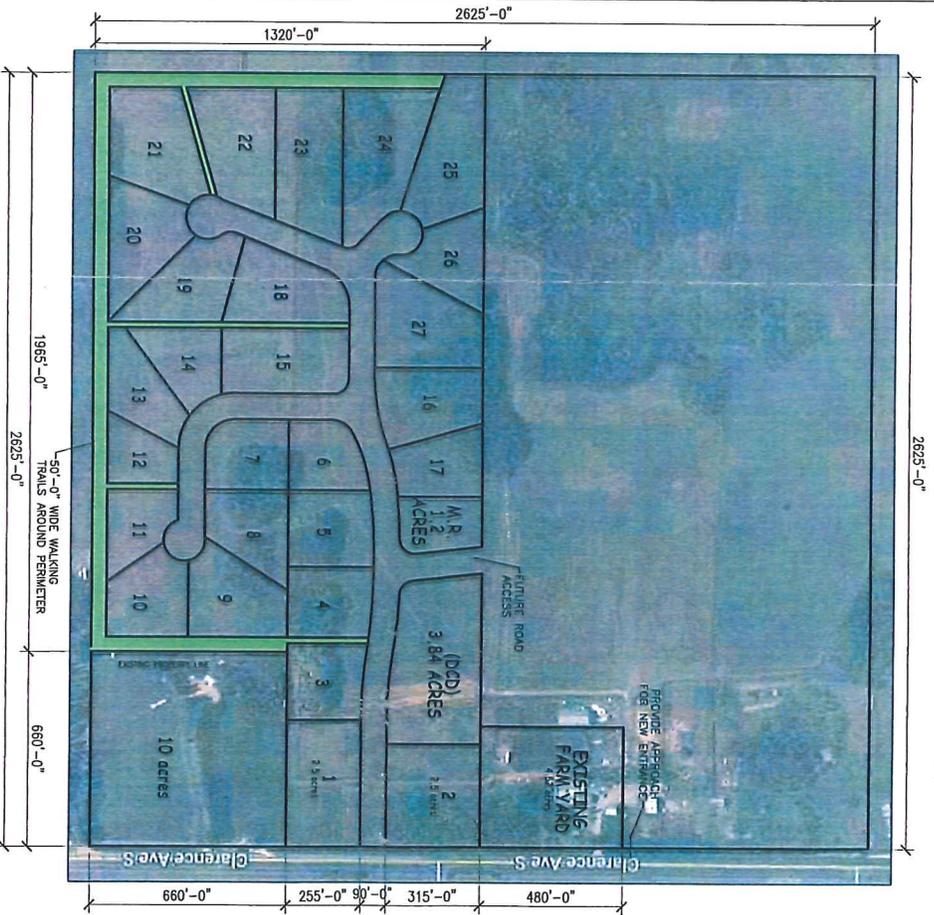
PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 1

LOTS VARY IN SIZE FROM
0.65 ACRES TO 1.8 ACRES
TOTAL AREA: 70 ACRES
GREEN SPACE: 8 ACRES
% OF GREEN SPACE: 11%

PROPOSED SUBDIVISION FOR NE - SECTION 28, TOWNSHIP 35, R5, W.3



PROPOSED LOT LAYOUT - OPTION 2

LOTS VARY IN SIZE FROM
1.0 ACRES TO 2.6 ACRES
TOTAL AREA: 70 ACRES
GREEN SPACE: 5 ACRES
% OF GREEN SPACE: 7%

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Tim Britton and Sae Britton

Phone number(s) 306 222 1647

Address or Land Description 285 Barklands Rd, Grasswood SK

Option 1: Input Far to dense with close to 60 houses on 20 acres

- like the idea of a residential care facility.
- Would prefer to see a reasonable amount of lots, such as possibly 14 ~~lots~~ small lots with 20 acres of green space and trails.

Option 2: Input

Option 2 is also still to dense for the area. ~~Once~~ Once again I would recommend a maximum of 14 small lots with lots of trails + green space.

- Like the idea of a residential ~~development~~ care facility.

General comment or input This area already has lots of development with bigger acreages that allow for privacy. I would prefer not to have this concentration of development.

I would be more supportive of a development of a maximum of 14 plots with lots of trails + green space for the residence.

Signature(s): Tim Britton

Would you like to be contacted by the applicant: Yes No
the applicant can contact me if they want to.

Like the idea of a residential care facility.

Postal? STT1A7

Rec via email Nov 19/13.

Copy

December 12 2013

Mr. and Mrs. Britton
285 Parklands Road
Grasswood, SK
S7T 1A7

Dear Tim and Sue

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

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Thank you for your time.

Larry and Joan Grozell



Larry Grozell < grozell55@gmail.com >

Proposal Input

1 message

Larry Grozell < grozell55@gmail.com >

Sun, Nov 17, 2013 at 11:02 AM

To: Sherry Mervold < rmcormandiv2@gmail.com >

As Councillor for Division 2 you are aware I have put forward two proposals in the RM's multi parcel application process for the NE 1/4 Sec 28 35 5 w3 on Clarence Ave.

I would like to extend an invitation to the come and go open house at the Grasswood Esso meeting room on Thursday, November 21 from 7 to 9 PM.

In an effort to make improvements to the proposals or address possible concerns I would appreciate your thoughts and comments on each proposal.

Would you please send back an e mail with any questions, input or concerns that you may have or expressed by residents who may have contacted you directly.

You time is appreciated

Thank You

Larry Grozell



Larry Grozell < grozell55@gmail.com >

Proposal Input

2 messages

Larry Grozell < grozell55@gmail.com >

Sun, Nov 17, 2013 at 11:02 AM

To: Sherry Mervold < rmcormandiv2@gmail.com >

As Councillor for Division 2 you are aware I have put forward two proposals in the RM's multi parcel application process for the NE 1/4 Sec 28 35 5 w3 on Clarence Ave.

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In an effort to make improvements to the proposals or address possible concerns I would appreciate your thoughts and comments on each proposal.

Would you please send back an e mail with any questions, input or concerns that you may have or expressed by residents who may have contacted you directly.

Your time is appreciated

Thank You

Larry Grozell

Sherry Mervold < rmcormandiv2@gmail.com >

Wed, Nov 20, 2013 at 7:34 PM

To: Larry Grozell < grozell55@gmail.com >

Hi Larry,

Unfortunately I will not be able to attend your open house tomorrow as I already have another commitment. I am waiting to see more of the replies of the people within the 1 mile radius. One of the things that I am concerned with is the small lot sizes, this is not very compatible to the surrounding multi-parcels.(Casa Rio and Wood Meadows) But we will know more once all the replies are in. Please feel free to call me if there is anything I can help you with.

Thanks

Sherry

[Quoted text hidden]

Input Form

Application: Zoning Change
Location: NE ¼ Section 28 Township 35 Range 5 W3
Proposed use: Multi-parcel Subdivision

Gerry McNab, P. Eng. and Sharon McNab, B. Ed.
5519 Clarence Avenue South
Casa Rio, SK S7T 1B6

General Comments:

This development, if it goes ahead, will increase the number of residences in the Casa Rio area by over 80 percent. This will, no doubt, also significantly increase the daily traffic flow on Clarence Avenue since access to the proposed development will be from Clarence Avenue.

The Clarence Avenue roadbed is already failing in many areas under its existing traffic flow regimen. This failure is especially noticeable in the area of the intersection with the north leg of Eldorado Lane, about ¼ mile north of the proposed development. The sloughs on both sides of the road there are more than likely saturating the road base, and promoting the surface failure. Similar situations exist on Grasswood Road in front of the Jemini Arena, and on Baker Road, in the South Point acreage area. Increased traffic will only exacerbate the problem, and either increase the cost and frequency of repair, or increase capital costs for roadbed redesign and replacement. The RM should consider this when deliberating about this project's approval.

The increased population, too, will negatively affect the lifestyles of those of us who moved to this area for the quiet life. There are already several snow mobiles, ATVs and dirt bikes that zoom through the ditches in this area, especially during the evenings and weekends. Almost doubling the local population will, no doubt, increase the abundance of these vehicles, and the annoyance that they cause.

In the proposals, the north half of the quarter is being left open for future development (future access road). A similar sized development there will only elevate our traffic, road damage and lifestyle impact concerns.


Sharon McNab

Rec
NOV 20/13

December 12 2013

Mr. and Mrs. McNab
5519 Clarence Avenue South
Casa Rio, SK
S7T 1B6

Dear Gerry and Sharon

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

I have been requested by Council to present a brief overview of the project and a summary of the public consultation results on December 18th at 11:45 am.

Council has indicated this is an open council meeting and invites contacts from the public consultation process to sit in and observe the discussion from the gallery. It should be noted that Council also indicated that it is not a public hearing or forum in which the gallery will be invited to speak.

Thank you for your time.

Larry and Joan Grozell

Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) Dalton Mervold

Phone number(s) 306-242-4347(Home) 306-659-4077(work)

Address or Land Description 1160 Baker Road

Option 1: Input These lots are too small to be compatible with the surrounding developments. Clarence Ave is not designed to handle the increased traffic. Both Wood Meadows and Pasa Rio have larger sized acreages, also Grasswood South as all around

Option 2: Input Again the same concerns I have ^{10 acres} with Option 1 are present in Option 2

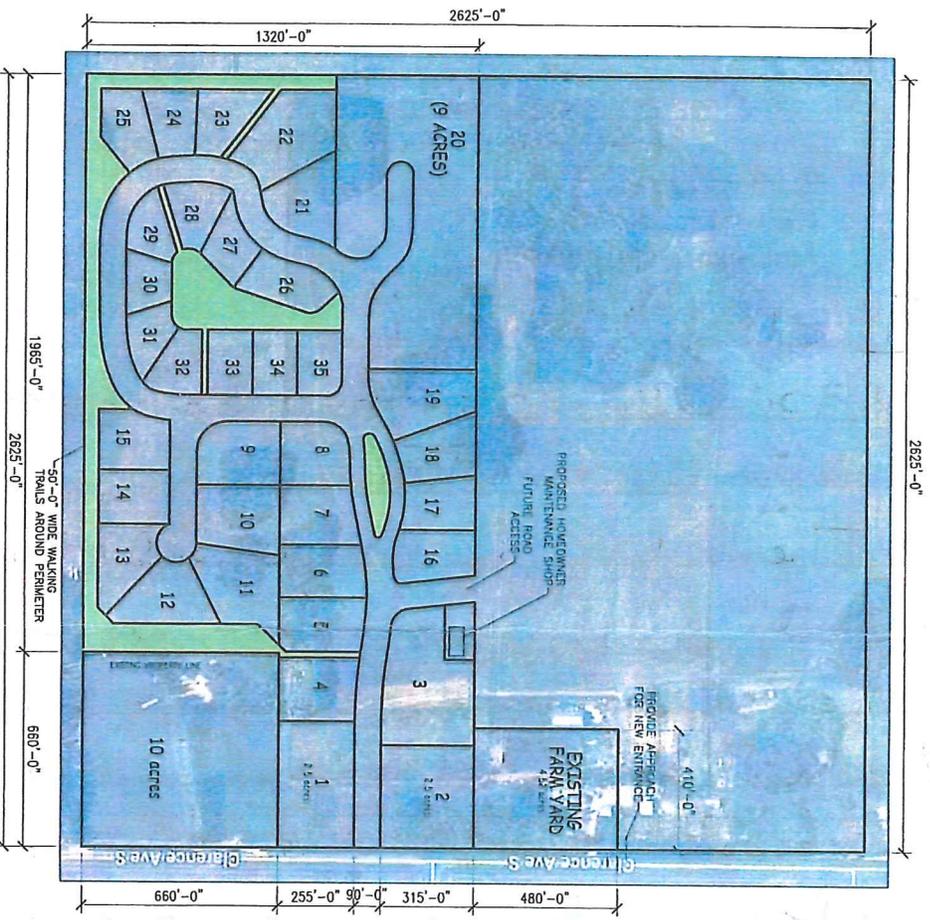
General comment or input I would like to see larger lots with the average at least around the 10 acre size. There could be some as small as 5 acres but then larger ones to bring the average up. Also something built in to pay to upgrade Clarence Ave + Baker Roads. Because extra traffic will be using these.

Signature(s): Dalton Mervold

Would you like to be contacted by the applicant: Yes No

Rec
2/13
at meeting

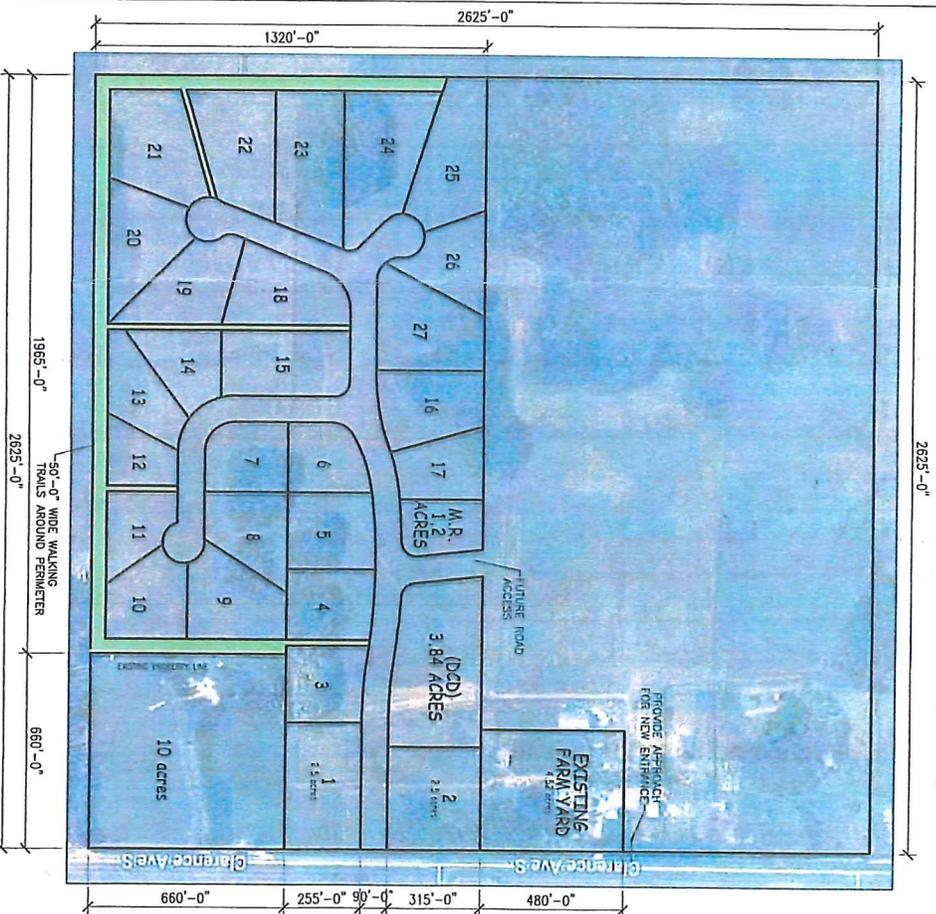
**PROPOSED SUBDIVISION FOR
NE - SECTION 28, TOWNSHIP 35, R5, W.3**



LOTS VARY IN SIZE FROM
0.65 ACRES TO 1.8 ACRES
TOTAL AREA: 70 ACRES
GREEN SPACE: 8 ACRES
% OF GREEN SPACE: 11%

PROPOSED LOT LAYOUT - OPTION 1

**PROPOSED SUBDIVISION FOR
NE - SECTION 28, TOWNSHIP 35, R5, W.3**



LOTS VARY IN SIZE FROM
1.0 ACRES TO 2.6 ACRES
TOTAL AREA: 70 ACRES
GREEN SPACE: 5 ACRES
% OF GREEN SPACE: 7%

PROPOSED LOT LAYOUT - OPTION 2



Larry Grozell <grozell55@gmail.com>

Information letter

1 message

Larry Grozell <grozell55@gmail.com>

Thu, Dec 12, 2013 at 11:21 AM

To: Sherry Mervold <rmcormandiv2@gmail.com>

Good Morning to the Mervold's

I am sending this letter out to contacts in the public consultation process to pass on information at the request of council. I'm sorry but I didn't have your postal code so I am sending the letter to this E mail address.

December 12 2013

Mr Dalton Mervold

1160 Baker Road

Casa Rio, SK

Dear Dalton

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

I have been requested by Council to present a brief overview of the project and a summary of the public consultation results on December 18th at 11:45 am.

Council has indicated this is an open council meeting and invites contacts from the public consultation process to sit in and observe the discussion from the gallery. It should be noted that Council also indicated that it is not a public hearing or forum in which the gallery will be invited to speak.

Thank you for your time.

Larry and Joan Grozell

grozell55@gmail.co...

Error checking mail for groz@sasktel.net. Details Dismiss

Gmail

More

2 of 28

COMPOSE

MBNA - Platinum Plus MasterCard - Get 0% for 12 months and save on interest charges. Be Good With Money. Why this ad?

Inbox (2)

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Important

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- Roy & Mina Grozell
- Roy Taylor
- Sarah & Mitchell
- Carla MacLeod
- couch.j.c
- David Fox

Comments on Proposed Zoning Change NE 1/4 Sec 28 35

W3 Inbox x

John Jarrell <johnjarrell@yourlink.ca> 2:09 PM (6 hours ago)
to me, rm344, rmcormandiv2

Larry,

Thank you for taking the time last Thursday (the 21st) to more fully explain your proposed development plans for the property immediately north of us. We appreciated having the time to discuss this with you face-to-face. As discussed at the Information Meeting, and as requested in your information note provided to us prior to the meeting, we have had an opportunity to put our thoughts down on paper. I am sorry that we could not get this to you a few days earlier, and as such, I am emailing you our comments. I have, however, also put the comments in the mail to you which you will hopefully receive in the next couple of days. Since the cycle time for receipt of comments and their consideration by RM council is relatively short, I have also copied both the RM general office and Councillor Mervold.

Yours sincerely,

John & Anita Jarrell
 49 Rolling Hills Lane
 Casa Rio, SK
 S7T 1B8
 306-955-0265

People (3)

John Jarrell
johnjarrell@yourlink.ca

Show details

Ad

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 Lot Servicing, Septic Tank Installs
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Input Form

Application: Zoning Change
Location: NE 1/4 Sec 28 35 5 w3
Proposed use: Multi-parcel Subdivision

Name(s) John & Anita Jarrell

Phone number(s) 306-955-0265

Address or Land Description 49 Rolling Hills Lane, Casa Rio, SK

Option 1: Input _____
See attached letter

Option 2: Input _____
See attached letter

General comment or input _____

Signature(s): John Jarrell
Anita M. Jarrell

*Rec
Nov 27th*

Would you like to be contacted by the applicant: Yes No

*We have already spoken to
Larry Grozell at the Information Meeting
held November 21st, 2013.*

also -
Received
By E Mail

November 25, 2013.

Comments on Proposed Zoning Change – NE 1/4 Sec 28 35 5 w3

Outlined below are our comments regarding the above-noted proposed zoning change. We are situated immediately south of the subject property, sharing a fence line. As requested in the input form provided prior to the information meeting held on November 21st, we have structured our comments in the three requested categories – General Comments as well as comments on the two specific proposed options for land development.

General Comments

Our primary comment relates to compatibility with overall land use planning development strategy south of Saskatoon (or lack thereof). We have followed with interest the current debate between the RM of Corman Park and city of Saskatoon regarding future planning needs as the city grows and expands. We have also watched with interest what seems to be relatively unencumbered (and possibly lightly regulated) development of residential subdivisions immediately south of Corman Park in the RM of Dundurn. We were surprised to learn at the Open House held last week that the city's long-term planning horizon goes as far north as Osler, yet apparently stops at Grasswood Road to the south of the city. We find this surprising given our close proximity to Stonebridge. Perhaps the overall plan is to develop green spaces between various residential developments as was done in development of the Greater Toronto Authority (GTA), or perhaps this is not the case, as we have yet to see the city's plans for the future.

In any event, we note that the RM of Corman Park has approved the creation of a substantial residential development with Crossmount Village, located within the circled immediate impact zone provided in the correspondence for the current proposal. As we understand it, Crossmount will be a variously reported 300-650 acre development largely targeted for seniors with 1,100 housing units ranging from independent living to Level 4 care. We also note that the Casa Rio East development, which is nearing completion and the Grasswood Estates development, which is in the early phase of development, are both immediately outside the immediate impact zone for the subject proposal.

Looking further afield, we note in the latest Division 2 newsletter provided by Councillor Mervold, that there are an additional six land development proposals under consideration within Division 2, excluding the Greenbryre Estates which is relatively close by in Division 1.

When considered in its entirety, it strikes us that there is a great deal of concurrent country residential development underway south of Saskatoon. While this could be seen as generally good news, it certainly brings into question the overall land use planning strategy and some concerns should “SaskaBoom” devolve into “SaskaBust”. After all, the current growth is largely based on development plans for only a few resource-based sectors which seem to have economic cycles. While no-one would wish such a turn of events, it occurs to us that if there were a large number of land developments within close proximity to one another competing for a shrinking number of prospective buyers, this would negatively impact both the developers and adjacent land owners. Partially completed developments slowed down or halted due to economic issues would not be an attractive outcome nor a particularly desirable neighbour. Half-finished developments would, in our view, detract from land and property values and hence housing prices for properties immediately adjacent to such arrested developments.

It strikes us that the answer to this conundrum is most likely found in a slow, steady development approach rather than risking a cycle of over-reaction/under-reaction. As such, our main question is as follows: Is there an overall master plan to govern growth in Corman Park Division 2? Looking in from the sidelines, it is not obvious that such a plan exists. As we noted at the information meeting, to be perfectly frank, our hope would be for development that matches or closely matches those residential developments immediately bordering the proposed new development site. Plainly put, the proposal in question is surrounded on three sides by Casa Rio Estates and Wood Meadows, all essentially developed with 5-20 acre lots. As we understand it, the area immediately north of the proposal (the only remaining border property) will remain ‘as is’, undeveloped, for the foreseeable future.

In informal discussions with the former reeve of Corman Park, Ed Hobday, it was our understanding that an overriding RM development objective was to provide either significantly-sized buffers around existing developments or transition land uses to avoid sharply demarcated zoning changes. Hobday explained that any RM-approved residential developments adjacent to existing residential developments would exhibit a similar appearance in that lots within the new development would be specifically equal to or the next level down in terms of lot size, so as to avoid a sharp contrast with the existing residential developments. While we understand that plans can change, naturally our preference would be a residential land development that is structured similar to those immediately surrounding it.

When Larry Grozell sought approval for development of a group home on Clarence Ave. about two years ago, we had no objection to the proposal, but did respond with a concern about the impact that the group home development would have on developments for the remainder of subject property within which it resides, which is located immediately north of our country residential property. We addressed those concerns to the Planner for the RM two years ago, as we thought this concern was largely in his bailiwick, but we were told at the time to take our concerns to the owner, specifically Larry Grozell. We did not pursue this avenue at that time because we were primarily interested in the RM’s viewpoint, not the developer’s viewpoint.

In summarizing our general comments, we still have questions and concerns regarding the RM's overall planning strategy for development, especially in those areas close to the city of Saskatoon, and as stated above, would prefer to see development more closely compatible with developed areas surrounding it. Our comments regarding the two specific options are provided below.

Option 1 comments (0.65 – 1.8 acres)

In looking at this proposal, we were surprised to see that it included a gated community proposal fashioned after the current development within the Willows. Equally surprising was hearing the suggestion that the lot prices would likely be similar to Willows, given that it is lacking an adjacent golf course. While we would fully support a residential care facility in close proximity to the group home development under construction on Clarence Ave., we wonder how a gated community located directly to the east of the Wood Meadows development could possibly compete with 1,100 housing units currently being built immediately west of Wood Meadows - this given that the target market is likely very similar to that of Level 1 independent living at Crossmount. While no doubt some purchasers would prefer a 24 unit development over one in the nearby village development, one should wonder about trying to develop both at the same time for what is still a relatively small city.

The Option 1 proposal contains a much greater number of residential properties than Option 2, which from our perspective, makes it a less desirable option.

Option 2 comments (1.0 – 2.6 acres)

It will come as no surprise that we would prefer Option 2 over Option 1, given that it essentially involves 27 lots rather than the approximately 70 lots in Option 1. Having said that, we do not believe that a 50' wide walking trail constitutes the spirit or intent of a real buffer zone and as noted above, we do not believe that the fence line transition from our 8 acre lot to the smallest 1.0 acre size of the proposed lots along a shared fence line represents the spirit of a gradual transition, if in fact that remains a guiding principle for the current RM council. Option 2 is obviously slated for a different market than Option 1, being more akin to current residential developments – albeit further pressing the envelope on minimum acreage sizes relative to existing and competing residential acreage developments in the immediate vicinity. Ironically, the only market niche which seems to be currently under-represented is our 5-20 acre residential development niche.

In closing, when we purchased our property seven years ago, we sat on the porch, looked north and while admiring the wonderful view of farm land, recognized that development of the subject agricultural-zoned property would be likely to occur. We based this speculation on the presence of residential developments on its borders (to the west, south, and east) and particularly with the city of Saskatoon beckoning to the north. Living so close to a city with city water in a semi-rural area is obviously desirable and what we sought in purchasing our current property. We fully understand that others have similar desires. The rapid and abundant growth of residential acreage developments in the RM of Dundurn stands testament to this desire. Our only hope is that transitional planning and buffer zone allowances between various developments be given full consideration when this proposal is considered by the RM of Corman Park.

Sincerely,

A handwritten signature in blue ink, consisting of two lines. The first line is a stylized 'J & A' followed by 'Jarrell'. The second line is 'Anita M. Jarrell' written in a cursive script.

John & Anita Jarrell
49 Rolling Hills Lane,
Casa Rio, SK
S7T 1B8
306-955-0265
johnjarrell@yourlink.ca



Larry Grozell < grozell55@gmail.com >

Information letter

1 message

Larry Grozell < grozell55@gmail.com >
To: Johnjarrell@yourlink.ca

Thu, Dec 12, 2013 at 11:59 AM

Good Morning to the Jarrell's

I am sending this letter out to contacts in the public consultation process to pass on information at the request of council. .

December 12 2013

Thank you for taking the time to respond and provide input to the proposed subdivision on the NE 1/4 section 28 35 5 w3.

I have been requested by Council to present a brief overview of the project and a summary of the public consultation results on December 18th at 11:45 am.

Council has indicated this is an open council meeting and invites contacts from the public consultation process to sit in and observe the discussion from the gallery. It should be noted that Council also indicated that it is not a public hearing or forum in which the gallery will be invited to speak.

Thank you for your time.

Larry and Joan Grozell



Larry Grozell <grozell55@gmail.com>

meeting

8 messages

Larry Grozell <grozell55@gmail.com>
To: ksakundiak@gmail.com

Fri, Nov 24, 2017 at 11:36 AM

Hi Kim

I now have a concept plan that would show current thinking on the development of the quarter.

The assumption would be there is still an interest in having a meeting for discussion to provide input by yourself and or others.

Let me know if this is still the case and what would be most convenient for you to meet.

Thanks and have a great day
Larry Grozell



Virus-free. www.avast.com

Kipp Sakundiak <ksakundiak@gmail.com>
To: Larry Grozell <grozell55@gmail.com>

Mon, Nov 27, 2017 at 8:39 AM

Larry,
Thank you for your message. Would you be able to send me a few details, I can pass along to the group and then we can arrange to meet with you.

I am thinking this Sunday afternoon perhaps might work.

What do you think?

Kipp
mobile: 306-261-7818

[Quoted text hidden]

Kipp Sakundiak <ksakundiak@gmail.com>
To: Larry Grozell <grozell55@gmail.com>

Tue, Nov 28, 2017 at 11:29 AM

Hi Larry,
Just trying to arrange some dates that will work for people. Are you free this coming Sunday at say 3:00pm? 1/2 hour or so good enough?

Kipp (from mobile phone)
[Quoted text hidden]

Larry Grozell <grozell55@gmail.com>

Tue, Nov 28, 2017 at 1:43 PM

To: Kipp Sakundiak <ksakundiak@gmail.com>

Hi Kipp

My apologies for referring to you as Kim.

Sunday I play hockey in North Battleford at 7PM so 1:30 would work better for me in order to leave the city at the appropriate time. I think 1/2 hour would be ample time.

Currently being considered overview for your info

150 acres located on NE 1/4 sec 25 5 w 3

40 acres along north border remain agricultural to maintain existing farm and Walter Lane activities for physically and intellectually challenged .

Remaining 110 acres developed residential on south end of the 1/4 with either 40 lots CR1 or 48 lots if CR4

In either case 2 of those lots would be designated as care sites similar to Walter Lane and would be placed in close proximity to the existing group home.

If you would like further information prior please let me know

Thanks

Larry

[Quoted text hidden]

Kipp Sakundiak <ksakundiak@gmail.com>

Tue, Nov 28, 2017 at 3:31 PM

To: Larry Grozell <grozell55@gmail.com>

Hi Larry,

That is ok. I have been called worse.

Ok let's tentatively book from 1:30-2:00 in the log cabin right beside South Corman Park School.

Please send me a Google Map image highlighting the quarter you are referencing. Appears to me your land description is missing a number

I will confirm with you once I know for sure that I have the venue.

Please plan to have any material printed out for the attendees prior to the meeting (approx 20 people)

Thank you.

Kipp

[Quoted text hidden]

Larry Grozell <grozell55@gmail.com>

Tue, Nov 28, 2017 at 4:12 PM

To: Kipp Sakundiak <ksakundiak@gmail.com>

Sorry 28 35 5 w3 across from Eldorado lane west side of Clarence immediately south of Spca

lg

[Quoted text hidden]

Kipp Sakundiak <ksakundiak@gmail.com>

Wed, Nov 29, 2017 at 3:51 PM

To: Larry Grozell <grozell55@gmail.com>

Larry,

New Meeting time and date.

Location: Kipp & Amanda Sakundiak's (4890 Praire Lane)

Date: When: Monday Dec 4, 2017

Appendix K: Walter Lane Discretionary Use Approval



Development Permit – Notice of Decision

Issue Date: April 2, 2012
Expiry Date: December 31, 2012

Property Information:

Quarter: NE **Section:** 28 **Township:** 35 **Range:** 5 **Meridian:** 3 **Block:** **LSD**

Details of Development:

Proposed Development: Community Care Facility – Residential Group Home

Development Category: Discretionary Use

Applicant: Larry Grozell

Mailing Address: 51 Wood Meadows Lane
Corman Park SK
S7T 1C7

Comments:

The applicant applied for and received Council's approval to develop the above noted lands as a Residential Group Home for persons suffering from autism and Down syndrome. The applicant intends to renovate an existing residence on the property to establish 18 leasehold bachelor style suites along with public kitchen/dining, storage, and laundry areas. The residence will have at least one full time staff member providing 24 hour assistance.

Decision:

Approved

Conditions of Decision:

1. The authorized capacity of the Residential Group Home shall not exceed 18 leasehold bachelor style suites.
2. This **temporary Development Permit** will expire on December 31, 2012; the applicant is required to provide the Municipality with proof of licensing pursuant to *The Personal Care Homes Act and Regulations*. Upon provision of this evidence of approval, the Development Officer will authorize the issuance of a permanent Development Permit.
3. The applicant will be responsible for providing the Municipality with a copy of an annual licence from the Ministry of Health.
4. The applicant shall be responsible for notifying the Municipality in the event that the license has been cancelled or suspended for any reason.
5. This Development Permit does not authorize any renovations or additions; a separate Building Permit will be required prior to proceeding with any improvements on the property.
6. Signage on the property shall be prohibited and the building renovations shall be designed to complement the surrounding residential developments.

Development Officer:

Appendix L: School District Correspondence

Maggie Schwab

From: Brenda Erickson <brenda.erickson@spiritsd.ca>
Sent: Thursday, May 23, 2019 1:51 PM
To: Maggie Schwab
Cc: Clint Reddekopp; Kerry Donst
Subject: RE: Proposed Ravenswood Residential Development

Good afternoon, Maggie:

Prairie Spirit schools have the capacity for any future students that could come from this development.

Please let me know if you have any questions about this.

Thank you,

Brenda Erickson
Communication Manager, Prairie Spirit School Division

From: Maggie Schwab <mschwab@crosbyhanna.ca>
Sent: May 22, 2019 9:18 AM
To: Brenda Erickson <brenda.erickson@spiritsd.ca>
Subject: Proposed Ravenswood Residential Development

Good Morning Brenda,

I am writing to inform you of a proposed multiple parcel country residential development in the RM of Corman Park. I have attached the concept plan for this development to my email.

As per our usual request, we are requesting that you confirm that any school-aged students residing at this development could be accommodated at the South Corman Park School and Clavet School.

If you have any questions, please feel free to email or call me directly.

Kindest regards,

Maggie Schwab RPP, MCIP

CROSBY HANNA & ASSOCIATES

407C 1st Ave N

Saskatoon, SK S7K 1X5

t : 306.665.3441

f : 306.652.9613

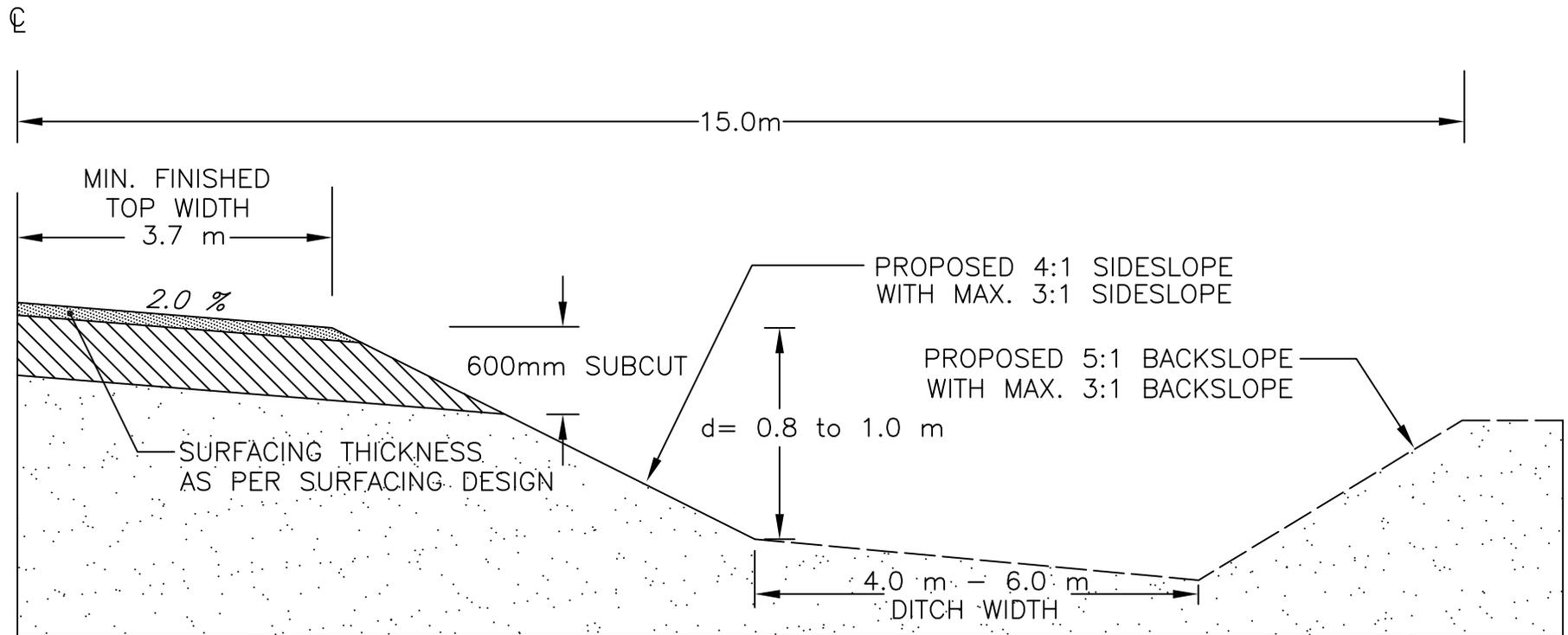
e : mschwab@crosbyhanna.ca

www.crosbyhanna.ca

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Appendix M: Corman Park Road Standards

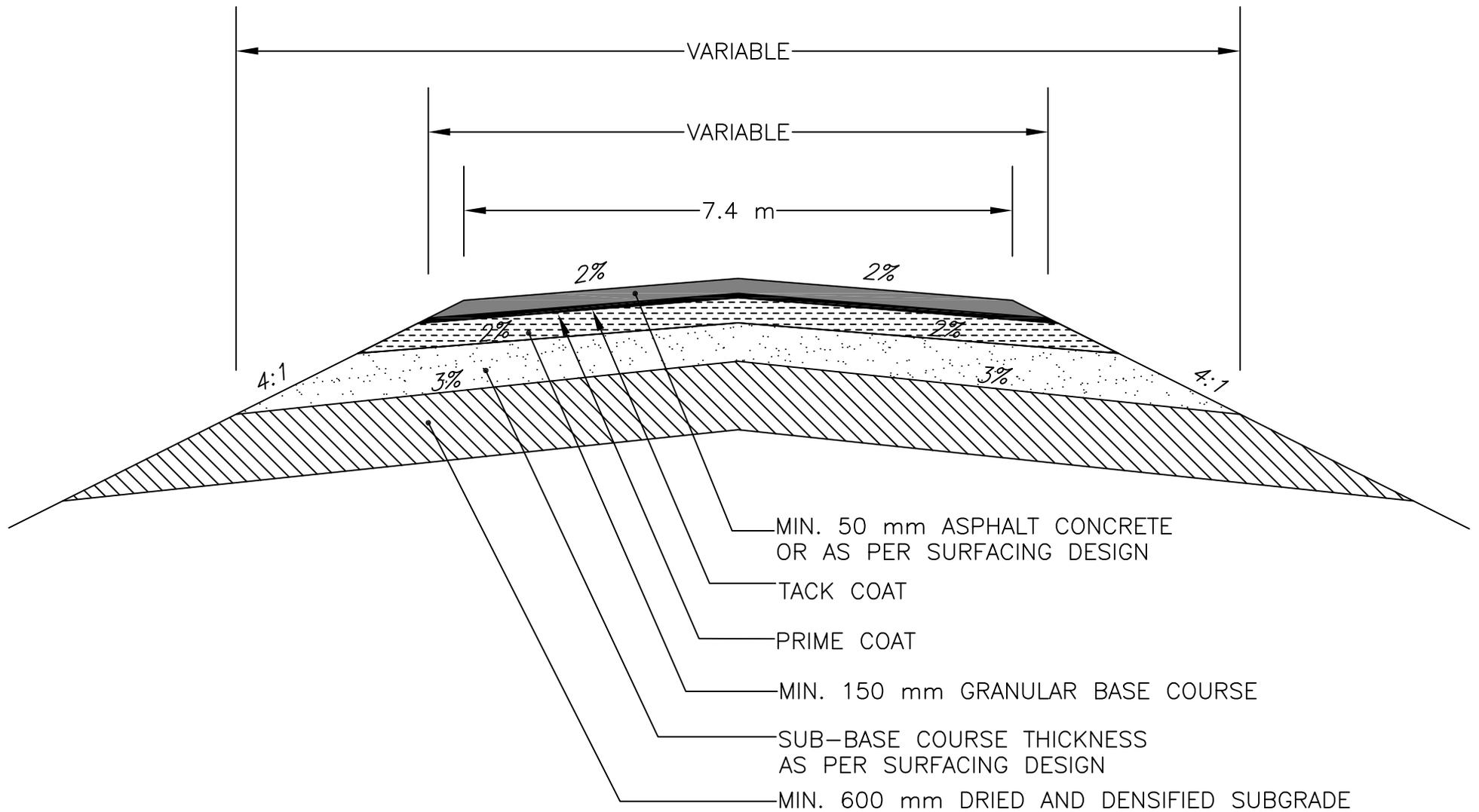


PUBLIC WORKS
 COUNTRY RESIDENTIAL - TYPICAL CROSS SECTION
 SUBGRADE

DATE: 2017

SCALE: NTS

DRAWN BY: WOOD E&I



PUBLIC WORKS
COUNTRY RESIDENTIAL - TYP. SURFACING
ASPHALT CONCRETE

DATE: 2017

SCALE: NTS

DRAWN BY: WOOD E&I

1. Description

- Road design and construction standards for paved (asphalt concrete) subdivisions and special roads as designed within the Rural Municipality of Corman Park, No. 344 (Municipality).

2. Miscellaneous

- For the purposes of this document, the term “proponent” shall be used to address duties that shall be undertaken by the owner, developer, contractor and engineer interchangeable.
- During construction, the proponent shall be responsible for all traffic accommodation measures. This shall include but not limited to:
 - Proper signing of all access roads whereby traffic (construction or local) may access existing Municipality roads.
 - Traffic gravel shall be applied, if or as necessary for local traffic.
 - Proper measures shall be taken to ensure that local traffic can safely interact with construction equipment.
- The proponent shall ensure that all necessary Haul Road Agreements are in place including any provisions for dust control prior to the hauling of materials.
- Dust control to be applied on any approved detour routes.

3. Required Right-Of-Way Standards

- Minimum allowable Right-of-Way (ROW) purchased shall be 30.0 meters (m).
- The proponent shall be responsible for the purchase of all ROW.
- The minimum allowable ROW for cul-de-sacs and turnabouts purchased shall be 60.0 m with a minimum of 15.0 m radius for the driving surface.
- The road shall be designed and constructed in the center of the Right-Of-Way unless with special permission of the Municipality.

4. Road Widths and Geometric Standards

4.1. Finished Road Width and Height

- The finished asphalt driving surface (paved width before the start of the asphalt slope) shall be as follows:
 - For fill heights of 3.0 m or less (where the road surface is from 0.0 m to 3.0 m in height), a 7.4 m finished road top width (asphalt) shall be required.
 - For fill heights greater than 3.0 m (where the road surface is from 3.1 metres in height or more), a 8.0 m finished road top width (asphalt) shall be required.
- The road cross-fall (slope) shall be constructed to 2.0% with any curves must be constructed with the proper super-elevation.

- The average shoulder elevation of the road surface should be approximately 0.8 m to 1.0 m above the adjacent ground except in cut areas.
- The subgrade surface shall not be less than 1.5 m above high water level on the ground water table. (ie: level to which free water would rise in a hole sunk in the ground).

4.2. Surfacing and Hydraulic Design

- A grading, surfacing and hydraulic design shall be completed, signed and stamped by a Professional Engineer registered with the Association Of Professional Engineers and Geoscientists of Saskatchewan (APEGS) and licensed to practice (Permission to Consult in this field of expertise) within the Province of Saskatchewan.
- The surfacing structure shall be based upon the Saskatchewan Ministry of Highways and Infrastructure's Shell Curve method and shall be based on a 15 year design life (N_{15}).
- Soils testing shall be in accordance with the Saskatchewan Ministry of Highways and Infrastructure's Standard Test Procedures manual.
- Hydraulic structures (culverts) with significant flows shall be designed (sized) in accordance with the Saskatchewan Ministry of Highways and Infrastructures Hydraulic Manual and shall be based on a Q^{25} flow (1 in 25 year (1:25)) frequency.
 - The Municipality may request that the design be based on a Q^{50} flow (1 in 50 year (1:50)) frequency based on the location (proximity) of any residences upstream of the crossing.
 - The proponent shall apply for, and shall meet all of the listed requirements, an Aquatic Habitat Protection Permit (AHPP) from SaskWatershed Authority for hydraulic passages requiring such.

4.3. Sideslopes

- Sideslopes shall range from 3:1 to 4:1 depending upon situation and with approval from the Municipality.
 - The standard required sideslope shall be 4:1.
 - For road fills ranging from 0.0 to 3.0 m in height, the sideslope shall be 4:1.
 - For road fills ranging in height from 3.0 m to 4.0 m, the toe of slope shall be 12.0 m from shoulder of the road.
 - For road fills greater than 4 m the sideslope shall be 3:1.
 - If upon review by the Municipality, a sideslope of 3:1 may be allowed only with special permission from the Municipality.

4.4. Ditch Bottom Widths

- Ditch bottom widths shall be range from 4.0 to 6.0 m depending upon grade height and backslope requirements.
 - The desirable is 6.0 m for snow storage.

4.5. Backslopes

- Sideslopes shall range from 5:1 to 3:1 depending upon the situation and with approval from the Municipality.
 - The standard required back slope shall be 5:1.
 - A backslope of ranging from a minimum of 3:1 to the standard backslope of 5:1 will be allowed in conjunction with maximizing the ditch bottom width.

4.6. Maximum Road Gradient

- The maximum road gradient allowed shall be 5.0%.
- With special approval by the Municipality, a 6.0% gradient may be allowed.

4.7. Stopping Sight and Intersection Distances

- The stopping sight distance for intersections with any road shall be a minimum of 140 m. This is based upon the SARM guidelines for an 80 km/h road design.
 - For urban (low speed internal roads), reduced stopping sight distances will be utilized and approved based on design and operating speeds.
- The minimum length of road (constructed past an approach) shall be 100 m.
 - This is done in order to meet Stopping Sight Distances, snow and ice removal and road maintenance.
- For intersecting roads, the sight triangles shall be clear of any obstructions.
 - The sight triangle shall be a minimum of 85.0 m from the point of intersection on municipal roads and grid intersections and to a maximum of 140.0 m on primary grid roads using 80 km/h design speed.
 - For urban (low speed internal roads), the sight triangles will be utilized and approved based on design, operating speeds and applicable signing.

4.8. Existing Roads

- Consideration may be given within existing multi-parcel subdivisions for reduced finished road widths to a maximum of 7.4 m.

5. Snow Clearance Standards

- When shoulder grade elevation is 0.3 m or less above natural surface at 15.0 m to 20.0 m from center line then the backslope must be flattened using a variable slope of 5:1 to a maximum of 3:1.

6. Road Construction

6.1. Clearing and Grubbing

- Timber, brush, duff (vegetation), roots, logs and stumps shall be completely cleared from the surface of the Right-of-Way.
- Debris from clearing and grubbing operations shall not be used in the construction of embankments (any portion of the road structure).

- Debris from clearing and grubbing operations shall not be buried within the Right-Of-Way.

6.2. Removal and Replacement of Topsoil

- All topsoil within the Construction Footprint shall be removed and stockpiled.
 - The Construction Footprint is defined as the area within the cut or fill stakes.
- The Contractor shall install appropriate sediment control to ensure no sedimentation from topsoil stockpiles enters into adjacent water bodies.
- Upon completion of the construction, topsoil shall be replaced to a uniform depth over the Construction Footprint excluding the road surface.
 - The maximum compacted depth of topsoil replaced will be 100 mm.
- Stones (rocks) 75 mm or more in diameter shall be removed and disposed of from the topsoil replaced.

6.3. Drainage (culvert) Installations

- If the foundation is unsuitable, the bottom of the bed shall be sub-cut to a minimum of 0.3 m below the granular backfill layer.
- A geotextile fabric shall be installed to separate the ground surface from the granular materials.
 - A minimum 8 ounce (Geotex 801 or equivalent) nonwoven geotextile shall be used.
- The bedding line shall be shaped to fit the culvert.
- Corrugated metal pipe culverts (CSP) shall be placed with the inside circumferential laps pointing downgrade and with the longitudinal laps at the sides or quarter points. The sections of the culvert shall be firmly joined with coupling bands. Joints shall be as tight as possible.
- Culverts shall be to the following minimum sizes unless larger sizes are required to meet flow requirements:
 - Approach culverts shall be a minimum of 400 mm in diameter.
 - Through grade culverts shall be a minimum of 600 mm in diameter.
- CSP culverts shall have a minimum thickness of 2.0 mm (12 gauge).
- Granular material shall be composed of sand or gravel free from undesirable quantities of soft or flaky particles, loam, and organic or other deleterious material. Granular material shall comply with the following requirements:

Sieve Designation	Percent by Weight Passing Canadian Metric Sieve Series		
	TYPE		
	115	116	10
50 mm	100	-	100
9.0 mm	-	100	-
900 µm	-	30 - 100	-
400 µm	-	15 - 75	-
160 µm	-	0 - 10	-
71 µm	0 - 15	-	0 - 20
Plasticity Index	0 - 6	0 - 6	0 - 6

- For backfilling all types of culverts and bridge abutments, Type 115 shall be used.
- For backfilling subsurface drain pipes, Type 116 shall be used as a filter Material.
- For backfilling curbs, curbs and gutters, sidewalks, driveways, storm sewers, and manholes, catch basins, and other ancillary structures, Type 10 shall be used.
- Earth backfill under the haunches of culverts, except those in approaches not to be paved shall be compacted with mechanical impact tampers.
- After the earth backfill and granular backfill has been placed and compacted around the culvert, the remainder of the embankment shall be constructed by drying the earth material to at least the optimum moisture content and compacted to an average of not less than one-hundred (100) percent of the maximum density as determined by a Saskatchewan Ministry of Highways and Infrastructure Standard Proctor test.
- The earth material above the bedding line shall be placed, simultaneously and uniformly, in lifts on each side of the culvert. In subcut sections, the lift shall extend to the limits of the sub-cut; otherwise the lifts shall extend not less than 15 m from each side of the culvert.
- No objectionable material shall be used within that portion of the embankment above or below the bedding line on culverts through the roadbed.
- The embankment, within three diameters or three span; of the culvert barrel, shall be free from rocks having a dimension of 80 mm or greater when measured in any direction.
- Random riprap shall be installed at all culvert locations where the culvert diameter is greater than 800 mm.
 - A nonwoven geotextile shall be placed prior to the placement of the riprap material.

6.4. Subgrade Embankments

- Earth embankments shall consist of acceptable earth material and rock material free from objectionable quantities of organic matter, frozen soil, stumps, trees, moss, and other unsuitable materials.
- The embankment shall be constructed by placing the material in successive layers.
- The depth of each layer shall not be more than fifteen (15) centimetres (cm) uncompacted. The full width of each segment of each layer shall be bladed with a motor grader at least twice prior to being compacted.
- The slopes and surface of the embankment shall be shaped and trimmed to a uniform smooth surface conforming to the cross-sections shown on the plans, or as staked.
- Stones having a dimension of eight (8) cm or more when measured in any direction shall be removed from the top fifteen (15) cm of the subgrade.
- The following requirements will apply for all embankments:
 - When unsuitable material is encountered below the natural ground surface in embankment areas, the material shall be excavated and removed.
 - The embankment layer (other than at culverts including the sub-cut backfill layer) from 750 mm to 600 mm below the top of the subgrade shall be dried to within 3% of the optimum moisture content.

- Each layer of the top 600 mm of the subgrade shall be dried to at least the optimum moisture content and compacted to an average of not less than one-hundred (100) percent of the maximum density as determined by the Saskatchewan Ministry of Highways and Infrastructure Standard Proctor test. The moisture and densities will be considered satisfactory when:
 - All individual moisture test results are equal to or less than the optimum moisture content.
 - Density test results average not less than one hundred (100) percent of the maximum density.
 - All individual density tests are greater than ninety-eight (98) percent of the maximum density.
- If the moisture existing in the soil is insufficient for compacting to the specified density and for finishing, the proponent may elect to add water.
- The foregoing requirements will also apply to backfill of subcuts and the embankment required to prepare the beds and backfill drainage structures.
- Approaches to be constructed as per Municipalities Approach Construction policy.

6.5. Traffic Gravel

- Traffic gravel shall comply with Type 106.

Sieve Designation	Percent by Weight Passing Canadian Metric Sieve Series
	TYPE
	106
40.0 mm	-
31.5 mm	-
22.4 mm	100
18.0 mm	63 – 92
5.0 mm	0 – 50
2.0 mm	0 – 35
400 µm	
Fractured Faces	40% Minimum

- A tolerance of 3% in the percent by weight passing the maximum size sieve shall be permitted.

6.6. Traffic Gravel Behind Construction

- Type 106 Traffic Gravel shall be placed and spread on a newly constructed subgrade surface.
- Traffic gravel Type 106 shall not be deposited until the subgrade surface has been compacted (to the required density) and trimmed.
- Traffic gravel shall be dumped and spread uniformly on the subgrade surface as required.
- Traffic gravel shall be applied to the finished surface of all approaches.

6.7. Sub-Base Course

- Sub-base aggregate shall be composed of sound, hard, and durable particles of sand, gravel and rock free from injurious quantities of soft or flaky particles, shale, loam, clay balls and organic or other deleterious material.
- Sub-base course shall comply with the requirements listed in following table:

Sieve Designation	Percent by Weight Passing Canadian Metric Sieve Series
50 mm	100
2.0 mm	0 – 80.0
400 µm	0 – 45.0
160 µm	0 – 20.0
71 µm	0 – 8.0
Plasticity Index	0 – 6

A tolerance of 3% in the percent by weight passing the maximum size sieve shall be permitted providing 100% of the oversize passes the 63.0 mm sieve.

- The thickness of any one compacted lift of sub-base course shall not exceed 120 mm.
- Sub-base courses shall be compacted until no further settlement is apparent and the particles are well keyed into place.
- The finished surface of the sub-base course shall be true to grade and cross section and free of any surface defects, rutting or deformations the placement of the next course.

6.8. Granular Base Course

- Base aggregate shall be composed of sound, hard and durable particles of sand, gravel and rock free from injurious quantities of elongated, soft or flaky particles, shale, loam, clay balls and organic or other deleterious material.
- Base Course Mix (Type 33) shall comply with the requirements listed in following table:

Sieve Designation	Percent by Weight Passing Canadian Metric Sieve Series
18.0 mm	100
12.5 mm	75.0 – 100.0
5.0 mm	50.0 – 75.0
2.0 mm	32.0 – 52.0
900 µm	20.0 – 35.0
400 µm	15.0 – 25.0
160 µm	8.0 – 15.0
71 µm	6.0 – 11.0
Plasticity Index	0 – 6
Fractured Faces (%)	50.0% Minimum
Lightweight Pieces	5.0% Maximum

- A tolerance of 3% in the percent by weight passing the maximum size sieve shall be permitted providing 100% of the oversize passes the 22.4 mm sieve.
- Granular Base Mix shall be spread on dry and unfrozen surfaces and shall not be compacted if the atmospheric temperature is less than 2° Celsius.
- The finished surface of the Granular Base Course shall be true to grade and cross section and free of any surface defects.
- The Granular Base Course shall be considered satisfactory when:
 - It contains no surface defects.
 - The average density meets or exceeds 100% of maximum density.
 - All individual test results are greater than 98% of maximum density.
 - The moisture content is less than or equal to the optimum moisture content.
- A prime coat shall be placed on the finished final lift of Granular Base Course
 - Prime coat shall be placed within 24 hours, weather permitting.

6.9. Asphalt Prime and Tack Coat

- The proponent may elect to use MC-30, an emulsified asphalt primer, road-mixed SS-1, road-mixed SS-1H for the prime coat.
 - If using SS-1 or SS-1H, the SS-1 must be incorporated into the top 25 mm to 50 mm of the Granular Base Course.
- SS-1 or SS-1H emulsified asphalt shall be used as a tack coat.
- The tack coat shall be applied in accordance with the application rates outlined in the following table:

Surface Type	Application Rate (L/m ²)		
	Residual	Undiluted	Diluted (one part water to one part emulsified asphalt)
New Asphalt Concrete	0.14 – 0.18	0.23 – 0.32	0.45 – 0.60

- Potable water shall be used to dilute the emulsified asphalt.
- The tack coat shall be applied in a single application and uniformly across the prepared surface.
- Asphalt for prime coat and tack coat shall not be applied to a prepared surface when:
 - The surface temperature is less than 2° C.
 - The weather is misty, rainy, or if rain is impending.
- Traffic will not be permitted to travel on prime coat until 6 hours after application. After 6 hours, excess asphalt remaining on the surface shall be blotted by sand before traffic is permitted to travel on the surface.

6.10. Asphalt Concrete

- Virgin aggregate used for Asphalt Concrete shall be composed of sound, hard and durable particles of sand, gravel and rock, free from injurious quantities of elongated, soft or flaky particles, shale, clay, loam, ironstone, coal and organic or other deleterious materials.

- Type 150 – 200A asphalt shall be used as bituminous binder.
 - This material shall meet the requirements of Saskatchewan Ministry of Highways and Infrastructure’s Specifications for Manufactured Materials (SMM) For Asphalt Cements.
- Hydrated-lime or liquid anti-strip shall be used as an anti-stripping agent.
 - The stripping potential shall not exceed 5% as determined by SMHI Standard Test Procedure (STP 204-15).
 - Liquid anti-stripping agent shall be added at a rate of approximately 1.0% of the weight of liquid asphalt added.
 - The amount of hydrated lime added shall be approximately 1% of the total dry aggregate by weight.
 - The Contractor shall ensure the procedures and equipment used for the addition of hydrated lime anti-stripping agent are adequate to ensure that the hydrated lime is added at a uniform consistent rate.
- Only the following Mix Design Type will be permitted:

Sieve Designation	Percent By Weight Passing Canadian Metric Sieve Series
12.5 mm	100
9.0 mm	76-89
5.0 mm	50-60
2.0 mm	30-48
900 um	19-38
400 um	10-26
160 um	3-10
71 um	2-5
Fracture Minimum %	70 (1 face)
Sand Equivalent Minimum %	45
Los Angeles Abrasion (% loss)	35 (max)
Organic Content (% passing 5 mm)	1.0
Marshal Blows	50
Marshal Stability (kN) at 60°C min	8
Retained Stability (min %)	75
Marshal Flow Index (mm)	2-4
Air Voids in Mixture	3-5
Voids Filled With Asphalt %	70-80
Min Film Thickness	8.0

- A tack coat shall be applied and allowed to fully cure prior to the placement of the asphalt mix (paving operations).
- Asphalt concrete shall be spread on dry, clean, and unfrozen surfaces.
- Asphalt concrete shall be placed in accordance with the following temperature limitations:

- Paving may begin, for other than the final lift, when the temperature is 0° C provided the temperature is forecast, by Environment Canada, for the closest location to the project, to reach at least 5° C that day.
- The final lift of asphalt concrete shall not be placed if:
 - The atmospheric temperature is less than 5° C;
 - The surface temperature is less than 7° C.
- The asphalt concrete mat shall be constructed to a field density range of 97% to 98% of the Marshall Density based on readings from a correlated Nuclear Densometer gauge.
 - The proponent will develop a correlation between the results of the nuclear gauge and the results of the asphalt concrete cores obtained from the compacted lift of asphalt concrete. The density results obtained from the cores will be used to correct the Field Density results obtained from the nuclear gauge.
- The asphalt mat shall be constructed so that:
 - There are no pavement depressions.
 - Longitudinal construction joints from one lift to the next shall be separated by at least 100 mm.
- The minimum and maximum thickness of a compacted lift of asphalt concrete shall meet the following requirements:
 - Minimum asphalt mat thickness shall be 30 mm.
 - Maximum asphalt mat thickness shall be 50 mm.
- The asphalt mix temperature in the paver shall not be less than 110° C.
- Contact faces of curbs, gutters, manholes, and sidewalks shall be coated with asphalt using a hand applicator before placing the asphalt mix.
- When paving is discontinued on the roadway, the asphalt concrete shall be temporarily feathered to a slope of 10 horizontal to 1 vertical. When paving is resumed, the transverse joint shall be straight and have a vertical face when the taper is removed.
- Asphalt mix shall not be placed or allowed to fall on previously laid top lift asphalt concrete or the existing asphalt concrete.
- Transverse construction joints from one lift to the next shall be separated by at least 2.0 m.
- The proponent shall construct the asphalt mat so that there are no areas of:
 - Segregation.
 - Surface defects which may consist of:
 - Roller marks.
 - Open texture.
 - Improper matching of longitudinal and/or transverse joints.
 - Cracking or tearing.
 - Contamination by diesel, hydraulic fluids, detergent or other harmful products.
 - Foreign objects or materials that are detrimental to the asphalt concrete.
 - Clay balls or oversized materials.
 - Any repairs required shall be to the satisfaction and approval by the Municipality.

6.11. Seeding

- Prior to seeding, the area to be seeded shall be true to grade and cross section and free from irregularities.
- The proponent shall harrow the seeded areas immediately after the seeding is completed.
- The seed material shall contain the following blend of seeds:

Seed Mix Common Name	% of Mix
Sheep's Fescue	15
Canada Blue Grass	15
Blue Fescue	15
Hard Fescue	15
Chewings Fescue	15
Creeping Red Fescue	15
Perennial Rye Grass	10

- The seed application rate shall be 14 kg per hectare (31 lbs per acre).
- The Municipality may approve other grass seed mixtures having similar grass seeds or slight changes in mixture percentages.

7. Design and Construction Certification

- The Municipality reserves the right to request any and/or all test result(s) or other associated documentation at any stage of the project.
- Upon completion of the project and prior to the start of the warranty period, the proponent's Engineer and/or engineering firm shall complete and submit a signed and sealed Statutory Declaration stating that all design and construction criteria/specifications in accordance with the parameters aforementioned have been met.
 - The Engineer of Record shall be a Professional Engineer registered with the Association Of Professional Engineers and Geoscientists of Saskatchewan (APEGS) and licensed to practice (Permission to Consult) within the Province of Saskatchewan.
 - The Engineer(s) of Record shall have reviewed and/or been involved with the design and/or construction of the project and shall have firsthand knowledge of the work completed.

Appendix B: Traffic Impact Assessment

Appendix C: Hydrogeological Report and Correspondence

Appendix D: Potable Water Information

Appendix E: Storm Water Management Plan

Appendix F: Loraas Disposal Services Correspondence

Appendix G: Heritage and Environmental Screening

Appendix H: Geotechnical Report

Appendix I: Corman Park Correspondence

Appendix J: Public Consultation

Appendix K: Walter Lane Discretionary Use Approval

Appendix L: School District Correspondence

Appendix M: Corman Park Road Standards