COMPREHENSIVE DEVELOPMENT REVIEW

GRASSWOOD ESTATES

Prepared for:

THE RURAL MUNICIPALITY OF CORMAN PARK NO. 344

Prepared By:

K & K Land Management and Urban Elements Development Corp.

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EXECUTIVE SUMMARY

Urban Elements Development Corp. (the Developer) is applying to rezone the W ½ 26-35-5 W3M to Country Residential 1 District (CR1) for the purpose of developing an 80 lot country residential development. The proposed development is known as Grasswood Estates residential subdivision and is situated on lands located within the R.M. of Corman Park. The proposed development is located approximately 2 miles south of the City of Saskatoon, immediately east of the Organized Hamlet of Casa Rio and north of Casa Rio East. The proposed development is located on land that is primarily being used for pastureland. The Developer will strive to integrate design elements of a recreational lifestyle with the aesthetic of open spaces as well as the privacy of acreage living. The development will feature linear parks with a 2.4 m wide pathway, created between the interior lots, and will act as an interlinking causeway for people to walk, jog, and bike in a relaxed country atmosphere. These pathways will lead to one of two large pond areas. The linear parks and associated pathways are designed and are intended to enable children to travel to school without walking or biking on the major roadways, as well as to be used by the broader community. The internal ponds will be the focal points of the development for recreation uses, as well as for the enjoyment of nature all year round. Country residential development is the proposed land use. The Developer has determined a series of architectural controls and conditions for site development, homes and accessory buildings that will be required conditions of lot sales.

A total of 80 lots are planned for the residential development. The Developer is proposing to proceed with development in two phases. Phase I will include the construction of the residential lots on the perimeter (42 in total) in addition to the construction of associated roadways and the water retention pond. Phase II will see the construction of the remaining residential lots (38). The development will affect a total of approximately 109.58 ha (270.8 ac) of land. The developer is requesting that Council rezone the entire development to CR1 with Phase II being designated with a holding provision.

The Developer is proposing to undertake a number of special initiatives with the development of the Grasswood Estates subdivision. The primary objective of the Grasswood Estates subdivision is to create a unique, highly desirable, environmentally sound, multi-parcel residential development that complements and contributes to the existing community. The development has been designed for people who like space and who enjoy outdoor recreational activities. In addition to the linear parks and associated pedestrian trails that are proposed between the interior lots, two large ponds in the east and central portions of the property will be designed and engineered to be the focal point of the development for recreational activities. Two gazebos will be constructed to overlook each of the ponds, and a simulated creek bed with a small water stream will provide for bird watchers and nature lovers to enjoy the scenery. Lastly, a small cottage, will also act as a warming hut for winter activities such as snowshoeing, ice skating, and cross-country skiing. A small pump will be contained within the cottage to circulate water in the pond during the summer months for aesthetic purposes only (i.e. to prevent algae growth). The gazebos and cottage will be owned and maintained by the Grasswood Estates Community Association. The gazebos and cottage will be designed to be portable, and thus be able to be moved, should water levels fluctuate over the long term (both up and down).

The Developer has contacted various public utility companies with regard to the placement of shallow utilities to the site including power, natural gas, and telephone. Communication with these utility providers has indicated that there are no problems anticipated in accommodating the development. Shallow utilities will be provided by SaskPower, SaskEnergy and SaskTel along with underground cable following the construction of deep utilities.

The Dundurn Rural Water Utility (DRWU) has confirmed their ability to provide potable water to the proposed development. There are two existing water pipelines that run along the west side of the development within the Preston Avenue right-of-way, in addition to a line running along the south side of the proposed development, within the Baker Road right-of-way. The DRWU will be responsible for all billing and administration of the water lines in this subdivision. The DRWU has a stated policy that all new developments that will be eligible for participation in the Building Canada Infrastructure grant must have completed roads and the legal survey by July 31, 2012. This policy is in place in order to enable the DRWU to install the city water infrastructure in the fall of 2012 as the government program and all funding must be completed by March 31, 2013. Since Grasswood Estates is an applicant and is approved to obtain city water under the DRWU's project, this policy applies to Grasswood Estates. The DRWU has given permission to extend the July 31 deadline, as long as the project is approved in time for installation in the fall of 2012. SAL Engineering Ltd., DRWU's engineers are presently designing and making arrangements for installations in late September, early October but time is of the essence. If the project does not proceed, it will have negative implications to DRWU and the entire project.

Geotechnical investigations were conducted by Clifton Associates. The investigations were made to evaluate slope stability, determine wastewater disposal characteristics, and to provide preliminary foundation and construction recommendations based on a geotechnical investigation. Subsurface geology was investigated by a total of 19 test borings on the site. Additionally, piezometers were installed and water levels were measured in February, 2008 and June, 2012. In 2012, groundwater levels were measured between 1.1 m to 5.8 m below existing ground surface. It was recommended that at a minimum, basement walls and floors be damp-proofed. Additionally, it was recommended that a perimeter subdrainage system be installed at the base of the footing for each home, although this requirement can be reviewed depending on the specific conditions at each site. In terms of footings, it was recommended that the proposed structures be supported on shallow spread footings or augered cast-in-place concrete piles. Assuming basements or crawlspaces are insulated, the footing must be constructed below the anticipated depth of frost, estimated at approximately 1.8 m in the area. Recommendations are further made with regard to soil conditions, grading, and floors. In terms of potential for the sulphate content of the soil, it was considered to be moderate to severe for concrete in contact with clay. It was recommended that sulphate resistant cement be specified for all concrete in contact with clay soil. Prior to building development and as a condition of sale, the Developer will be requiring all lot owners to undertake a lot-specific geotechnical investigation (by a qualified professional geotechnical engineer) to determine soil conditions and whether basement development could occur on the site. A further condition of sale will be that a copy of each of these reports be provided to the R.M. with a development permit application.

In terms of wastewater management, the Developer have decided to make a three-cell septic systems mandatory for all lots within the subdivision. A Hydrogeological study, completed in July 2012, has confirmed that for nitrogen impacts, there does not appear to be a concern for cumulative impacts due to the subdivision development. This mandatory condition will be included with the Building Restrictions and registered against each title. The mandatory condition will state that a "Fast, three-cell waste water treatment or equivalent system must be used for waste water disposal systems". This condition will provide for the long term safety of the ground water for the proposed residences, as well as neighbouring residents, as these systems exceed health and environmental regulations, and also fit into the proposed layout and existing topography of the proposed Grasswood Estates subdivision. The hydrogeological report was provided to Public Health for their review (see Appendix R). Based on the draft report, Mr. Brent Latimer, Safe Communities, Saskatoon Public Health indicated that their office would consider the package treatment plants as an acceptable means of sewage disposal. A formal reply from public health is expected in late July or early August, 2012. The Developer has also committed to conducting an ongoing environmental monitoring program. This program will include the installation of strategic monitoring piezometers at two of the lots on the property in addition to annual water sampling, analysis and public reporting to the R.M. of Corman Park. Ongoing annual system inspections will also be implemented at residential each site. The administration of this monitoring system will be provided through the septic utility created as a part of this development.

The runoff impacts of the proposed development in the W1/2-26-35-5 W3M was reviewed by Water Resource Consultants Ltd. and a follow-up Conceptual Stormwater Management Plan (SWMP) was undertaken by Clifton Associates. The intent of the proposed stormwater management system is to design facilities that can negate the impact, or at least reduce the impact, to that which would have occurred naturally regardless of site development. The conceptual SWMP proposes the use of an evaporative stormwater pond system to collect stormwater. Consideration was made for effective drainage to the ponds based on the layout proposed and appropriate sizing to ensure evaporative functionality is adequate.

The SWMP indicates that the site has no natural drainage and water tends to collect in local low lying areas, including the existing pond on the east central border of the site, in which local drainage occurs. The preliminary drainage report prepared by WRC Consultants indicated that the one pond in the northeast corner of the proposed residential development was sufficient to collect drainage water. However, when preliminary drainage and grading was initiated, it was clear that the entire development would require a significant amount of grading to achieve drainage to the naturally existing pond. Therefore, a second pond was considered. Clifton Associates calculated predevelopment conditions and developed conditions and associated change to inflow and outflow. Based on the calculated information, including total impervious surface area, maximum flood levels from the preceding 51 years of available data, the pond design was completed. In order to recognize the 1 in 100 year design plus 25% used by the R.M. of Corman Park, which also recommends a 25% increase in value, several options for pond design were considered. It was concluded that the existing pond in the northeast corner of the development property and a second pond (totalling 2.6 ha) in the centre of the development property would be sufficient to handle on-site drainage. Both water features will be permanent features, and as such, it will be necessary to deepen the features. The R.M.'s standard flood level (1 in 100 year event plus 25%) is located well within the boundaries of the two large municipal reserve parcels outlined on the plan of proposed subdivision.

This information was submitted to SWA for review, but they were not willing to review the file until it was referred to them by Community Planning Branch.

The pond areas will be designed and engineered to provide year-round opportunities for recreational activities and for the enjoyment of nature. The two pond areas will be enhanced to accommodate multiple species of wildlife. Opportunities will be made available for activities such as walking along the trails located within the linear parks, observing plants and wildlife that thrive in a wetland setting, as well as rafting, canoeing, or rowing on the water. Winter-time activities may include cross-country skiing, skating and snowshoeing. The ponds and linear parks will initially be managed by the proposed Grasswood Estates Community Association, which everyone must join in order to purchase a lot. The Developer is committed to maintaining and looking after the common areas until 75% of the lots in Phase I and Phase II have homes that have been built.

A traffic impact study was completed by Clifton Associates in 2009 and follow up letters were issued in 2012 based on recently published traffic counts for 2010. The study reviewed past and expected traffic scenarios for Highway #11, Baker Road and Preston Avenue. One of the follow up letters dating to January 2012 indicates that the most significant traffic changes seen in the 2010 counts were to Baker Road, just west of

Highway #11. The letter indicates that existing traffic volumes warrant a right hand turn lane from Highway 11 southbound to Baker Road. With an increase in traffic on Baker road forecasted for the next 10 years, the letter also indicates that the future traffic level could increase by approximately 27%. With this level of traffic the warrant for the right turn lane would be somewhat higher than at present. However, due to the low percentage of trucks, it was felt that there would be no need for an acceleration lane for vehicles travelling north from Baker Road to Highway #11. In 2009, the Ministry of Highways and Infrastructure had a tentative plan to construct a right turn lane on Highway #11 to Baker Road in either 2010 or 2011, however, this project has been postponed to the future and timing will depend on overall priorities and funding for this type of project. This information has been submitted to Saskatchewan Highways and Infrastructure. It was indicated that there were no action items generated as a result of the review and the Ministry did not require any additional information.

In terms of internal roadways, one major internal access road and one secondary access road will be constructed and paved with a seal coat to the R.M.'s specifications for subdivision and special roads. It should be noted that the final paved seal coat will not be installed by the developer until 80% of the houses are built on the lots. Primary access to the subdivision will occur from either the westerly Preston Avenue or the southerly Baker Road access roads. Two signs will be erected to denote the location of the proposed development. They will be located at the southern access point at Baker Road and the western access point at Preston Avenue. For safety reasons, the initial plan of proposed subdivision was revised so that the southern access to the proposed development now aligns directly opposite to the access south of Baker Road to the Casa Rio development.

The Developer is working with Saskatoon Fire and Protective Services to ensure that there are no concerns with the proposed development. The R.M. of Corman Park currently funds the Saskatoon Fire Department to provide coverage within the Municipality. The Corman Park Police Service currently works in conjunction with the R.C.M.P. to provide protective services to the area.

In terms of solid waste, Loraas Disposal has indicated that they would be willing to remove the waste at the proposed subdivision development. They require a minimum of 6 containers to begin with and the waste will be removed on a weekly basis.

A desktop environmental screening report was completed in 2009 by Canada North Environmental Services (CanNorth). The objective of the report was to identify any possible issues with the proposed Grasswood Estates subdivision. The report indicates that the project area does not cross any wildlife habitat protection land, nor any crown agricultural land, which precludes the need for a permit. Although eight wildlife species had been previously recorded in the 20 km search radius around the project, only one was ever recorded in the project area. This species is known as the olive-backed pocket mouse, which does not have a recommended setback distance. In terms of vegetation, 37 provincially ranked plant species have been previously recorded within the 20 km search radius for the project. Five of these species found within the project study area have recommended setback distances with accompanying restricted activity dates. The project is not located on any migratory bird sanctuaries and does not contain any known fish bearing waterbodies. The report recommends that construction activities should ensure that nearby wetlands or ephemerally low-lying areas should not be modified or drained. If possible, ephemeral waterbodies should be avoided due to the possible presence of sensitive species. The report recommends that as per the regulatory requirements that an ecologist with the Ministry of Environment be contacted regarding any environmental concerns that they may have with the proposed project. Mr. Steve Hyde (Ecological Protection Specialist) was contacted and this information was submitted to the Ministry of Environment for review. It was determined that a species survey (vegetation and animal) be conducted in order to ensure no species at risk are located within the proposed development boundaries. The Developer has contracted

Canada North Environmental Services to have this survey undertaken in the Spring of 2012 prior to the onset of any construction. It expected that the final results of this survey and recommendations will be available in late summer 2012. Pending approval of the Ministry of Environment, it is possible that heavy construction during certain times of the year may be restricted within a defined distance of the existing wetland.

In terms of heritage resources, a query was submitted to the Heritage Resources Branch at the Ministry of Tourism Parks Culture and Sport. The development was reviewed and it was determined that a Heritage Resource Impact Assessment was not required as there are no previously recorded archaeological sites in conflict with the proposed development. In addition, the area has been disturbed in the past, and was felt to exhibit low potential for intact heritage resources. The review letter was issued on January 26, 2009.

Based on the 2011 average household size for the R.M. of Corman Park (2.9), the total population of the community is projected to reach up to 232 people. Consultations with the Prairie School Division indicated that there is enough room in the South Corman Park School to accommodate future students residing in the subdivision. Classroom space will need to be monitored within Clavet School and additional relocatables will be added as enrollment increases.

Recreation opportunities for residents will be encouraged within 15 m wide linear parks that will feature a 2.4 m wide walking and cycling trail proposed between the interior lots. This linear parks and associated trail systems will act as interlinking causeways that will allow for people to walk, jog or bike in a relaxed, natural environment. The development will also feature two pond areas, of which both will incorporate a gazebo for recreational use. Additionally, a creek bed with a small water stream will be featured at the larger of the two ponds, providing the perfect ambience for bird watchers and nature lovers. A small cottage will serve as a pump house for the water system, and will also function as a warming hut for winter activities such as snowshoeing, cross-country skiing, and skating. Summertime activities such as walking within the linear parks, observing plants and wildlife that thrive in a wetland setting, as well as rafting, canoeing, or rowing on the water will also be possible.

In May, 2008 a public meeting was held at the Corman Park Community Centre to introduce and provide details about the proposed development. This meeting was attended by approximately 50 people. Discussions ranged from the number of lots proposed, waste water management methods including groundwater contamination. Engineers from Clifton Associates were present to explain the details about the project and to information concerning the steps that were taken to ensure that water quality and environmental safety would not be compromised. K&K Land Management, on behalf of Urban Elements, indicated to the group that they were investigating sources for potable (city) water for the proposed development and extended an invitation to others who were interested in joining the effort.

A second public meeting was held on October 9, 2008 at the Corman Park Community Centre. This meeting was attended by approximately 35 people. Again, the proposed Development was described and details were provided to the attendees in terms of future services, waste water treatment, and the draft layout of the proposed subdivision. K&K Land Management, on behalf of Urban Elements, proposed that, with the support of the community, the Developer would donate a minimum of $250,000 towards a school or Community Association facilities based on a build-out of 83 residential lots, rather than building a major community centre on-site. The Community Association has provided a letter of full support of the proposed development.

Two additional public meetings were held on April 9, 2012 and April 16, 2012 at the South Corman Park Community Association Log Cabin at the South Corman Park School. Both public open houses were well attended, with over 50 people attending each meeting including the Developers, council members from the

R.M. of Corman Park, as well as Corman Park planning staff and several R.M. Councillors. Generally, feedback on the proposed development was quite positive and several favourable comments were submitted regarding the detail, forethought, and aesthetic design of the proposed subdivision. A number of positive comments regarding the walking and cycling trails were also received. The concerns expressed by residents included the use as 3051 as a haul route for construction trucks and equipment, light pollution, groundwater contamination due to septic fields, as well as noise and dust associated with new construction. In order to mitigate these concerns, the Developer has chosen package sewage treatment plants a requirement for each lot in the proposed Development. Additionally, an environmental monitoring program will be established on via 13 existing boreholes on site to quantify the extent of migration of septic plume against the engineered expectations. Data from the program will be provided to the Municipality for public record. In terms of lighting, the Developer has agreed to install low light pollution lights in an effort to minimize light pollution to the development and surrounding area. Lastly, one resident indicated that there is an aerodrome located kitty corner (to the southeast) of the proposed subdivision. The aerodrome, known as Grasswood Landing, falls under the jurisdiction of the Ministry of Transportation. A total of 11 private aircraft are currently operating and based out of this facility. It was noted that while the approach and departure pattern do not conflict with the proposed development, the legal established downwind flying pattern for the runway does go over the property at 1,000 feet. The owner wished to make the Developer aware of the aerodrome, and suggested that home buyers be informed of its location and activity. The Developer intends to list the aerodrome on all titles to the properties in order to ensure that all residents are aware of the operation.

An agreement for sale with the landowner of Parcel B, Plan 102002768 has been finalized to facilitate the development of their existing private access to the westerly public road access shown on the plan of proposed subdivision.

It is noted that a number of studies and referrals identify the subdivision as Casa Grande, which was the initial name of the proposed subdivision, prior to being re-designated as Grasswood Estates.

DEVELOPMENT CONTEXT

Grasswood Estates will be a high-quality, outdoor-oriented, recreation-friendly country residential community. For a rural community, it will be in close proximity to amenities, services and commercial development in the broader Saskatoon - Corman Park region. Nearby development includes the Hamlet of Casa Rio to the west, South Point and Ashwood Estates to the east, and the City neighbourhood of Stonebridge to the north. Overall, the Developer and the design team are of the opinion that Grasswood Estates will compliment surrounding development. The Development will incorporate linear parks and two water features that will be the focal points for recreation activities and for the enjoyment of nature year round, by residents and neighbours alike.

1 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide the Rural Municipality of Corman Park No. 344 with a Comprehensive Development Review (CDR) as required in Section 5.2.3 of the R.M. of Corman Park Official Community Plan (the OCP).

This Review provides a framework for a proposed community consisting of 80 residential lots at the W1/2-26-35-5 W3M (see plan of proposed subdivision attached as Appendix A). The name of the proposed community is Grasswood Estates and the Developer of the project is Urban Elements Development Corp (landowner) and K&K Land Management (land developers). The plan for both phases of the development is attached as Appendix A to this document.

Questions on the proposal or the material contained within this document should be directed to Jim Walters, P.P.S., M.C.I.P. (306-665-3441) or Darren Hagen (306-227-0606) or Neil Ketilson (306-229-8976).

1.2 OVERVIEW

It is the intention of the Developer to compliment the open space of the region by carefully integrating housing into the development. The Developer intends to minimize the environmental footprint of the development as well as to provide for a variety of recreational and nature-oriented opportunities for residents.

Designed to be an environmentally friendly community, the Development incorporates planning, engineering and architectural principles with the goal of creating a community unlike any other in the region.

- Development boasts minimal travel distance from the City of Saskatoon, as well as from the highway to the development.

- All homes will be built to minimum Energy Star Qualified Home Ratings.

- The Developer is working with Bill Elliot, President of WSE Technologies to provide an economical and environmental solar energy system as an option for home and water heating. Each homeowner will have the option and subsidized incentive to install a solar energy system.

- As a part of the building restrictions, the Developer will require three-cell septic systems to be installed for all homes.

- An environmental monitoring program will be established via 13 existing boreholes on site to quantify the extent of migration of septic plume against the expected engineered expectations. Data from the program will be provided to the Municipality for public record. The administration of this monitoring system will be provided through the septic utility created as a part of this development.

- The development will be completed in two phases. Phase I will consist of all lots along the perimeter of the proposed development (lots 1 to 42). Phase II will consist of the remaining residential lots (38 in total), in addition to the secondary access roads.

1.3 LAND USE CONTEXT

The proposed development will be situated on lands located within the R.M. of Corman Park in the W1/2-26-35-5 W3M. The site is north of Baker Road and east of Preston Avenue. According to the 2009 CanNorth Environmental Screening report (see Appendix B), the surrounding land uses in the Project area include country residential development, livestock grazing, nature observing, and recreational activities. The proposed development lies within the Saskatoon Wildlife Management Unit, which allows for primitive hunting only. The land is currently used for pastureland.

Present land use of the W1/2-26-35-5 W3M includes pastureland. Additionally, four existing yard sites are present within the proposed development area; one located at the northwest corner of the development and one at the west side of the development, near the division between the NW and SW quarter sections. The third yard site is located near the southwest corner of the proposed development, while the fourth is located in the centre. All existing landowners on the W1/2-26-35-5 W3M have given their consent regarding the proposed subdivision development. Should this occur, it is possible that the existing house will be incorporated into the development. The existing land use of the proposed development is detailed as follows:

The Existing Land Use Context of the Proposed Development is as Follows:

North

- Grasswood Road: 1.6 km north of north boundary
- Residence: On north side of Grasswood Road
- City of Saskatoon Approx. 3.2 km south of south boundary

East

- CNR Railway: Adjacent to east boundary
- Ashwood Estates: East of railway; adjacent to east boundary
- South Point Estates: East of railway; adjacent to east boundary
- Provincial Highway #11: 1.4 km east of east boundary

South

- Casa Rio East: Adjacent to south boundary, across Baker Road
- Hayland, Sloughs, Bushland: Across Baker Road

West

- Organized Hamlet of Casa Rio Approx. 800 m west of west boundary
- Hayland, Sloughs, Bushland: Adjacent to west boundary
- Residences: West of Preston Avenue

Nearby Neighbourhoods Include:

In Saskatoon

- Stonebridge	Approximately 3.2 km north of proposed development
- Lakeview:	Approx. 5.7 km northeast to proposed development
- Adelaide Churchill:	Approximately 5.6 km north to proposed development

Within the CanNorth Environmental Screening Report (see Appendix B), the surface topography of the north part of the Project area is classified as gently to moderately undulating (1 to 6% slopes), while the southern part of the project area is mixed undulating and rolling (again 1 to 6% slopes).

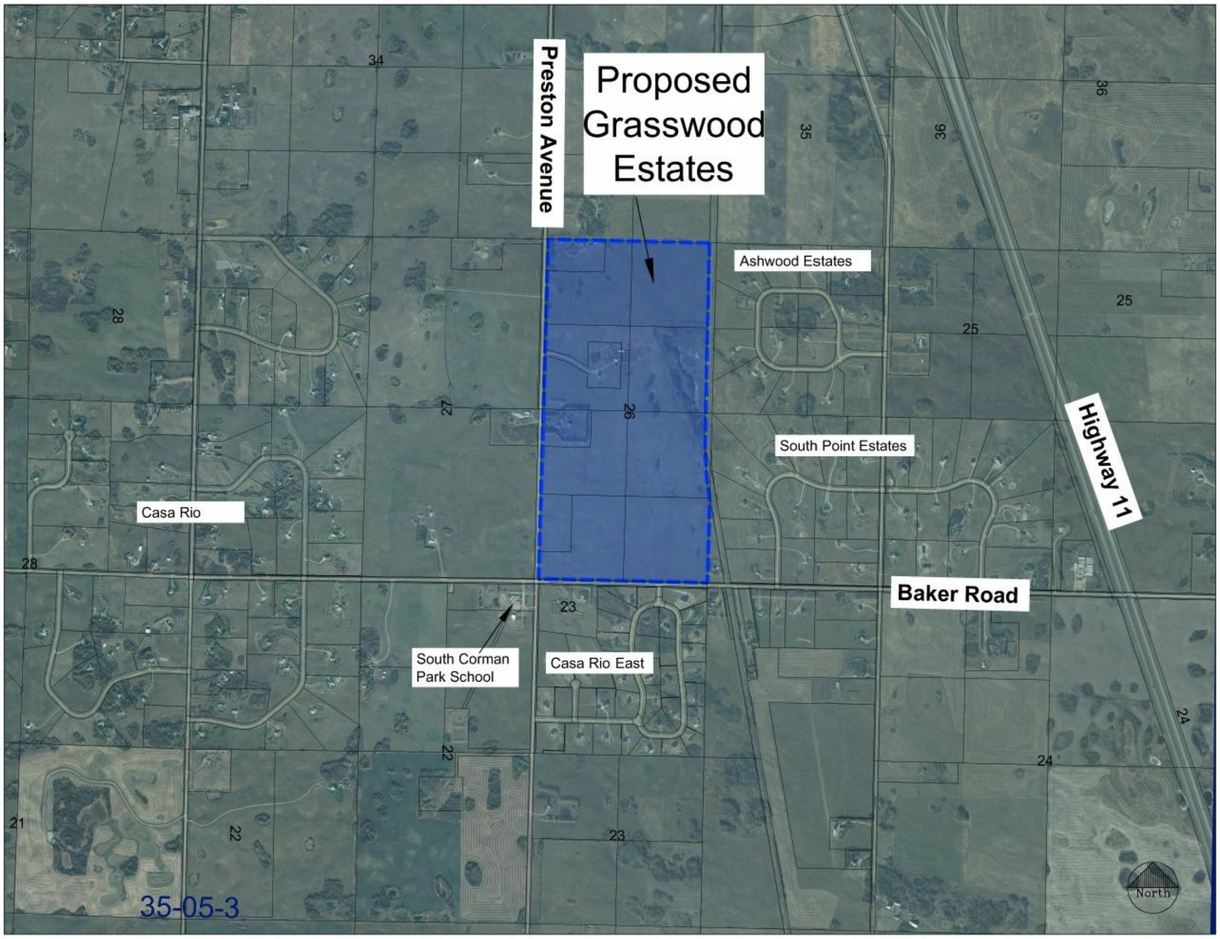
1.4 SURROUNDING LAND USE OPPORTUNITIES AND CONSTRAINTS

A Canadian National railway line currently runs adjacent to the east boundary of the proposed development. This line is classified as a collector and primary feedline, or branch line. According to the Proximity Guidelines and Best Practices prepared by Earth Tech Canada in 2007, it is indicated that building setbacks and berms are mainly intended to provide protective buffers and barriers to reduce the risks to surrounding land owners from a train derailment or other incident. Additionally, setbacks are intended to address land use incompatibilities from residential and other forms of development. For a branch/spur line, the recommended setback distance is 15 m. Berm height setback is recommended at 2.0 m. The developer has indicated they are willing to adhere to a 15 m setback. Additionally, berms will be constructed adjacent to lots 26 to 29, 37 and 39 adjacent to the existing railway line. The marsh area provides an effective buffer between the railway and the remaining lots along the east side of the proposed residential development.

The South Corman Park school is located to the southwest of the proposed development. The school has provided their full support for the proposed residential development (see correspondence attached in Appendix C). The school, located kitty corner (southwest) to the proposed Grasswood Estates subdivision, currently has a total of 24.77 ha of dedicated Municipal Reserve available for use by students as well residents from the surrounding communities.

Other surrounding residential developments in the area include Ashwood Estates, South Point Estates, Casa Rio East and the Organized Hamlet of Casa Rio. It is anticipated that the proposed Grasswood Estates subdivision will compliment the existing residential development in the area, although the lot sizes are larger in Ashwood Estates, South Point Estates as well as the Organized Hamlet of Casa Rio. Lot sizes are similar to those at Casa Rio East.

The map on the following page identifies the location of the proposed Grasswood Estates subdivision, as well as the existing adjacent land uses in the area.



Policy context map denoting location of proposed Grasswood Estates subdivision and adjacent land uses.

1.5 POLICY CONTEXT

Grasswood Estates has been designed to meet the requirements of the Official Community Plan (Bylaw No. 8/94) and Zoning Bylaw for the R.M. of Corman Park.

CORMAN PARK OFFICIAL COMMUNITY PLAN

General Development Policies (Section 5.2)

- 5.2.1 - General Country Residential Policies:
  - 5.2.1.6 - The proposed Development is located on land with "marginal" soil capability, as defined by the Canada Land Inventory (CLI) Soil Class Rating System.
  - 5.2.1.6 - The proposed Development is located along existing municipally maintained roadways.

- 5.2.3 - Multi Parcel Country Residential Subdivision Policies:

  - 5.2.3.1 - The intent of this Comprehensive Development Review is to serve as a part of the application to rezone and subdivide the land for multi-parcel country residential use. This CDR addresses all matters of land use integration, environmental sustainability, public involvement and conflict mitigation, as well as to identify the provision of services to the development, as set out in Zoning Bylaw No. 9/94.

  - 5.2.3.2 - In considering the current demand for and existing inventory of undeveloped multi-parcel country residential lots, it is noted that a large demand (upwards of 10,000 new homes) will be needed in the Saskatoon area within the next three years.

  - 5.2.3.3 - The primary objective of the Grasswood Estates design is to minimize the footprint of the proposed development on the environment above all other considerations. Residents will have the option and incentive to install a solar energy system. It is expected these systems will provide up to 50% of the hot water needs and floor heat energy of a home. Each home that is equipped with the solar heating system will reduce CO2 gas emissions by the equivalent of those produced by 3.9 cars. As a part of building restrictions, the Developer will be requiring a three-cell septic system to be installed for all homes. This system reduces nitrogen entering the septic field and potentially the groundwater by 70% to approximately 15 lbs of nitrogen per year. Lastly, the Developer has chosen to establish a monitoring program via 13 existing boreholes within the proposed development to monitor the septic plume produced by residents and compare those with the expected data. This data will be provided to the R.M. for public record. The administration of this monitoring system will be provided through the septic utility created as a part of this development.

  - 5.2.3.6 - The development will incorporate environmentally sustainable design principles by incorporating environmentally sensitive lands, particularly the existing hydrological feature in the northeast corner of the proposed development.

  - 5.2.3.6 - Surface drainage will be directed to the proposed pond in the northeast corner of the proposed development as well as a second pond that will be constructed near the centre of the development boundaries. These two ponds will remain entirely within the boundaries of the surrounding municipal reserve parcels if a 1 in 100 year plus 25% flood event were to occur. Size designs for the drainage ditches and culverts were completed by Clifton and Associates based on recommended dimensions from the R.M. of Corman Park.

  - 5.2.3.6 - The internal road network will be double loaded throughout the subdivision at full build out.

  - 5.2.3.7 - Phase I of the proposed development will affect a total of approximately 64.8 ha of land. Phase II of the development will affect approximately 44.78 ha of land.

  - 5.2.3.10 - This CDR contains a clear record of substantial public consultation including public review of the development. Two public meetings were held in 2008 with several residents attending. In November, 2009 the Corman Park Community Association provided their full support for the development, as stated in a letter dated November, 1, 2009. A revised letter was submitted to the Developer dated to January 19, 2012 indicating continued support for the proposed development, although it is noted that concern is held by some members regarding groundwater contamination and environmental impact (see Appendix D). Two additional open houses were held on April 9, 2012 and April 16, 2012. Prior to the open houses, two mail-out letters were sent to residents as indicated by the R.M. of Corman Park (also included in Appendix D). These open houses were come and go events intended to provide opportunities for people who may be affected by the proposed development. The Developer and members of the design team were present to answer any questions. A feedback form was also provided to all those who attended the event. Several informational display boards were erected and included general information on the proposed development. Feedback to the development was generally quite positive. The concerns that were expressed included potential contamination of groundwater with the additional septic systems, light pollution created by the proposed residential lots, as well as the use of heavy equipment and associated dust, noise, and debris. One resident was concerned about the use of construction equipment on road 3051 and another was concerned on ability of the DRWU pipeline to support the needs of an additional 80 residences (see feedback forms attached in Appendix D). Other verbal concerns expressed at the open houses included the protection of the farm property to the north from trespassing and stray dogs. Traffic concerns included maintenance issues of Baker Road and Preston Avenue, as well as the location of the proposed entry on the south side of the development. Concern was also expressed regarding potential drainage impacts to the eastern Ashwood and South Point Estates subdivisions. In terms of mitigating these concerns, the Developer has made several modifications to the proposed development. First, the subdivision will feature package sewage treatment plants as a requirement for each lot at the proposed Development. According to the Saskatoon Health Region, package treatment plants are a “more than adequate means of sewage disposal” (see correspondence in Appendix E). Additionally, an environmental monitoring program will be established via 13 existing boreholes on site to quantify the extent of migration of septic plume against the engineered expectations. Data from the program will be provided to the Municipality for public record. The Developer has also agreed to utilize low light pollution fixtures to minimize the impact to surrounding residents and their view of the night sky (see information on low-light pollution fixtures in Appendix F). In terms of water line capacity, the DRWU is prepared to handle the demand of an additional 80 residences, and, in fact, will significantly reduce the cost of the utility to other users. In terms of trespassing and stray dogs to the north of the property, the Developer has indicated they are willing to construct a white vinyl fence along the northern property line, as well as a chain link fence. This fence will serve to keep quads, snowmobiles, pedestrians, and stay dogs from impacting the farm function on the north side. In terms of traffic, the Developer has re-aligned the southern entry point to line up with the access south of Baker Road to Casa Rio East. Concerns regarding excess drainage into adjacent land will be mitigated through how drainage is handled on site. Lastly, one resident indicated that there is an aerodrome located kitty corner (to the southeast) of the proposed subdivision. The aerodrome, known as Grasswood Landing, falls under the jurisdiction of the Ministry of Transportation. A total of 11 private aircraft are currently operating and based out of this facility. It was noted that while the approach and departure pattern do not conflict with the proposed development, the legal established downwind flying pattern for the runway does go over the property at 1,000 feet. The owner wished to make the Developer aware of the aerodrome, and suggested that home buyers be informed of its location and activity. The Developer intends to list the aerodrome on all titles to the properties in order to ensure that all residents are aware of the operation.

- 5.2.3.13 - The Dundurn Rural Water Utility has confirmed its availability to supply potable water to the project, as noted in the written correspondence attached to this report (see attached correspondence in Appendix G).

- 5.2.3.14 - Based on the recommendations in the Geotechnical and Hydrogeological reports prepared by Clifton Associates, the Developer will be requiring residents to install three-cell waste water disposal system at each lot (see Appendix H and Appendix R). This mandatory condition will ensure the long term safety of the groundwater not only for the subdivision's residents but also in providing assurance to neighbouring residents that the Development will not cause ground water contamination or other concerns for those in the area. Correspondence with Saskatoon Health Region indicating support for the package treatment plants is attached as Appendix E. The Developer will be setting up a septic utility for the development as per the bylaw requirements.

- 5.2.3.15 - Abutting existing multi-parcel country residential development is located to the west, east and south of the proposed Grasswood Estates subdivision. The proposed development has been designed to complement existing development in the area by providing complementary lot sizing to achieve compatible land use and development. Drainage will be handled entirely on site through the construction of two catchment areas (see Conceptual Stormwater Management Plan and Drainage Map prepared by Clifton Associates in Appendix I).

- 5.2.3.17 - Hazard Lands - Foundation recommendations made by Clifton Associates indicated that groundwater levels were between 1.1 and 5.8 m below ground surface at throughout the development area and typically, basement floors will be about 1.5 to 2.0 m below finished grade. It was indicated that on this basis, it is not likely that hydrostatic pressures will develop on basement walls and floors, but that the walls can be waterproofed to accommodate any future increases in groundwater levels that could lead to seepage. At a minimum, it was recommended that walls and floors be damp-proofed. It was further recommended that a perimeter subdrainage system be installed at the bas of the footing, and the excavation be backfilled with a free draining granular soil to ensure that water can drain to a perimeter weeping tile system (see Appendix H). Prior to the construction of buildings, each lot will be the subject of a site-specific geotechnical report that will examine soil conditions and determine whether basement development is possible. Copies of these reports will be provided to the R.M..

- 5.2.3.17 - The proposed development meets all of the separation distances set out in Section 5, Bullet 5.2.3.17 of the separation distance policies contained within the OCP.

- 5.2.3.18 - A desktop environmental screening was completed by CanNorth and it was determined that the proposed development does not cross any wildlife habitat protection land and therefore does not need a permit in order to proceed. It was recommended that construction activities should avoid draining wet low-lying areas where possible and that should any rare or endangered species be encountered the guidelines for the SKCDC for sensitive species in natural habitats (see CanNorth Environmental Screening Report in Appendix B). It was also recommended that the Ministry of Environment be contacted regarding any concerns they may have. This report has been submitted to Mr. Steve Hyde at the Ministry of Environment for review. It was determined that a species survey (vegetation and animal) be conducted in order to ensure no species at risk are located within the proposed development boundaries. The Developer has contracted CanNorth Environmental Services to have this survey undertaken in the Spring of 2012 prior to the onset of construction. It is expected that this report will be completed in July or August in 2012 and may require heavy construction activities near the existing wetland be restricted during sensitive times of the year (e.g. spring).

- 5.2.3.18 - A review of the heritage potential of the proposed development location was undertaken by Heritage Resources Branch. It was found that there were no recorded sites in conflict with the proposed development and that the area exhibits low potential for intact heritage resources, and as such there were no further concerns with the development. See Appendix J for the clearance letter issued by Heritage Resources Branch.

- 5.2.3.19 - The soil capability of this parcel is considered marginal, or Class 4. The geotechnical investigation completed by Clifton Associates indicates that the site is located on a glacial lake basin, with subsurface soil consisting primarily of sand and silt with some clay (see report attached in Appendix H).

- 5.2.3.20 - Access - The residential subdivision is east of Preston Avenue and north of Baker Road. The proposed development will meet municipal and provincial regulations respecting access to and from provincial highways and other municipal roads. A traffic impact study was completed by Clifton Associates in 2009 and two follow up letters were issued in 2012 based on recently published traffic counts for 2010. The study reviewed past and expected traffic scenarios for Highway #11, Baker Road and Preston Avenue. The letter dated to January 2012 indicates that the most significant traffic changes seen in the 2010 counts were to Baker Road, just west of Highway #11. The letter indicates that warrants for a right hand turn lane on Highway 11 southbound are currently met. With an increase in traffic on Baker Road forecasted for the next 10 years, the letter also indicates that the future traffic level could increase by approximately 27%. With this level of traffic the warrant for the right turn lane would be somewhat higher than at present. However, due to the low percentage of trucks, it was felt that there would be no need for an acceleration lane for vehicles travelling north from Baker Road to Highway #11. No traffic counts were completed for Preston Avenue, but it was indicated by the traffic engineer that the average daily traffic assumption of 200 vehicles is a reasonable estimate and may even be on the high side. In 2009, the Ministry of Highways and Infrastructure had a tentative plan to construct a right turn lane from Highway #11 to Baker Road in either 2010 or 2011, however this project has been postponed and will occur based on future priorities and resources (see Traffic Impact Reports and supplementary information attached as Appendix K).

- 5.2.3.21 - The Developer has consulted with the Prairie School Division and it has been determined that there is enough room in the South Corman Park School to accommodate future students residing in the subdivision. Classroom space will need to be monitored within Clavet School and additional relocatables will be added as enrollment increases (see correspondence in Appendix C).

Servicing Policies (Section 11)

- 11.2 - Servicing Policies:
    - 11.2.1 - All roads in the proposed subdivision will be paved with a seal coat and completed to the R.M. standard for subdivision and special roads.
    - 11.2.2 - The proposed development will have legal and year round, all weather physical access to a municipal maintained roadway. Internal roads will be constructed at the expense of the Developer.
    - 11.2.3 - The Developer has provided correspondence with the Prairie School Division indicating that there is capacity within the present school system to accommodate potential new school-age children (see Appendix C).

Implementation Policies (Section 12)

- 12.2 - General Policies:
    - 12.2.1 - A servicing agreement between the Developer and the R.M. of Corman Park is expected to address the following (but not limited to):
        - Outline the requirement for site-specific geotechnical reports.
        - Identify the proposed phasing, including the proposed construction time lines.
        - Identify roadway and approach specifications, including roads that will not be public roadways.
        - Identify pre-site investigation requirements for the installation of septic systems. This may include information pertaining to regular maintenance reports for the individual systems.
        - Identify the proposed form of water distribution and sewage collection and treatment including how it will be administered.
        - Identify off-site servicing fees, payable to the R.M.
        - Identify the value of the required performance bond or letter of credit.
        - The proposed Municipal Reserve comprises approximately 12.29 ha of land. As the subdivision is approximately 109.58 ha of land in total, this exceeds the minimum Municipal Reserve requirement of 10%.

ZONING BYLAW

The Developer is applying to rezone the W1/2-26-35-5 W3M to Country Residential 1 District (CR1). Development standards and regulations within the District's Zoning Bylaw will be met.

1.6 SPECIAL INITIATIVES

- The Developer is committed to providing environmentally friendly amenities which are not normally found in acreage developments. All homes will be built to minimum Energy Star Qualified Home Ratings. Additionally, the Developer is working with Bill Elliot, President of WSE Technologies to provide an economical and environmental solar energy system as an option for home and water heating.

- As a part of the building restrictions, the Developer will require a three-cell septic tank system (package treatment plant) to be installed at each house. The Saskatoon Health Region has verbally indicated that this requirement is acceptable, pending final review of the hydrogeological report. A formal response is expected in July or August, 2012.

- An environmental monitoring program will be established via 13 existing boreholes on site to quantify the extent of the migration of a septic plume and compare this data to the expected data. Data from the monitoring program will be provided to the R.M. of Corman Park for public record. The administration of this monitoring system will be provided through the septic utility created as a part of this development.

- Several recreational opportunities will be available for residents who enjoy outdoor activities such as walking, jogging and cycling. A 15 m wide linear park featuring a 2.4 m walking and cycling trail is proposed between the interior lots that will act as an interlinking causeway that will allow for use in a relaxed, natural environment. The development will also include two large pond areas of which both will feature a gazebo for recreational use. Additionally, the larger pond on the east boundary of the proposed development will feature a creek bed with a small water stream, that will provide the perfect ambience for bird watchers and nature lovers. A small cottage will serve as a pump house for the water system, and will also function as a warming hut for winter activities such as snowshoeing, cross-country skiing, and skating. The cottage will be owned and maintained by the Grasswoods Estates Community Association. The cottage will be designed to be moveable, in case site conditions or water levels fluctuate from year to year.

Conceptual drawings of proposed linear parks and large pond featuring gazebo.

2 INVENTORY AND ANALYSIS

2.1 EXISTING LAND USE

The proposed development site consists of 109.58 hectares (270.76 acres) in the W1/2-26-35-5 W3M. The half section is currently occupied by pasture land, described as gently to moderately undulating to mixed undulating and rolling. Four existing parcels exist adjacent to or within the proposed development. Three of these parcels have houses. All existing landowners on the W1/2-26-35-5 W3M were approached and have given their consent regarding the proposed subdivision development.

2.2 PROPOSED LAND USE

The proposed land use is a residential community that will offer the opportunity for creative, environmentally friendly housing with large lot sizes, surrounded by opportunities for recreational activities. Three private residences are located adjacent to and within the proposed development boundaries and a fourth parcel has been subdivided in the southwest corner of Section 26-35-5 W3M. One of these lots may be incorporated into the proposed development (Plan 102002768).

2.3 SERVICING

- The subdivision will be provided with transportation access via Preston Avenue to the west and Baker Road to the south. Roadways will be paved with a seal coat and finished according to the R.M. standard for subdivision and special roads, as outlined in Appendix L.

- Shallow utilities will be provided by SaskPower, SaskEnergy and SaskTel following the construction of deep utilities. Shallow utilities will be located within the road right-of-way to provide service to the front of each lot (see attached correspondence in Appendix M).

- Surface drainage will be directed to one of two on-site wetlands / sloughs located on the east side of the property and in the centre of the property (see Appendix I).

- Sewage treatment and dispersal will be achieved by installing Type II mounds with a three-cell septic system at each residence. These systems treat water via mechanical and/or natural processes to the point where the treated wastewater can be safely released into the environment without causing harm to the surrounding environment or to human health (see Appendix E and N). The Developer will be setting up a septic utility for the development as per the bylaw requirements.

- Potable water will be supplied by Dundurn Rural Water Utility. This utility will manage the on-site water distribution lines and associated infrastructure (see Appendix G). It is noted that the proposed development must receive approval from the R.M. of Corman Park by Spring 2012, as roads and survey pins must be in place no later than July 31, 2012. While it has been indicated that there may be some leeway with this date, the Dundurn Rural Water Utility has indicated that this timeline is essential in order for the proposed subdivision to remain as Phase III of the expansion project and be eligible for government grant funds. This date is partly based on the fact that the water line needs to be completely installed prior to freeze-up in 2012, and as such, the Utility requires time for tendering, finding a contractor, as well as allowing time for the work to be completed. Should this development not proceed within the above-mentioned timeline, the Developer will not be in a position to contribute $550,000 towards the project, which would ultimately impact the cost to all other users.

- Mailboxes will be installed at the south entry of the proposed Development (see Plan attached in Appendix A). It was determined that this is the best location for mailboxes, in Phase I as it is easily accessible by residents as well as by Canada Post.

3 DESIGN ELEMENTS

3.1 CONCEPT

The development is a culmination of architectural, marketing and community research and planning. This development is designed to integrate and promote the privacy of acreage living integrated with recreational development.

3.2 LAND USE

Grasswood Estates is proposing a Country Residential Development in the W1/2-26-35-5 W3M with the intent of completing a unique, highly desirable, environmentally sound, multi-parcel residential development. The construction of this development will maintain and complement the surrounding land use of the area. As indicated in Section 1.3 the proposed development complements the existing country residential developments to the west (Organized Hamlet of Casa Rio), to the east (Ashwood Estates and South Point), and to the south (Casa Rio East). The proposed lots range in size from 1.4 acres to 4.85 acres with the average lot are being 2.51 acres.

Illustration of home envisioned at proposed Grasswood Estates subdivision.

4 TRANSPORTATION AND MUNICIPAL SERVICES

4.1 COMMUNITY ACCESS AND PROJECTED VEHICULAR TRAFFIC

There are two access roads into the community: from Preston Avenue on the west side and from Baker Road on the south boundary. Baker Road connects with Highway #11 which becomes Circle Drive in Saskatoon. Highway #11 is a double-lane highway.

A Traffic Impact Assessment (TIA) was completed by Clifton Associates in January 2009 resulted in the following findings and recommendations (see report attached in Appendix K):

- For the most part, the existing infrastructure is adequate to accommodate additional traffic.
- Rural residential development, the Stonegate commercial subdivision, as well as the development of the Whitecap golf course and casino, have resulted in the expectation that traffic will increase on the roads in the area by approximately 50% in the next 10 years.
- The Ministry of Highways and Infrastructure currently have had a tentative plan to construct a right turn lane on Highway #11 to Baker Road in 2010 or 2011. This has not yet occurred.
- It was anticipated that the R.M. of Corman Park will incur some additional road maintenance costs, and it may be necessary at some point to resurface Baker Road, regardless of whether the proposed Grasswood Estates subdivision proceeds. It is anticipated that these costs could be offset by tax revenues to the municipality, as the proposed development is only one contributing factor to the need for road maintenance and future upgrading (see William Brown Consulting Cost of Community Services report attached as Appendix O).
- If development proceeds the TIA indicates that there may be some demand to resurface Preston Avenue from the west access point north to connect to the Grasswood Road, at a distance of 1.3 miles.

Two letters dating to January 2012 indicate that the most significant traffic changes seen in the 2010 counts were to Baker Road, just west of Highway #11. This data was based on traffic counts undertaken by the R.M. of Corman Park in 2010. The letter indicates that warrants for a right hand turn lane on Highway 11 southbound are currently met. With an increase in traffic on Baker Road forecasted for the next 10 years, the letter also indicates that the future traffic level could increase by approximately 27%. With this level of traffic the warrant for the right turn lane would be somewhat higher than at present. However, due to the low percentage of trucks, it was felt that there would be no need for an acceleration lane for vehicles travelling north from Baker Road to Highway #11. In terms of Preston Avenue, the assumption of existing traffic was 200 ADT (average daily traffic). This assumption was based on comparisons with other roads, as no count data was available. According to the Traffic Engineer, it was felt that this assumption is reasonable, and may even be on the high side in terms of estimations. In 2009, the Ministry of Highways and Infrastructure had a tentative plan to construct a right turn lane on Highway #11 to Baker Road in either 2010 or 2011, however, this plan has been delayed and will be subject to future priorities and resources.

The proposed development has been submitted to the Ministry of Highways and Infrastructure for review. The response received indicates that the TIA completed in 2009 and subsequent counts undertaken in 2012 were reviewed and no action items were generated as a result. The Ministry does not require any additional information (see attached correspondence in Appendix P).

4.2 INTERNAL ROADS

The proposed development features two internal roads that service all of the lots with access to the subdivision occurring from the west boundary of the development at Preston Avenue and the south boundary of the development at Baker Road. The internal roads will be paved with a seal coat and constructed to the R.M. standard for subdivision and special roads, as outlined in Appendix L.

4.3 PEDESTRIAN AND BICYCLE TRAFFIC

Pedestrian and bicycle traffic will have access to internal roads as well as the proposed 15 m linear parks between the interior lots that will feature a 2.4 m walking and cycling trail. This linear park and associated trails will act as interlinking causeways that will allow for people to walk, jog or bike in a relaxed, natural environment. The linear park and trails were also designed as a safety feature, to enable children to travel on foot or bike without having to utilize the main roads.

4.4 POTABLE WATER SUPPLY AND DISTRIBUTION

Potable water will be supplied by the Dundurn Rural Water Utility. The Dundurn Rural Water Utility has constructed supply lines along the west and south boundary of the proposed development. Correspondence from the Dundurn Rural Water Utility to the Developer in December, 2011 indicated that they will be able to provide the subdivision with potable water. The Water Utility indicated that the subdivision is considered as a part of Phase III of the expansion project and, as such, would require R.M. approval by Spring 2012, in order to have the required roads and pins in place by no later than July 31, 2012. This includes all roads and pins for Phase I and Phase II of the proposed subdivision. While it has been indicated that there may be some leeway with this date, the Dundurn Rural Water Utility has indicated that this timeline is essential in order for the proposed subdivision to remain as Phase III of the expansion project and be eligible for government grant funds. This date is partly based on the fact that the water line needs to be completely installed prior to freeze-up in 2012, and as such, the Utility requires time for tendering, finding a contractor, as well as allowing time for the work to be completed (see correspondence in Appendix G). It is noted that if this development does not proceed within the above-mentioned timeline, the Developer will not be in a position to contribute $550,000 towards the project, which would ultimately impact the cost to all other users.

4.5 WASTEWATER TREATMENT

A geotechnical and hydrogeological investigation completed by Clifton Associates was undertaken to evaluate slope stability, determine wastewater disposal characteristics, and to provide preliminary foundation and construction recommendations based on a geotechnical investigation. The report suggests that potential onsite wastewater disposal systems for this area including Type II mounds and package sewage treatment plants with effluent disposal methods are both appropriate. See Appendixes H and R for the reports prepared by Clifton Associates and Appendix N for further information on MicroFAST wastewater treatment systems.

Since the geotechnical investigation was completed, the Developer has chosen to make package sewage treatment plants a requirement for each lot at the proposed Development. Package sewage treatment plants actively treats sewage before returning it to the environment. These systems exceed health and environmental regulation, and also fit ideally into the proposed layout and existing topography of the site at the proposed Grasswood Estates subdivision. An exceptional level of wastewater treatment will be provided to residents without the significant disturbance to the existing landscape that would otherwise be required to install a massive storage pond or lagoon that are associated with other communal collection and treatment systems. The ability to maintain large residential property sizes desired by acreage owners, while maximizing occupancy of the development is essential to the approach used by the MicroFAST wastewater treatment systems.

A hydrogeological investigation of the development site was undertaken in July 2012. Recommendations from the report include that the proposed sewage treatment method would be not be a cause of concern for cumulative impact on nitrogen levels, that ongoing monitoring of the site be undertaken and that the old manure pile in the north area of the site be removed. The Saskatoon Health Region has reviewed the hydrogeological report and verbally indicated that the sewage disposal method would be acceptable (pending final review). The Developer will remove the old manure pile from the site. Pursuant to engineering recommendations and as an added measure of ensuring wastewater is being treated effectively, the Developer intends to establish an environmental monitoring program on two properties to quantify the extent of migration of septic plume against the engineered expectations. Data from the program will be provided to the Municipality for public record. The administration of this monitoring system will be provided through the septic utility created as a part of this development. Additionally, a bi-annual inspection (twice per year) will occur for a minimum of two years following installation and ongoing annual system inspections will be implemented for a minor fee of $75 per year. Again, these inspections will be monitored by the septic utility created as a part of this development.

4.6 DRAINAGE AND STORMWATER MANAGEMENT

The runoff impacts of the proposed development in the W1/2-26-35-5 W3M was reviewed by Water Resource Consultants Ltd. and a follow-up Conceptual Stormwater Management Plan (SWMP) was undertaken by Clifton Associates (see Appendix I). The intent of the proposed stormwater management system was to design facilities that can negate the impact, or at least reduce the impact, to that which would have occurred naturally regardless of site development. The conceptual SWMP proposes the use of an evaporative stormwater pond system to collect stormwater. Consideration was made for effective drainage to the ponds based on the layout proposed and appropriate sizing to ensure evaporative functionality is adequate.

The SWMP indicates that the site has no natural drainage and water tends to collect in local low lying areas, including the existing pond on the east central border of the site, in which local drainage occurs. The preliminary drainage report prepared by WRC Consultants indicated that the pond in the northeast corner of the proposed residential development was sufficient to collect drainage water. However, when preliminary drainage and grading was initiated, it was clear that the entire development would require a significant amount of grading to achieve drainage to the naturally existing pond. Therefore, a second pond was considered. Clifton Associates calculated predevelopment conditions and developed conditions and associated change to inflow and outflow. Based on the calculated information, including total impervious surface area, maximum flood levels from the preceding 51 years of available data, the pond design was completed. In order to recognize the 1:100 year design used by the R.M. of Corman Park, which also recommends a 25% increase in value, several options for pond design were considered. It was concluded that the existing pond in the northeast corner of the development property and a second pond (totalling 2.6 ha) in the centre of the development property would be sufficient to handle on-site drainage. Both water features will be permanent features, and as such, it will be necessary to deepen the features. **These two ponds will remain entirely within the boundaries of the surrounding municipal reserve parcels if a 1 in 100 year plus 25% flood event were to occur.**

Additional recommendations made as a part of the Conceptual Stormwater Master Plan included the following:

- The ponds will need to be deepened in order to function as permanent water features. The excavated fill will be distributed as per the subdivision plan in the final design phase and will be utilized in order to achieve the proposed drainage.
- Model results indicated that the average level of water in the ponds was between 5.3 and 5.6 m below the maximum water levels;
- The minimum building elevations are recommended to be set 1 m above the maximum water level;
- Considering 1:100 year flood levels at each of the ponds were found to increase the water levels by two metres accordingly. As this event may never occur, it was recommended that some of the area be used as public land.

The detailed drainage plan and report will establish the minimum building elevation and be registered against each title. In addition to the safety provided by the ponds designed to the R.M.'s 1 in 100 year plus 25% flood standard, the more conservative modelling prepared by Water Resource Consultants Inc., and Clifton Associates will be taken account in defining the minimum building elevation for each lot (of particular significance for the lots adjacent to the ponds).

Appendix I contains the full details of the Conceptual Stormwater Management Plan and follow up analysis.

4.7 SHALLOW UTILITIES

Shallow utilities will be provided by SaskPower, SaskEnergy and SaskTel along with underground cable following construction of deep utilities. Shallow utilities will be located within the road right-of-way to provide service to the front of each lot. Letters confirming these arrangements are attached as Appendix M.

4.8 SOLID WASTE DISPOSAL

Loraas Disposal has indicated their willingness to provide for the removal of solid waste on a weekly basis. See Appendix M for the attached correspondence.

5 OTHER

5.1 GEOTECHNICAL

A geotechnical report and conceptual Stormwater Management Plan were both prepared by Clifton Associates (see Appendix H and I). The geotechnical report prepared by Clifton Associates outlines and evaluates slope stability, determines wastewater disposal characteristics, and provides preliminary foundation and construction recommendations based on a geotechnical investigation. The second report makes key recommendations concerning potential runoff impacts and safe building elevations.

According to the Clifton Associates report, subsurface geology was investigated by a total of 19 test borings on the site. Additionally, piezometers were installed and water levels were measured in February, 2008 and July, 2012. It was recommended that at a minimum, basement walls and floors be damp-proofed. Additionally, it was recommended that a perimeter subdrainage system be installed at the base of the footing for each home, although this requirement can be reviewed depending on the specific conditions at each site. In terms of footings, it was recommended that the proposed structures be supported on shallow spread footings or augered cast-in-place concrete piles. Assuming basements or crawlspaces are insulated, the footing must be constructed below the anticipated depth of frost, estimated at approximately 1.8 m in the area. Recommendations are further made with regard to soil conditions, grading, and floors. In terms of potential for the sulphate content of the soil, it was considered to be moderate to severe for concrete in contact with clay. It was recommended that sulphate resistant cement be specified for all concrete in contact with clay soil. The recommended safe building elevation at this proposed development be set at 1 m above the maximum water level (see Section 4.6 for further detail).

Prior to building development and as a condition of sale, the Developer will be requiring all lot owners to undertake a lot-specific geotechnical investigation (by a qualified professional geotechnical engineer) to determine soil conditions, whether basement development could occur on the site and define a minimum building elevation. A further condition of sale will be that a copy of each of these reports be provided to the R.M. with a development permit application.

5.2 FIRE AND PROTECTIVE SERVICES

The Developer contacted the Assistant Fie Chief regarding the Fire Service Agreement held between the R.M. of Corman Park and Saskatoon Fire and Protective Services. The Fire Department indicated to the Developer that they were working with the R.M. to set up general parameters for fire and protective services that could be addressed by all future developments. The Developer is fully committed to meeting these parameters.

5.3 POPULATION AND SCHOOLS

Based on the 2011 average household size for the R.M. of Corman Park (2.9), the total population of the community is projected to reach up to 241 people. Consultations with the Prairie Spirit School Division indicated that there is capacity within the school system for potential new students in the South Corman Park School, as well as in the Clavet School. In the Clavet School, it was indicated that due to the high utilization rate, the school division has been adding relocatables as required, and as such, enrolment increases resulting from this proposed development would need to be monitored. The Developer has indicated that they wish to work with the Prairie Spirit School Division (particularly the South Corman Park School) on appropriate matters to address any safety concerns at the intersection of Preston Avenue and Baker Road if and when they arise. Correspondence with the School Division is attached as Appendix C.

5.4 RECREATION

Recreation opportunities for residents will include activities such as walking along the 15 m wide linear parks proposed between the interior lots. This linear park will feature a 2.4 m pathway that will act as an interlinking causeway that will allow for people to walk, jog or bike in a relaxed, natural environment. The development will feature two pond areas, each of which will feature a gazebo (adjacent to lots 34 and 50, respectively). A creek bed with a small water stream will provide the perfect ambience for bird watchers and nature lovers at the larger of the two ponds, at the eastern boundary of the development. A small cottage will serve as a pump house for the water system (located adjacent to lot 34), and will also function as a warming hut for winter activities such as snowshoeing, cross-country skiing, and skating. Summertime activities such as walking through the linear parks, observing plants and wildlife that thrive in a wetland setting, as well as rafting, canoeing, or rowing on the water will also be possible. The ponds and linear parks will initially be managed by the proposed Grasswood Estates Community Association, which everyone must join in order to purchase a lot. The proposed Municipal Reserve comprises approximately 12.29 ha of land. As the subdivision is approximately 109.58 ha in total, this exceeds the minimum standard of 10%.

5.5 ECOLOGICAL AND HERITAGE CONCERNS

As per the R.M. of Corman Park's Official Community Plan policies, queries were made to the appropriate environmental agency (Saskatchewan Conservation Data Centre, or CDC) and heritage agency (Heritage Conservation Branch, or HCB) regarding any ecological or heritage concerns that may need to be addressed prior to the onset of development. The results of these queries can be found in Appendix B: Environmental Screening Report and Appendix J: Heritage Resource Review.

In terms of the wildlife and vegetation habitat assessment, a desktop Environmental Screening was completed by CanNorth in 2009. The objective of the report was to identify any possible issues with the proposed Grasswood Estates subdivision. The report indicates that the project area does not cross any wildlife habitat protection land, nor any crown agricultural land, which precludes the need for a permit. Although eight wildlife species had been previously recorded in the 20 km search radius around the project, only one was ever recorded in the project area. This species is known as the olive-backed pocket mouse, which does not have a recommended setback distance. In terms of vegetation, 37 provincially ranked plant species have been previously recorded within the 20 km search radius for the project. Five of these species found within the project study area have recommended setback distances with accompanying restricted activity dates. The project is not located on any migratory bird sanctuaries and does not contain any known fish bearing waterbodies. The report recommends that construction activities should ensure that nearby wetlands or ephermerally low-lying areas should not be modified or drained. If possible, ephermeral waterbodies should be avoided due to the possible presence of sensitive species.

The report recommends that as per the regulatory requirements that an ecologist with the Ministry of Environment be contacted regarding any environmental concerns that they may have with the proposed project. Mr. Steve Hyde (Ecological Protection Specialist) was contacted and this proposed development has been reviewed. It was determined that a species survey (vegetation and animal) be conducted in order to ensure no species at risk are located within the proposed development boundaries. The Developer has contracted CanNorth Environmental Services to have this survey undertaken and a final report is expected in late July or August.

In terms of any heritage concerns in the W1/2-26-35-5 W3M, the development was submitted to the Heritage Resources Branch (HRB) for review. It was determined that there were no recorded archaeological sites in direct conflict with the proposed development. Additionally, the area for proposed development has been previously disturbed in the past. Therefore the potential for encountering intact heritage resources was considered to be low. As such, there were no further concerns with the project proceeding as planned (see attached letter from HRB in Appendix J).

6 STAGING AND IMPLEMENTATION

This community, including a total of 80 residential lots, will be developed in two phases. Phase I will include the development of 42 lots around the perimeter of the proposed development, the dedication of Municipal Reserves MR1, MR2 and MR3, Municipal Buffers MB1, MB2, MB3, MB4, MB5, MB6, MB7 and MB8 as well as roads and culverts for this phase of the development. Phase II will consist of the remaining 38 lots in the centre of the proposed development in addition to the two secondary access roads and Municipal Reserves MR4 and MR5. The developer is requesting Council to rezone the entire development to CR1, and designate Phase II with a holding provision.

7 PUBLIC CONSULTATION

The Developer has consulted with the surrounding neighbours and public on several different occasions. In May, 2008 a public meeting was held at the Corman Park Community Centre to introduce and provide details about the proposed development. This meeting was attended by approximately 50 people. Discussions ranged from the number of lots proposed, waste water management methods including groundwater contamination. Engineers from Clifton Associates were present to explain the details about the project and to information concerning the steps that were taken to ensure that water quality and environmental safety would not be compromised. K&K Land Management, on behalf of Urban Elements, indicated to the group that they were investigating sources for potable (city) water for the proposed development and extended an invitation to others who were interested in joining the effort.

A second public meeting was held on October 9, 2008 at the Corman Park Community Centre. This meeting was attended by approximately 35 people. Again, the proposed Development was described and details were provided to the attendees in terms of future services, waste water treatment, and the draft layout of the proposed subdivision. K&K Land Management, on behalf of Urban Elements, proposed that, based on the development of 83 residential lots, and with the support of the community, the Developer would donate a minimum of $250,000 towards a school or Community Association facilities, rather than building a major community centre on-site. The Community Association has provided a letter of full support of the proposed development, as provided in Appendix D.

Two additional open houses were held on April 9, 2012 and April 16, 2012. Prior to the open houses, two mail-out letters were sent to residents as identified by the R.M. of Corman Park. These open houses were come and go events intended to provide opportunities for people who may be affected by the proposed development to ask questions and express any comments or concerns about the proposed subdivision. The Developer and members of the design team were present to answer questions by those who attended and a feedback form was also available to fill out. Several informational display boards were erected and included general information on the proposed development.

Generally, feedback on the proposed development was quite positive and several favourable comments were submitted regarding the detail, forethought, and aesthetic design of the proposed subdivision. A number of positive comments regarding the walking and cycling trails were also received. The concerns expressed by residents included potential contamination of groundwater with the installation of additional septic systems, light pollution with the surrounding 80 residential lots, as well as the use of heavy equipment and associated dust, noise, and debris. One resident was concerned about the use of construction equipment on road 3051 and another was concerned on ability of the DRWU pipeline to support the needs of an additional 80 residences (see feedback forms attached in Appendix D). Traffic concerns included maintenance issues of Baker Road and Preston Avenue, as well as the location of the proposed entry on the south side of the development. Concerns over the usage of the linear parks and associated trails by motorbikes and quads were also expressed.

In order to mitigate the sewage concerns, the Developer has chosen package sewage treatment plants as a requirement for each lot at the proposed Development. According to the Saskatoon Health Region, package treatment plants are a “more than adequate means of sewage disposal” (see correspondence in Appendix E). Additionally, an environmental monitoring program will be established via 13 existing boreholes on site to quantify the extent of migration of septic plume against the engineered expectations. Data from the program will be provided to the Municipality for public record. The Developer has also agreed to utilize low light pollution fixtures to minimize the impact to surrounding residents and their view of the night sky. In terms of water line capacity, the DRWU is prepared to handle the demand of an additional 80 residences, and, in fact, will significantly reduce the cost of the utility to other users. Concern regarding the location of the southern entry point to the proposed development were mitigated by aligning this entry with the access point directly opposite to the access south of Baker Road to the Casa Rio Development. The Developer has agreed to put up bollards along the trails and signs indicating that quads and motorized vehicles are not allowed.

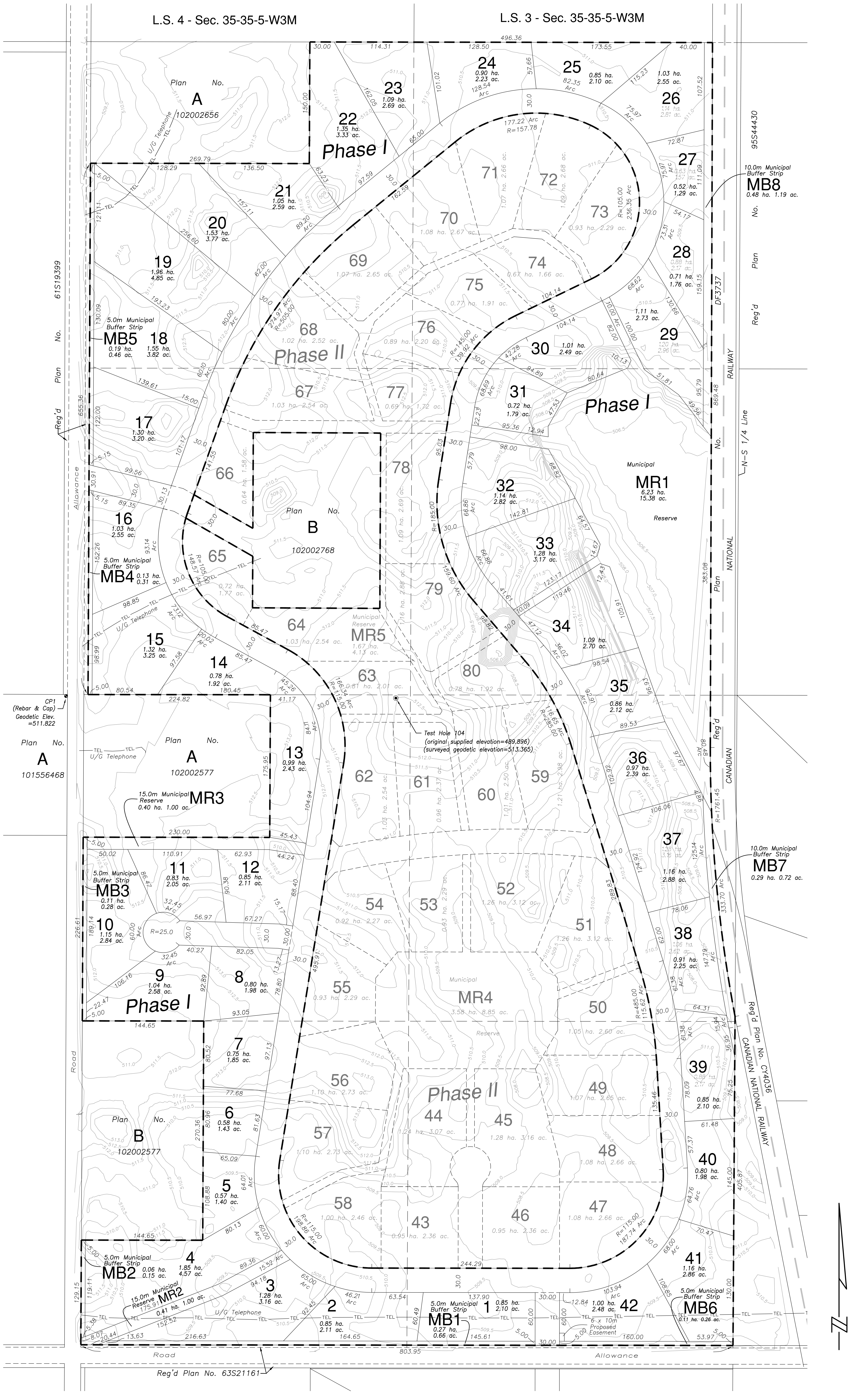
One resident indicated that there is an aerodrome located kitty corner (to the southeast) of the proposed subdivision. The aerodrome, known as Grasswood Landing, falls under the jurisdiction of the Ministry of Transportation. A total of 11 private aircraft are currently operating and based out of this facility. It was noted that while the approach and departure pattern do not conflict with the proposed development, the legal established downwind flying pattern for the runway does go over the property at 1,000 feet. The owner wished to make the Developer aware of the aerodrome, and suggested that home buyers be informed of its location and activity. The Developer intends to list the aerodrome on all titles to the properties in order to ensure that all residents are aware of the operation.

Other concerns identified during the course of undertaking these open houses included:
- General traffic concerns;
- Dogs being allowed to run or walk off-leash;
- Dust and noise associated with construction;
- Concern over increased population in the area and the subsequent need to lock doors due to theft and vandalism; and,
- Decreases to property values resulting with an additional 80+ residences in the area.

8 APPENDICES

Appendix A

Development Concept Plan



Phase I Area Table – 42 Lots		
	Area Ha.	Area ac.
Total Area	64.8	160
Average Lot	1.03	2.55
Largest Lot	1.96	4.85
Smallest Lot	0.52	1.29
Municipal Reserve	7.04	17.38
Municipal Buffer Strip	1.64	4.03
Road way	12.70	31.38

Phase II Area Table – 38 Lots		
	Area Ha.	Area ac.
Total Area	44.78	110.64
Average Lot	1.00	2.47
Largest Lot	1.34	3.30
Smallest Lot	0.64	1.58
Municipal Reserve	5.25	12.98
Road way	1.55	3.84

NOTES

- Phase I is outlined by a heavy broken line and contains 64.8 hectares (160 ac.) more or less.
- Measurements are in metres and decimals thereof.
- Standard Road Allowance shown on this plan are 20.117m in width.
- Contour interval is 0.5 metre.
- Contours are shown for planning purposes and represent the overall trends in the terrain. The contours are not intended for purposes such as detail site grading or detailed road design.
- Contours supplied by Developer.
- April 18, 2012 Survey:
  Adjusted supplied contours to geodetic datum.
  Original contours have been shifted by +23.469.
  Reference Benchmark 77S118 with geodetic elevation of 506.975m.
- Meridian Surveys Ltd. makes no guarantee as to the exact location of the underground facilities shown. The location of underground facilities must be verified by the owner of said facilities prior to any construction activities.
- All Phase II lots meet or exceed 60m frontage.
- Lots 14, 15, 29 to 38 and Municipal Reserve MR1 in Phase I have been modified from the original Community Planning submission dated February 14th, 2012.

By: ______________________

SASKATCHEWAN LAND SURVEYOR

Examined and Approved:

______________________ Representative

______________________ Date

Grasswood Estates Phase I & II
Concept Plan
showing subdivision of all of
W. 1/2 Sec. 26-Twp. 35-Rge. 5-W3rdMer.
R.M. of Corman Park No. 344
SASKATCHEWAN

Scale : 1 : 2500

No.	Date	Revision	Rev. By	Chd. By
1	Jun. 19/12	to add Municipal Buffer Strips MR7 & MR8.	bls	mep
2	Jul. 13/12	to add Walkway between Lots 57 & 58.	bls	bc

Drawn By:	Checked By:	Date:	File No.	Drawing Name:	Rev.	
bls		May 25, 2012	S09028Dev_D	S09028Dev_D.R2_client.dwg	2	Meridian Surveys Ltd.

Appendix B
Environmental Screening Report and Correspondence

From: Leanne DeLong
Sent: Wednesday, March 21, 2012 10:41 AM
To: Maggie Schwab
Subject: FW: New Referral - RM of Corman Park - Our File R303-12S -W1/2 Section 26-35-5-W3M-Residential

---

From: Dukart, Shawn MA [mailto:shawn.dukart@gov.sk.ca]
Sent: Wednesday, March 21, 2012 10:40 AM
To: Leanne DeLong; RJ.Morrison@MeridianSurveys.ca
Subject: FW: New Referral - RM of Corman Park - Our File R303-12S -W1/2 Section 26-35-5-W3M- Residential

Good morning,

Please see the most recent comments from the Ministry of Environment. Steve Hyde has requested species survey for the above noted subdivision. This is just a reminder that this survey should be conducted at the applicable time of year. If you have questions please contact Steve.

Regards,

Shawn

"Hi Shawn – I had discussions with Leanne Delong and/or Maggie Schwab from Crosby, Hanna and Assoc. around New Year regarding their report. There are a few possible species at risk that are mentioned in the report for this area and habitat. I suggested they do a species survey (vegetation and animal) at the applicable time of year to ensure none of these species exist there before any construction begins. They told me, if memory serves correct, that the proponent wouldn't have a problem with that. I used the scenario that if they brought in heavy equipment to do levelling and earth moving and came across a burrowing owl nest, then there would be an issue.

Let me know if you wish to discuss further.

Steve"

From: Dukart, Shawn MA
Sent: Tuesday, March 13, 2012 3:12 PM
To: 'land@saskpower.com'; 'landservices@saskenergy.com'; 'sasktel.land@sasktel.sk.ca'; Latimer, Brent SktnHR; 'Spencer McNie'; Hyde, Steve ENV; Andrie, Barry ED
Subject: New Referral - RM of Corman Park - Our File R303-12S -W1/2 Section 26-35-5-W3M- Residential

Re: RM of Corman Park No. 344

W ½ Section 26-35-5-W3M

Proposed Subdivision – Residential

For some frustrating reason, I am having trouble referring this application through SOLA. Many of you are already familiar with this application as the developer has submitted a Comprehensive Development Review to the RM that includes comments from many of the applicable agencies.

A copy of the above noted subdivision application is attached for your comments. Please consider the following in your reply.

1. Are you aware of any land use in the vicinity that would be incompatible with the intended use of the proposed sites, or any site conditions that make the land unsuitable for the intended use?

2. Do you have any facilities that could be affected by the proposed development? If so, please **send us a map** of your facilities that we can use to assess any site dimension or other changes that might be needed.

3. If you have any requirements of the applicant, please send the details directly to the applicant, and a copy of your correspondence to us.

The Subdivision Regulations require us to consider any concerns you have before we render a decision; however, to do so, we must have your reply within 40 days. Please call me if you need more time or information.

Shawn Dukart
Planning Consultant, Community Planning
Saskatchewan Ministry of Municipal Affairs
Room 978, 122 - 3rd Avenue North
Saskatoon, Saskatchewan S7K 2H6
Main (306) 933-6937, Direct (306) 933-7883, Fax: (306) 933-7720
shawn.dukart@gov.sk.ca

<< File: PPS.pdf >> << File: R202-12S APP.pdf >> << File: R202-12S UC.pdf >> << File: Acknowledgement - March 12, 2012.pdf >>

CanNorth
Canada North Environmental Services
Limited Partnership

ENVIRONMENTAL SCREENING CASA GRANDE SUBDIVISION PROJECT

Final Report

Prepared by:

Canada North Environmental Services
Saskatoon, Saskatchewan

Prepared for:

Clifton Associates Ltd.
Saskatoon, Saskatchewan

Project No. 1324

January 2009

A First Nations Partnership In Environmental Services
www.cannorth.com
#4 – 130 Robin Crescent, Saskatoon, Saskatchewan S7L 6M7
Telephone: (306) 652-4432 Facsimile: (306) 652-4431

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EXECUTIVE SUMMARY

Clifton Associates Ltd. contracted Canada North Environmental Services (CanNorth) to complete a desktop Environmental Screening Report for the proposed Casa Grande Subdivision project area to identify any possible environmental issues. The proposed housing development is located at W-26-35-05-W3M. The proposed project area is located on deeded land, which is primarily used for pastureland. The project area does not cross any wildlife habitat protection land and therefore, does not require a permit in order to proceed. In addition, the proposed project area does not cross any agricultural crown land.

Eight wildlife species have been historically recorded in the 20 km search radius around the project area. These species include the northern leopard frog (Rana pipiens), burrowing owl (Athene cunicularia), loggerhead shrike (Lanius ludovicianus), long-billed curlew (Numenius americanus), Sprague's pipit (Anthus spragueii), olive-backed pocket mouse (Perognathus fasciatus), monarch (Danaus plexippus), and western tiger swallowtail (Papilio rutulus). Five of the eight wildlife species have recommended setback distances for sensitive species in natural habitats. These include, northern leopard frog, burrowing owl, loggerhead shrike, long-billed curlew, and Sprague's pipit. The olive-backed pocket mouse, monarch, and western tiger swallowtail do not have recommended setback distances. All species are listed as rare and endangered species, with the exception of the western tiger swallowtail. The olive-backed pocket mouse was the only species that was historically recorded in the Casa Grande Subdivision project area. In addition, thirty-seven provincially ranked plant species have been historically recorded within the 20 km search radius for the project. All thirty-seven have recommended setback distances for sensitive species in natural habitats. The proposed project is not located on any migratory bird sanctuaries and does not contain any know fish bearing waterbodies.

The study area is not located on or near any First Nations Reserve areas or Provincial, National, or Regional parks. It is unknown if any heritage/archaeological sites exist within the proposed project area.

1.0 INTRODUCTION

1.1 Background

The project study area is located in central Saskatchewan near the City of Saskatoon (Figure 1) and consists of a new housing development area at W-26-35-05-W3M. The subdivision is located directly east of the Casa Rio neighbourhood and is located south of Saskatoon, Saskatchewan.

Clifton Associates Ltd. (Clifton) contracted Canada North Environmental Services (CanNorth) to complete a desktop Environmental Screening Report for the proposed project area. This included a desktop assessment of the land use, terrain, habitat, native vegetation, sensitive fish habitat, rare and endangered species, and designated areas.

2.0 PROJECT ENVIRONMENTAL OVERVIEW

2.1 Land Use

The proposed project is located within the Rural Municipality (R.M.) of Corman Park (No. 344) (Figure 2). The proposed development area is located on deeded land, which is primarily used for pastureland. The area contains quite high densities of white-tailed deer (*Odocoileus virginianus*). The study area lies within the Saskatoon Wildlife Management Unit, which allows primitive hunting only (A. Winarsky, MOE, pers. comm.). Other land uses within the study area include nature observing and recreational activities.

2.2 Terrain and Habitat

The proposed development area is situated in the Dark Brown Soil Zone of Saskatchewan (Government of Saskatchewan 2005). The surface topography for the northern portion of the project area is described as gently to moderately undulating (1 to 6 % slopes), while the southern portion is mixed undulating and rolling area (1 to 6 % slopes) (Mitchell et al. 1962).

The study area is situated within the Asquith soil association. Soil textures in this area largely consist of very fine sandy loam. In general, stones are rarely a serious problem in the Asquith soil association. Stony phases in the majority of the area range from stone free to areas with occasional stones. However, there are some mixed areas of soils that contain moderately stony to very stony phases (Mitchell et al. 1962).

2.3 Native Vegetation

The project is located within the Moist Mixed Grassland Ecoregion of the Prairie Ecozone. The study area lies within the Moose Wood Sand Hills landscape area bordering the Saskatoon Plain landscape area to the north. The Moist Mixed Grassland Ecoregion is dominated by cropland and tame pasture, with 80 % of the ecoregion under cultivation, although some native grassland areas remain (Acton et al. 1998).

The Moist Mixed Grassland Ecoregion is comprised largely of agricultural lands with distinct native habitat including wetlands and woodlands. Mid-grasses characterize the area with presence of wheatgrasses (*Elymus trachycaulus*), speargrasses (*Poa annua*), rough fescue (*Festuca hallii*), Hooker's oat grass (*Helictotrichon hookery*), and blue gamma grass (*Bouteloua gracilis*). Woodlands are less abundant in the Moist Mixed Grassland Ecoregion and are restricted to small stands around sloughs with presence of trembling aspen (*Populus tremuloides*) with shrubs such as western snowberry (*Symphoricarpos occidentalis*) and prairie rose (*Rosa arkansana*) comprising the understory. The most dominant shrub is pasture sage (*Artemisia frigida*), in addition to patches of willow (*Salix* spp.), wolf-willow (*Elaeagnus commutata*), Saskatoon (*Amelanchier alnifolia*), and choke cherry (*Prunus virginiana*) (Acton et al. 1998).

2.4 Sensitive Fish Habitat

The proposed project does not cross or contain any known streams or rivers in the area, however; the study area does contain one ephemeral waterbody. It is recommended that this ephemeral waterbody be avoided if possible during construction activities. There are not any known fish bearing waterbodies in the project study area.

2.5 Rare and Endangered Species

A data search was conducted through the Saskatchewan Conservation Data Centre (SKCDC) to determine the rare and endangered species that may occur within a 20 km radius around the project area (SKCDC 2005a; Table 1). A description of the SKCDC provincial (S) and global (G) rankings for plants and wildlife is provided in Table 2. A ranking is assigned to every species in the province and those species to which an S1, S2, or S3 ranking has been assigned are considered rare (SKCDC 2008). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) uses a system of seven ranks, including extinct, extirpated, endangered, threatened, special concern, data deficient, and not at risk (COSEWIC 2007). These categories are defined in Table 3.

Federally, the primary legal tool for protecting at-risk species is the Species At Risk Act (SARA). Species designated for legal protection are largely based on determinations by COSEWIC and are presented in Table 1 (SARA 2008). One wildlife species was recorded within the proposed project area. This is the olive-backed pocket mouse (*Perognathus fasciatus*), which is ranked as rare-uncommon by the SKCDC and is not yet listed by COSEWIC. The remaining seven species were found within the 20 km search radius but have not been historically recorded within the proposed project area. Six of these wildlife species are listed by both COSEWIC and SKCDC and were identified in the database search (COSEWIC 2006; Table 1; Figure 2[1]). In addition, one wildlife species that is listed by SKCDC but is not yet ranked by COSEWIC was also identified (SKCDC 2005b; Table 1). All eight of the species have been historically recorded in the 20 km search radius around the project area. These species include the northern leopard frog (*Rana pipiens*), burrowing owl (*Athene cunicularia*), loggerhead shrike (*Lanius ludovicianus*), long-billed curlew (*Numenius americanus*), Sprague's pipit (*Anthus spragueii*), olive-backed pocket mouse, monarch (*Danaus plexippus*), and western tiger swallowtail (*Papilio rutulus*). However, the western tiger swallowtail was an accidental sighting, which means that it was observed outside of the range of where it is expected to be found. For this reason the western tiger swallowtail is not a concern for the project study area (B. Sawa, SKCDC, pers. comm.). The western tiger swallowtail was included for completeness. The proposed project is not located on any migratory bird sanctuaries.

Thirty-seven provincially ranked plant species have been historically recorded within the 20 km search radius for the project (Figure 2[1]). Smooth arid goosefoot (*Chenopodium subglabrum*) is the only plant species listed by both COSEWIC and SKCDC. Five of the plant species are listed as extremely rare by the SKCDC (SKCDC 2005c). These include, Crawe's sedge (*Carex crawei*), dwarf bulrush (*Scirpus rollandii*), mingan moonwort (*Botrychium minganense*), small dropseed (*Sporobolus neglectus*), and smooth wild rose (*Rosa blanda*) (SKCDC 2005c). A complete list of listed plant species is provided in Table 1. The red club-rush (*Scirpus rufus* var. *neogaeus*) and neat bug-seed (*Corispermum nitidum*) were also historically recorded within the search radius but are not yet provincially ranked, however, they were included for completeness.

It is noted that this environmental screening report presents information from database searches and discussions with environmental professionals knowledgeable of the area. However, since no specific field investigations were completed for species at risk in the project's study area the possibility exists that rare species other than those discussed in this report are present.

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[1] Figure 2 only shows the locations of listed species within the map's boundary, which is smaller than the SKCDC search area.

2.6 Designated Areas

The proposed project area does not cross or enter any First Nations Reserve areas or Provincial, National, or Regional parks. In addition, the study area is not located on or near any designated Wildlife Habitat Protection Areas or any crown lands.

2.7 Heritage Resources

It is unknown if there are any existing heritage/archaeological sites in the area, as a heritage resource desktop survey was not completed for the proposed study area.

3.0 REGULATORY REQUIREMENTS AND RECOMMENDATIONS

3.1 Regulatory Requirements

Mr. Lorne Sullivan (Senior Ecological Protection Specialist – Saskatoon, 933-6532) with the Government of Saskatchewan must be contacted regarding any environmental concerns that he may have with the proposed project.

Consultation with the Rural Municipality (R.M.) of Corman Park (No. 344) is required regarding the general details of the project. It is possible that the R.M. may have specific guidelines in regards to subdivision development projects within their boundaries.

3.2 Recommendations

The following section provides recommendations based on appropriate guidelines for construction activities in Saskatchewan. In general, in order to minimize environmental impact, construction procedures should follow recommendations outlined in, SKCDC (2003).

A heritage resources desktop survey was not completed for the proposed study area, therefore, it is unknown if any heritage/archaeological sites exist in the study area. It is recommended that a screening report be completed prior to any construction activities.

One rare and endangered species has been historically recorded within the proposed Casa Grande Subdivision study area; this is the olive-backed pocket mouse. The SKCDC does not provide a recommended setback distance for the olive-backed pocket mouse. Therefore, it is recommended that the Saskatchewan Ministry of Environment be contacted to determine whether any further information is required on the possible presence of the olive-backed pocket mouse.

Habitats in close proximity to the project, including those of non-native vegetation, may be utilized by wildlife. Construction activities should ensure that, where possible, nearby wetlands or ephemerally wet low-lying areas are not drained or modified to facilitate construction activities. If possible, ephemeral waterbodies should be avoided due to the possible presence of sensitive species such as the northern leopard frog. In the event that any rare or sensitive species are encountered, the SKCDC's activity restriction guidelines for sensitive species in natural habitats apply. Five species found within the project study area have recommended setback distances for sensitive species in natural habitats. These setback distances have accompanying restricted activity dates, which are presented in Table 4. Three of the rare plant species have recommended setback distances with accompanying restricted activity dates, which are provided in Table 4. For all other sensitive plant species SKCDC takes a “one-size-fits-all” approach therefore, the remaining sensitive plants have identical setback distances for each disturbance category (SKCDC 2003).

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TABLES

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TABLE 1

List of rare and endangered animal and plant species historically recorded within a 20 km radius of the project area.

Scientific Name	Common Name	Provincial Rank	Global Rank	COSEWIC Rank	SARA Rank
Amphibians					
Rana pipiens	Northern leopard frog	S3	G5	Special Concern	Special Concern
Birds					
Athene cunicularia	Burrowing owl	S2B	G4	Endangered	Endangered
Lanius ludovicianus	Loggerhead shrike	S3B	G4	Threatened	Threatened
Numenius americanus	Long-billed curlew	S3B, S4M	G5	Special Concern	Special Concern
Anthus spragueii	Sprague's pipit	S4B	G4	Threatened	Threatened
Mammals					
Perognathus fasciatus	Olive-backed pocket mouse	S3	G5	NRA	NRA
Invertebrates					
Danaus plexippus	Monarch	S3B	G5	Special Concern	Special Concern
Papilio rutulus	Western tiger swallowtail *	SNA	G5	NRA	NRA
Plants					
Rorippa curvipes var. *truncata*	Blunt-leaved yellow-cress	S2S3	G5	NRA	NRA
Carex eburnea	Bristle-leaved sedge	S2	G5	NRA	NRA
Ambrosia acanthicarpa	Bur ragweed	S2	G5	NRA	NRA
Potentilla paradoxa	Bushy cinquefoil	S2S3	G5	NRA	NRA
Centunculus minimus	Chaffweed	S2	G5	NRA	NRA
Carex crawei	Crawe's sedge	S1	G5	NRA	NRA
Viola pedatifida	Crowfoot	S3	G5	NRA	NRA
Chenopodium desiccatum	Dry goosefoot	S2	G5	NRA	NRA
Scirpus rollandii	Dwarf bulrush	S1	G3Q	NRA	NRA
Eleocharis engelmannii	Engelmann's spike-rush	S2	G4G5Q	NRA	NRA
Aster pauciflorus	Few-flowered aster	S3	G4	NRA	NRA
Potentilla nivea var. *pentaphylla*	Five-foliate cinquefoil	S2	G5T4	NRA	NRA
Astragalus aboriginum	Indian milk-vetch	S2	G5	NRA	NRA
Myosurus minimus	Least mousetail	S2S3	G5	NRA	NRA
Astragalus lotiflorus	Low milk-vetch	S3	G5	NRA	NRA
Lomatogonium rotatum	Marsh felwort	S2	G5	NRA	NRA
Silene menziesii	Menzies' catchfly	S3	G5	NRA	NRA
Botrychium minganense	Mingan moonwort	S1	G4	NRA	NRA
Elatine rubella	Mud purslane	S2	G5	NRA	NRA
Chenopodium leptophyllum	Narrowleaf goosefoot	S4B	G5	NRA	NRA
Corispermum nitidum	Neat bug-seed	S2?	GU	NRA	NRA
Scirpus pallidus	Pale bulrush	S2	G5	NRA	NRA
Marsilea vestita	Pepperwort	S2S3	G5	NRA	NRA
Carex hystericina	Porcupine sedge	S2	G5	NRA	NRA
Senecio plattensis	Prairie ragwort	S3S4	G5	NRA	NRA
Scirpus rufus var. *neogaeus*	Red club-rush	SNR	G5TNR	NRA	NRA
Sambucus racemosa ssp. *pubens*	Red elderberry	S3	G5T4T5	NRA	NRA
Hedeoma hispida	Rough pennyroyal	S3	G5	NRA	NRA
Elymus lanceolatus ssp. *psammophilus*	Sand-dune wheatgrass	S2	G5T3	NRA	NRA
Sporobolus neglectus	Small dropseed	S1	G5	NRA	NRA
Lupinus pusillus	Small lupine	S3	G5	NRA	NRA
Chenopodium subglabrum	Smooth arid goosefoot	S2	G3G4	Threatened	NRA
Rosa blanda	Smooth wild rose	S1S2	G5	NRA	NRA
Elymus glaucus	Smooth wild-rye	S2	G5	NRA	NRA
Bidens frondosa	Tall beggar's-ticks	S2S3	G5	NRA	NRA
Potamogeton strictifolius	Upright narrow-leaved pondweed	S2	G5	NRA	NRA
Erigeron strigosus	White-top	S2S3	G5	NRA	NRA
Impatiens noli-tangere	Yellow touch-me-not	S3S4	G4G5	NRA	NRA
Rhinanthus minor	Yellow-rattle	S2S3	G5	NRA	NRA

NRA = no ranking available

Rankings from SKCDC 2005b, 2005c, COSWIC 2006, and SARA 2008.

* Western tiger swallowtail occurred outside its typical range and therefore is not a concern for the project study area.

TABLE 2

Saskatchewan Conservation Data Centre (SKCDC) rank definitions of plants and wildlife.

Provincial (S) Rank	Global (G) Rank	Status	Description
S1	G1	Extremely Rare	5 or fewer occurrences; or only a few remaining individuals.
S2	G2	Rare	6 to 20 occurrences or with many individuals in fewer occurrences.
S3	G3	Rare – Uncommon	21-100 occurrences, may be rare and local throughout its range, or in a restricted range (may be abundant in some locations or may be vulnerable to extirpation because of some factor of its biology).
S4	G4	Common	Apparently secure under present conditions, typically >100 occurrences, but may be fewer with many large populations; may be rare in parts of its range, especially peripherally.
S5	G5	Very Common	Demonstrably secure under present conditions, > 100 occurrences, may be rare in parts of its range, especially peripherally.
Provincial Rank Modifiers			
A		-	Accidental or casual in the province, including species (such as birds or butterflies) recorded infrequently that are far outside their range.
B		-	For a migratory species, rank applies to breeding population.
E		-	Exotic species established in the province, may be native to nearby regions.
H		-	Historical occurrence but without recent verification (e.g., within 20 years).
N		-	For a migratory species, rank applies to non-breeding population.
M		-	For migratory species, rank applies to the transient population.
SNR		-	Species not ranked.
SNA		-	Conservation status not applicable.
X		-	Believed to be extinct or extirpated.
Z		-	No practical conservation concern since there are no mappable and predictable occurrences (migrants).
?		-	Not yet ranked in Saskatchewan.
Global Rank Modifiers			
Q		-	Taxonomic question: taxonomic status is questionable; numeric rank may change with taxonomy.
G#T#		-	Subspecies: numeric designations based on same criteria as those for global ranks.
G#?		-	Uncertain: insufficient information to give a definitive ranking. Confidence of numeric rank is plus or minus one rank.
HYB		-	Hybrid.

Source: SKCDC 2008.

TABLE 3

Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status categories.

Status Category	Definition
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)	A species that is particularly sensitive to human activities or natural events, but is not an endangered or threatened species.
Data Deficient (DD)	A species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction.
Not At Risk (NAR)	A species that has been evaluated and found to be not at risk.

Source: COSEWIC 2007.

TABLE 4

Saskatchewan Conservation Data Centre (SKCDC) activity restriction guidelines for sensitive species in natural habitats.

Scientific Name	Common Name	Key Wildlife Areas	Restricted Activity Dates	Recommended Setback Distance for High Disturbance Category
Amphibians				
Rana pipiens	Northern leopard frog	Ponds used for breeding, living, or hibernating	April 1 - October 31	500 m
Birds				
Athene cunicularia	Burrowing owl	Nest site	April 1 - July 15	500 m
			July 16 - October 15	500 m
			October 16 - March 31	500 m
Lanius ludovicianus	Loggerhead shrike	Nest site	May 1 - August 15	400 m
Numenius americanus	Long-billed curlew	Nest site	April 15 - July 15	200 m
Anthus spragueii	Sprague's pipit	Nest site	April 21 - August 31	250 m
Invertebrates				
Danaus plexippus	Monarch	N/A	N/A	N/A
Papilio rutulus	Western tiger swallowtail	N/A	N/A	N/A
Mammals				
Perognathus fasciatus	Olive-backed pocket mouse	N/A	N/A	N/A
Plants				
Rorippa curvipes var. *truncata*	Blunt-leaved yellow-cress	N/A	N/A	25 m *
Carex eburnea	Bristle-leaved sedge	N/A	N/A	25 m *
Ambrosia acanthicarpa	Bur ragweed	Population	Year round	50 m
Potentilla paradoxa	Bushy cinquefoil	N/A	N/A	25 m *
Centunculus minimus	Chaffweed	N/A	N/A	25 m *
Carex crawei	Crawe's sedge	N/A	N/A	25 m *
Viola pedatifida	Crowfoot	N/A	N/A	25 m *
Chenopodium desiccatum	Dry goosefoot	N/A	N/A	25 m *
Scirpus rollandii	Dwarf bulrush	N/A	N/A	25 m *
Eleocharis engelmannii	Engelmann's spike-rush	N/A	N/A	25 m *
Aster pauciflorus	Few-flowered aster	N/A	N/A	25 m *
Potentilla nivea var. *pentaphylla*	Five-foliate cinquefoil	N/A	N/A	25 m *
Astragalus aboriginum	Indian milk-vetch	N/A	N/A	25 m *
Myosurus minimus	Least mousetail	N/A	N/A	25 m *
Astragalus lotiflorus	Low milk-vetch	N/A	N/A	25 m *
Lomatogonium rotatum	Marsh felwort	N/A	N/A	25 m *
Silene menziesii	Menzies' catchfly	N/A	N/A	25 m *
Botrychium minganense	Mingan moonwort	N/A	N/A	25 m *

TABLE 4

Saskatchewan Conservation Data Centre (SKCDC) activity restriction guidelines for sensitive species in natural habitats.

Scientific Name	Common Name	Key Wildlife Areas	Restricted Activity Dates	Recommended Setback Distance for High Disturbance Category
Elatine rubella	Mud purslane	N/A	N/A	25 m *
Chenopodium leptophyllum	Narrowleaf goosefoot	N/A	N/A	25 m *
Corispermum nitidum	Neat bug-seed	N/A	N/A	25 m *
Scirpus pallidus	Pale bulrush	N/A	N/A	25 m *
Marsilea vestita	Pepperwort	N/A	N/A	25 m *
Carex hystericina	Porcupine sedge	N/A	N/A	25 m *
Senecio plattensis	Prairie ragwort	N/A	N/A	25 m *
Scirpus rufus var. *neogaeus*	Red club-rush	N/A	N/A	25 m *
Sambucus racemosa ssp. *Pubens*	Red elderberry	N/A	N/A	25 m *
Hedeoma hispida	Rough pennyroyal	N/A	N/A	25 m *
Elymus lanceolatus ssp. *psammophilus*	Sand-dune wheatgrass	N/A	N/A	25 m *
Sporobolus neglectus	Small dropseed	N/A	N/A	25 m *
Lupinus pusillus	Small lupine	Population	Year round	50 m
Chenopodium subglabrum	Smooth arid goosefoot	Population	Year round	50 m
Rosa blanda	Smooth wild rose	N/A	N/A	25 m *
Elymus glaucus	Smooth wild-rye	N/A	N/A	25 m *
Bidens frondosa	Tall beggar's-ticks	N/A	N/A	25 m *
Potamogeton strictifolius	Upright narrow-leaved pondweed	N/A	N/A	25 m *
Erigeron strigosus	White-top	N/A	N/A	25 m *
Impatiens noli-tangere	Yellow touch-me-not	N/A	N/A	25 m *
Rhinanthus minor	Yellow-rattle	N/A	N/A	25 m *

N/A = none available

SKCDC 2003

* General setback distance for plants

FIGURES

LIST OF FIGURES

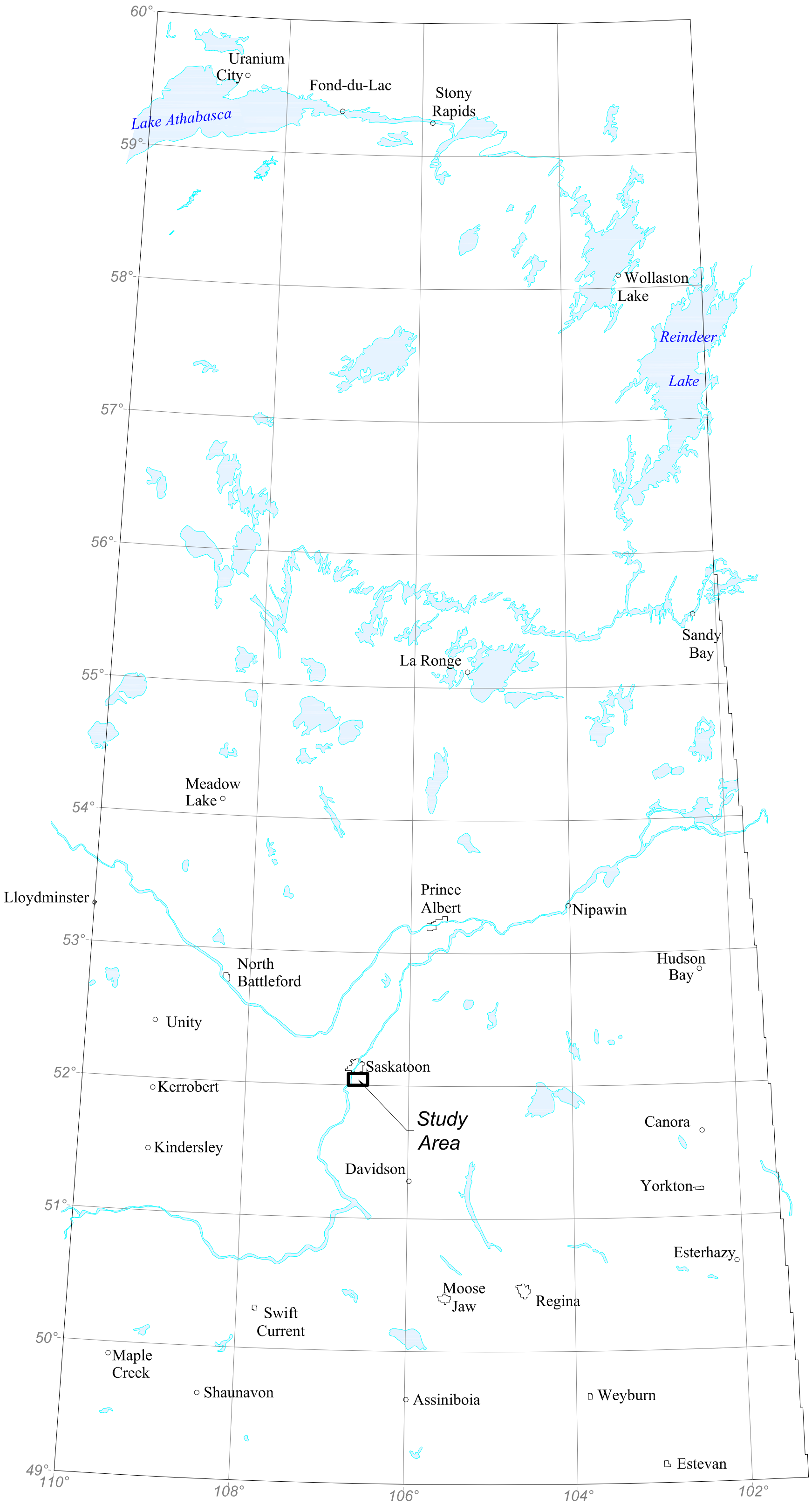
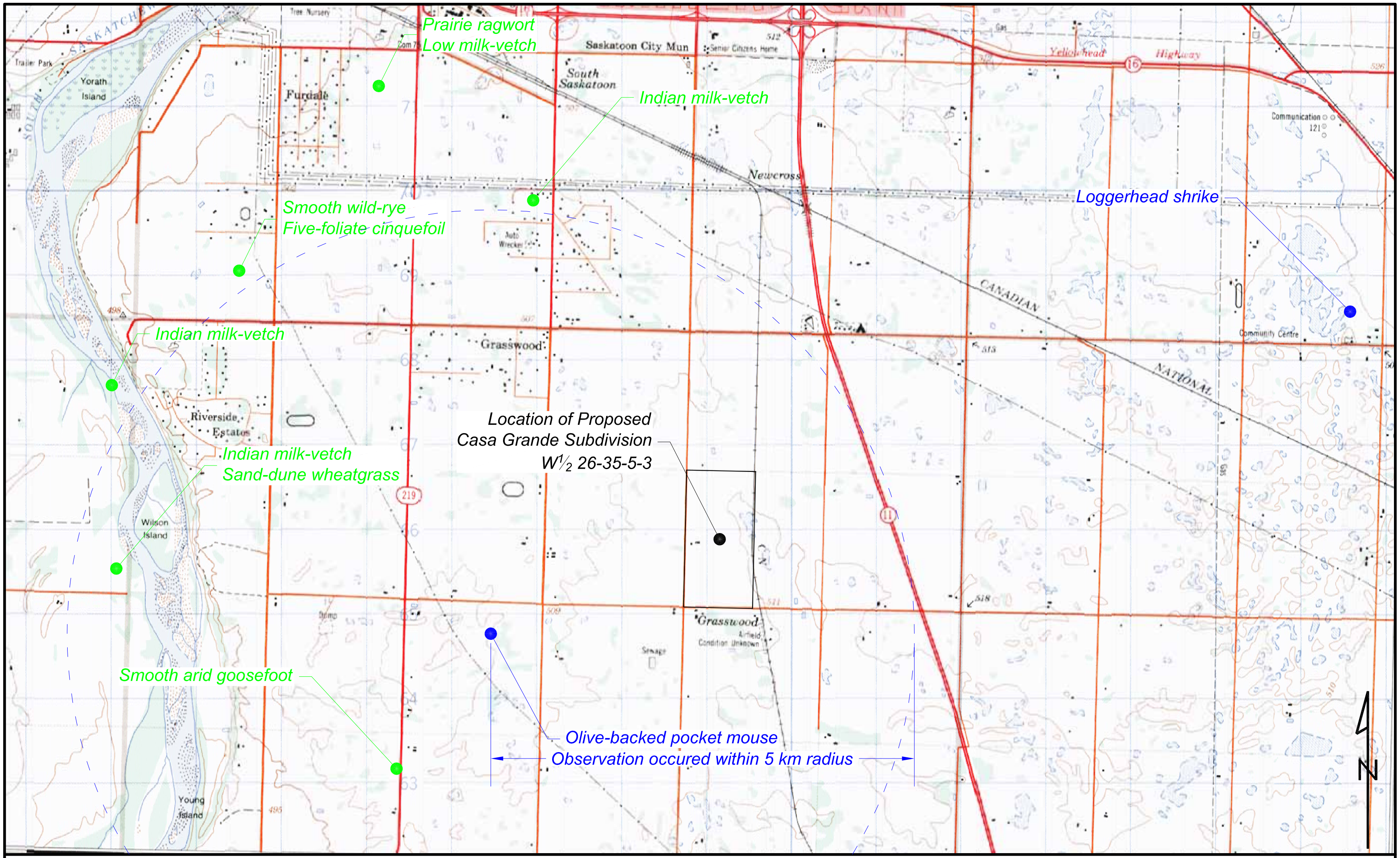


Figure 1 Study location.



Plant Species
Animal Species

CanNorth

0 3
kilometres

Figure 2
Study area.

Appendix C
Prairie Spirit School Division Correspondence

Maggie Schwab

From: Sharon Compton [sharon.compton@spiritsd.ca]
Sent: December 12, 2011 5:47 PM
To: mschwab@crosbyhanna.ca
Cc: Maureen Brown
Subject: FW: Grasswood Estates Proposed Subdivision
Attachments: Grasswood Estates Subdivision November 2011.pdf; ATT00001..htm

Hi Maggie,

Thanks for your patience with a response on your query. I am currently the superintendent responsible for the schools in this area and wanted to be sure to connect with our facilities team in order to provide you the most accurate information.

From a facilities perspective, our present utilization for South Corman Park School is fairly low. We can accommodate a lot more students than we have right now and the influx from the proposed subdivision should not be a problem to absorb.

The challenge will be when these new students attend Clavet School (Gr. 7). They have a high utilization rate and we have been adding relocatables as required and so, we would have to monitor this new development.

Let me know if there is any other information that you might need at this time.

Sharon

Sharon Compton
Learning Superintendent
Prairie Spirit School Division # 206
Box 809
Warman, SK. S0K 4S0
Phone (306) 683-2903

PRAIRIE SPIRIT
SCHOOL DIVISION
PURSUING STUDENT SUCCESS

We shall not cease from our exploring;
and the end of all our exploring shall be to arrive at the place we started
and know it for the first time." Cicero

> **From:** "Maggie Schwab" < >
> **To:** "Karen LaPointe" <karen.lapointe@spiritsd.ca>
> **Subject: Grasswood Estates Proposed Subdivision**
>
> Hi Karen,
>
> I am e-mailing to inquire about the enrolment implications of a proposed new subdivision called the Grasswood Estates subdivision.
>
> Would the school(s) in the R.M. of Corman Park be able to accommodate the potential increases in enrolment generated by this development? There are a total of 83 lots proposed for this

subdivision and it is located in the W ½ 26-35-5 W3M.

I have attached the draft proposed plan of subdivision for your information.

If you could kindly get back to me at your earliest convenience, it would be appreciated.

Thanks,

Maggie Schwab, M.A.
CROSBY HANNA & ASSOCIATES
407 1st Avenue North
Saskatoon, SK S7K 1X5
T (306) 665-3441
F (306) 652-9613
E mschwab@crosbyhanna.ca
www.crosbyhanna.ca

Appendix D
Public Consultation

September 27, 2009

Corman Park Community Association
c/o Mrs Ridgeway,

Dear Council

Urban Elements has purchased the E ½ 26-35-5 W3, the land just north of Casa Rio East, for the purpose of developing the property into 85 residential lots. The property conforms to Corman Park's new residential development bylaws and we have completed an extensive review of all aspects of development as required by Corman Park's planning department. The property has received approvals from all referral agencies for the planned sub division, including Public Health. Urban Elements is now in the final stages of making a formal application to Corman Park and the provincial Community Planning department for their review.

The Corman Park Community Association will remember Urban Elements and K&K Land Management have discussed this project on a number of previous occasions with the Association.

This letter is written to request the Community Associations support for the project as well as respond to a couple of outstanding issues.

First, Urban Elements has offered the Corman Park Community Association $250,000 cash or a new lot in Grasswood Estates for a lottery home, the proceeds of either to go towards improvements at the School and/or Community Association if the development obtains approval to proceed. At our last meeting, the Association expressed an interest in a Home Lottery as a means to make additional money for the Community. We have not heard of the direction in which the Council would like to proceed, however to make the lottery easier for the Association, we would offer a new lot within the sub division as well as finance and manage the new home construction for such a lottery. Urban Elements would provide a free lot and management for the construction on the condition the home cost would be reimbursed to Urban Elements by the Association at the end of the lottery. The choice is yours, please let us know.

Second, there is always a concern with respect to environmental protection, especially as it relates to septic fields and the potential for increased nitrate levels in ground water. To put this issue into perspective, a family of four is estimated to contribute approximately 50 pounds of nitrate nitrogen per year into the septic field. While not insignificant, it is considerably less than the average nitrogen application to the majority of seeded agricultural land in Saskatchewan.

Regardless this is an important issue for people and one which we take very seriously.

We have taken a number of steps to protect the ground water in the area namely; first a geotechnical review of the property was done by Clifton Associates, a qualified engineering firm, to determine the suitable and recommended type of septic system required. They determined the property was suitable for the number of residential lots on the property and that each could safely have an on site septic disposal field. Public Health concurred and has issued a letter allowing septic fields for all lots.

To further assure perspective lot purchasers and neighbouring residences of the measures taken for environmental protection, Urban Elements is making a mandatory requirement for each lot purchaser to upgrade the septic holding tanks from a two to a three cell system. The three cell systems treat the septic water within the holding tank and reduce nitrate levels by 70%, or to approximately 5 pounds of nitrates per year. Please refer to the attached brochure on the Fast system. In addition, two properties within the development will be monitored, directly adjacent to the septic field, on an ongoing basis to determine the long term extent of septic plume and impact. The result of this review will be posted on the Community Association website.

Urban Elements and K&K Land Management have been very involved in land development over a number of years with an excellent track record for community and municipal involvement. On behalf of our companies we would sincerely ask for your support and encouragement for our residential project and on making this area of Corman Park a preferred place to live.

Sincerely

Urban Elements   K&K Land Management

South Corman Park Community Association Inc.
Box 31, Site 816, R.R. 8
Saskatoon, Saskatchewan
S7K 1M2

March 26, 2012

Urban Elements
K&K Land Management
4780 Prairie Lane
Grasswood, SK S7T 1A7

Re: ***Presentation to Board – January 19, 2012 - Development in South Corman Park***

Dear Neil Ketilson,

The SCPCA, Inc. Board of Directors thanks you for involving us in your residential development plans for the land on the west half of 26-35-5 W3. You have made several presentations to the SCPCA Board of Directors, since 2009, both in person and in writing, that have outlined the research and intensive planning done in preparation for your rural residential development. You have satisfactorily addressed the concerns raised in our early meetings regarding the issue of ensuring suitable septic systems for a rural residential development and the potential negative impact this development may have on the local ground water quality and supply.

Although the issues of groundwater contamination and the environmental impact of increasing population density in the community remain of concern to some of our members, the SCPCA, Inc. Board of Directors has determined that we are not equipped to evaluate these aspects of your proposal nor do we have the financial resources to engage our own experts in examining the information. We must, therefore, defer to the RM Corman Park # 344, other government agencies and private organizations that have been entrusted with the mandate of ensuring that your proposed rural residential development systems are in compliance with applicable provincial and/or national standards. We expect there will be ecologically responsible solutions determined for these important matters.

We are interested in growing our community. We endeavor to create and sustain community spaces for families through playground developments; sports facility and field maintenance; social events; soccer, volleyball and other sporting programs as requested by community members. We provide building spaces, as required, for Preschool Programs, Before and After School Programs and local elementary school activities. These activities require monetary and volunteer contributions from our community members and the SCPCA, Inc.'s Board of Directors for success. We believe that your rural residential development will bring additional community members who will share our views and become actively involved in creating and sustaining safe country places for our families to live, grow, play and learn.

The SCPCA, Inc. Board of Directors looks forward to the RM Corman Park # 344 approving your rural residential development and the growth that will result in our community.

Regards,

Lois Ridgway

Lois Ridgway, Secretary
SCPCA, Inc. Board of Directors

GRASSWOOD ESTATES PROPOSED RESIDENTIAL SUBDIVISION
OPEN HOUSE RESPONSE FORM

Please use this form to record your reactions to the proposed Grasswood Estates residential subdivision and to provide any comments you may have. When completed, please leave the form with us before leaving. Thank-you for your input.

Alternatively, you may send comments to Maggie Schwab by April 23rd, 2012:
mschwab@crosbyhanna.ca

I am impressed with the design of this development. Consideration has been given to make this development community orientated. Due diligence in regards to [illegible] proper sewage disposal, providing [illegible] recreation in a water park, a bike path and/or walking path, thematic colors or cladding all combine to make this development attractive and useful.

Ken Pizurny
5467 Cormorant Park.

GRASSWOOD ESTATES PROPOSED RESIDENTIAL SUBDIVISION
OPEN HOUSE RESPONSE FORM

Please use this form to record your reactions to the proposed Grasswood Estates residential subdivision and to provide any comments you may have. When completed, please leave the form with us before leaving. Thank-you for your input.

Alternatively, you may send comments to Maggie Schwab by April 23rd, 2012:
mschwab@crosbyhanna.ca

Kathy du Plessis 978 9620

- Please can building trucks not use 3051 as main route

GRASSWOOD ESTATES PROPOSED RESIDENTIAL SUBDIVISION
OPEN HOUSE RESPONSE FORM

Please use this form to record your reactions to the proposed Grasswood Estates residential subdivision and to provide any comments you may have. When completed, please leave the form with us before leaving. Thank-you for your input.

Alternatively, you may send comments to Maggie Schwab by April 23rd, 2012:
mschwab@crosbyhanna.ca

I am impressed + pleased to see the detail and fore thought placed on this development. It is good to see a Community being planned not just a group of rural residences. In the past it took 20 yrs before a development acheived the estetic appeal to be called a community. I strongly support a plan such as Grasswood Estates to be a part of South Corman Park.

Dave Bilansk
23 Aspen Way
Beaver Creek Sk.
306-222-4095

GRASSWOOD ESTATES PROPOSED RESIDENTIAL SUBDIVISION
OPEN HOUSE RESPONSE FORM

Please use this form to record your reactions to the proposed Grasswood Estates residential subdivision and to provide any comments you may have. When completed, please leave the form with us before leaving. Thank-you for your input.

Alternatively, you may send comments to Maggie Schwab by April 23rd, 2012:
mschwab@crosbyhanna.ca

I think this development would be good for the area. I'm hoping it will help to improve Preston Ave road.

Grasswood Estates Proposed Residential Subdivision
Open House Response Form

Please use this form to record your reactions to the proposed Grasswood Estates residential subdivision and to provide any comments you may have. When completed, please leave the form with us before leaving. Thank-you for your input.

Alternatively, you may send comments to Maggie Schwab by April 23rd, 2012:
mschwab@crosbyhanna.ca

Suggested that all yard lights
be low wattage or pointed down
to reduce light pollution.

GRASSWOOD ESTATES PROPOSED RESIDENTIAL SUBDIVISION
OPEN HOUSE RESPONSE FORM

Please use this form to record your reactions to the proposed Grasswood Estates residential subdivision and to provide any comments you may have. When completed, please leave the form with us before leaving. Thank-you for your input.

Alternatively, you may send comments to Maggie Schwab by April 23rd, 2012:
mschwab@crosbyhanna.ca

We think this will be a positive residential subdivision. We hope that it will be passed through the RM soon. We also hope that this development will improve Preston Ave. road.

GRASSWOOD ESTATES PROPOSED RESIDENTIAL SUBDIVISION
OPEN HOUSE RESPONSE FORM

Please use this form to record your reactions to the proposed Grasswood Estates residential subdivision and to provide any comments you may have. When completed, please leave the form with us before leaving. Thank-you for your input.

Alternatively, you may send comments to Maggie Schwab by April 23rd, 2012:
mschwab@crosbyhanna.ca

We love the dark starry nights so please ensure there is no light pollution.

GRASSWOOD ESTATES PROPOSED RESIDENTIAL SUBDIVISION
OPEN HOUSE RESPONSE FORM

Please use this form to record your reactions to the proposed Grasswood Estates residential subdivision and to provide any comments you may have. When completed, please leave the form with us before leaving. Thank-you for your input.

Alternatively, you may send comments to Maggie Schwab by April 23rd, 2012:
mschwab@crosbyhanna.ca

As ✓ developments most immediate neighbor my concern is - impact on my lifestyle.

I raise high-end reining horses and have a considerable investment there.

One of my concerns is roaming dogs and the safety of my herd. I would like to see a dog proof - privacy fence along - north perimeter of - development

Maggie Schwab

From: Maggie Schwab
Sent: Thursday, April 26, 2012 11:59 AM
To: 'brad.fettis@shaw.ca'
Cc: 'Darren Hagen'; nketilson@saskpork.com
Subject: RE: Comments on Grasswood Estates open house
Attachments: Response_April_26_Mr_Fettis.docx

Hi Brad,

I forwarded your questions to the Developer. Please see the attached word document for their response.

Thanks,
Maggie

-----Original Message-----
From: brad.fettis@shaw.ca [mailto:brad.fettis@shaw.ca]
Sent: Sunday, April 22, 2012 10:11 PM
To: Maggie Schwab; Sarah Fettis; Bradley V. A. Fettis; durban@sasktel.net
Subject: Comments on Grasswood Estates open house

Maggie,

Please find below the comments and discussion points on the Grasswood Estates open house held after easter.

Firstly, let me say thank you for inviting us to view the proposed development plans.

From this session, my family and I have a few comments that we pass along for your consideration, and feedback, in the near future:

What affects will the sewage disposal have on our well?

What groundwater studies have been done?

What construction schedule will be imposed - evenings/ weekends? During earthmoving? During home construction? What is the estimated duration of each phase of construction? When will it start?

What traffic management will be done on heavy loads? Volume? Limited speeds past residences? For prston and baker?

What socioeconomic studies have been done on the area - schools? Our classrooom size is small, hence the excellent rating of the south cp school.

Will extra resources (grading, gravel dust control) will be put in place for preston grid? Paving?

What dust control measures will be implemented during land scraping, grading of property?

What minimum setback distance will there be from your neighbours? Construction? Home location?

What will be done to ensure pets are kept off our property? We have had and plan to have chickens and will have cows.

Pollution - noise and light? Both during construction and after? White lighting and poorly designed streetlights cause ample light pollution (grasswood esso is a good example)

Will berms be contructed around the outside perimeter during construction?

Will existing fencelines be relocated to the property line? We have had cows, and will again this year.

What weed control will be used during construction?

What baseline waterwell testing has occurred? May we see it? Will monitoring be ongoing?

Where does the groundwater flow? Surface water?

Does the pond have fish? Now? In the future?

Will neighbours be granted access to the amenities of the development?

Will the development grant cash to the community association for facility expansion?

Will dRWU water supply be enough or will it be expanded?

Will existing trees on the property be tore out? And if so, will replacements be planted as greenspace/perimeter trees?

Is the full environmental proposal available for review?

Will there be any job opportunities for community members?

Will there be ongoing community sessions with neighbors from time to time?

That's it for now Maggie.

Please do not hesitate to contact me at any time to discuss.

Thanks,

Bradley Fettis
5207 Preston
Corman Park
2219771
Sent from my BlackBerry® wireless handheld

Dear Mr. Fettis,

Firstly, as you are undoubtedly aware the property for the GWE project was purchased from 3 vendors, one of them being Dennis Muso, the person to whom you purchased your property (house) from. Mr. Muso was fully aware of our proposed development and was totally in support of it. It was a condition of our purchase that he support the project. I trust that you were made of aware of this in advance of your purchase of your house.

Please note our responses your questions below are in blue.

What affects will the sewage disposal have on our well? The septic experts and the Geotechnical Report all suggest that there will be no negative impact on surrounding wells.

What groundwater studies have been done? A detailed Geotechnical Report was prepared by Clifton & Associates.

What construction schedule will be imposed - evenings/ weekends? During earthmoving? During home construction? What is the estimated duration of each phase of construction? When will it start? Construction will be started as soon as the required approvals and permits are in place. The pace and schedule will depend on a number of factors such as weather, season, availability.

What traffic management will be done on heavy loads? Volume? Limited speeds past residences? For preston and baker? If the RM requires constraints in this regard it will be done thru various contractual obligations between the developer and the RM. It is noted that a Traffic Impact Assessment was completed in 2009 and then updates were completed in 2012 as a part of this proposed Development and the only issue identified was a warrant for a right hand turning lane at Baker Road at Highway 11. Please note that the Ministry of Highways and Infrastructure have had a tentative plan to construct this turning lane for the last two years.

What socioeconomic studies have been done on the area - schools? Our classrooom size is small, hence the excellent rating of the south cp school. We have written confirmation from the Prairie Spirit School Division that the enrollment at South Corman Park school is low. The school has indicated they can accommodate more students, and that the potential influx of students from our development will not be a problem.

Will extra resources (grading, gravel dust control) will be put in place for preston grid? Paving? This is an issue that may be addressed with the RM through Servicing Agreements.

What dust control measures will be implemented during land scraping, grading of property? Same as issue above.

What minimum setback distance will there be from your neighbours? Construction? Home location? All RM setbacks will be strictly adhered to, as specified in the R.M.'s Zoning Bylaw.

What will be done to ensure pets are kept off our property? We have had and plan to have chickens and will have cows. Thank you for making us aware of this issue, as it could cause a problem for us. Please advise what type of fence you have in place to ensure that your livestock do not wonder off your property during and after construction.

Pollution - noise and light? Both during construction and after? White lighting and poorly designed streetlights cause ample light pollution (grasswood esso is a good example). We are writing in lighting restrictions in our building restrictions. We will make every effort to protect against light pollution. Please advise what type of lighting you have as it may be a good option for us to implement.

Will berms be contructed around the outside perimeter during construction? No.

Will existing fencelines be relocated to the property line? We have had cows, and will again this year. We are not sure what you mean by this. We will not be fencing all the proposed lots.

What weed control will be used during construction? Potentially an issue that will be handled through the Servicing Agreement.

What baseline waterwell testing has occurred? May we see it? Will monitoring be ongoing? We have not undertaken well water testing. The Geotechnical report will be a matter of public record with the RM. The Saskatoon Health Region has provided written confirmation that the proposed septic system is "a more than acceptable" means of treating wastewater. We have also committed to conducting an ongoing environmental monitoring program. This program will include the installation of strategic monitoring piezometers at two of the lots on the property in addition to annual water sampling, analysis and public reporting to the R.M. of Corman Park. The administration of this monitoring system will be provided through the septic utility created as a part of this development.

Where does the groundwater flow? Surface water? The drainage plan as designed by the engineers indicates that surface water will drain to the existing pond.

Does the pond have fish? Now? In the future? We have hired biologists to complete an environmental study to be conducted this spring. As such, we cannot at this time speak to the presence of fish in the pond, but please be ensured that we are undertaking the necessary steps to identify any animals including fish, waterbirds, amphibians, and birds existing on the property. Additionally, the biologists we have hired will be documenting the health of the vegetation community at the site, and will conduct a rare plant survey. Lastly, a wetland classification will be undertaken for the existing pond at the east side of the property. If any issues are identified by the biologists at the time of the assessment, we will work with them to avoid or mitigate any problems.

Will neighbors be granted access to the amenities of the development? Yes, we are intending this to be the case and expect that the amenities to be treated with respect by all users.

Will the development grant cash to the community association for facility expansion? Yes provided that full approval is granted by all governmental authorities in a timely manner. The cash grant/gift is $250k.

Will dRWU water supply be enough or will it be expanded? It is sufficient to accommodate the needs of the proposed development. In fact GWE was has paid a sizeable deposit. In the event that approval is not granted by the summer of 2012 then GWE will not be making the further half million dollar payment required. We understand that this will cause all other users to contribute additional funds.

Will existing trees on the property be tore out? And if so, will replacements be planted as greenspace/perimeter trees? Yes it is very likely some trees will need to be removed, but it is our intention to retain as many as possible to provide for a natural-looking environment. We expect that landscapes, including trees will be developed by residents as the development fills in.

Is the full environmental proposal available for review? The Comprehensive Development Review (which will contain the environmental assessment report) will become a matter of public record once the document has been submitted to the RM.

Will there be any job opportunities for community members? Not sure what you are referring to. I anticipate that if there are part time jobs there may be a preference given to those that pay the GWE Community Association fees.

Will there be ongoing community sessions with neighbors from time to time? We suspect that you are a member of the SCPCA. Undoubtedly the two associations will communicate.

Thanks for your questions Mr. Fettis.

From: Maggie Schwab
Sent: Thursday, April 26, 2012 10:29 AM
To: 'Dave Gillespie'
Subject: RE: Proposed Grasswood Estates

Hello Mr. Gillespie,

I forwarded your response to the Developers. They have asked that I reply with the following:

"Thank you for your email of April 24th, 2012. We were aware of the Aerodrome and we appreciate your comments. We will of course make sure all parties including purchasers of the lots are aware of the Aerodrome. If you have any questions please feel free to contact the developer: Darren Hagen email durban@sasktel.net."

Kindest regards,

Maggie Schwab, M.A.
CROSBY HANNA & ASSOCIATES
407 1st Avenue North
Saskatoon, SK S7K 1X5
T (306) 665-3441
F (306) 652-9613
E mschwab@crosbyhanna.ca
www.crosbyhanna.ca

From: Dave Gillespie [mailto:gillespiebright@gmail.com]
Sent: Tuesday, April 24, 2012 8:18 PM
To: Maggie Schwab
Subject: Proposed Grasswood Estates

Maggie Schwab,
I have just returned to the country and have received your letter regarding the proposed Grasswood Estates. I would like to take this opportunity to inform you that there is an Aerodrome on my land which is "kitty corner" to your planned location. You can see my property on your plan map. It is south of Baker Rd. and east of Casa Rio East. My property is shaped like a keystone, and easy to see on your plan. This Aerodrome , known as Grasswood Landing, has been is service since the early 1980s . It is recognized as an Aerodrome and falls under the jurisdiction of the Minister of Transportation. There are 11 private aircraft usually based and operating here. While the approach and departure pattern does not conflict with your property , the legal established downwind flying pattern for runway 31 does go over your property at 1000' . I would like you to be aware of this and perhaps you should inform your home buyers of the Aerodrome location and activity. Casa Rio East has the location of the Aerodrome listed on all the titles to those properties, so there can be no misunderstanding by the home buyers,that the Aerodrome exists and will continue operation in the future. Aircraft will be operating in the vicinity of your proposed Grasswood Estates. If you have questions or require more information about our Aerodrome pleas contact me.

Dave Gillespie
Grasswood Landing
35326 Range Rd. 3051
Corman Park, SK. S7T 1C1

Ph.. 955-1320
Cell 230-6404

Maggie Schwab

From:	Maggie Schwab
Sent:	Wednesday, May 02, 2012 9:41 AM
To:	Rod Newlove
Cc:	nketilson@saskpork.com; Darren Hagen
Subject:	RE: proposed residential subdivision

Please find responses from the Developers below in blue.

From: Rod Newlove [mailto:rnewlove@apdweblink.com]
Sent: May-01-12 12:08 PM
To: 'Maggie Schwab'
Cc: 'Darren Hagen'; Neil Ketilson; Brenda; rmcormandiv2@gmail.com
Subject: RE: proposed residential subdivision

Can you let me know when this will be going to a public vote

Yes, there will be an opportunity for public input again, although the date has not yet been set.

See my responses in RED

From: Maggie Schwab [mailto:mschwab@crosbyhanna.ca]
Sent: Tuesday, May 01, 2012 10:57 AM
To: Rod Newlove
Cc: Darren Hagen; 'Neil Ketilson'
Subject: RE: proposed residential subdivision

Good Morning Mr. Newlove,

Please find attached the responses from the Developer below in blue.

RE: Proposed residential subdivision.

This being basically built in our back yard I have several huge concerns.

One of the main reasons we moved out here is so that we wouldn't be surrounded by residences, a place you can walk away from your house and not having to worry about locking down everything. We are not sure how to respond to this. Many of the original residents in the South Corman Park area can say the thing about the development that you reside in. I have a good friend that has lived in the area for over 25 years and he understands that development if done properly is a good thing.
Will the developer be held responsible for any theft, vandalism from having an additional 80+ homes put in within crawling distance of the back my house? No the Grasswood Estates developer will not be responsible for any future theft, vandalism etc , nor as is reasonable, the developer of South Point responsible for present issues of theft or vandalism etc. Further, we anticipate the new residents of Grasswood Estates will be as concerned about property security in the entire neighbourhood and therefore new neighbours through a community watch program will be good for all.

Huge concerns with the ground water contaminations with the additional 40-80 + septic fields a few hundred feet from our well. The proposed septic system is a very good "state of the art" system. The engineers have told us that it is

environmentally sound and in fact Saskatoon Health has indicated that the proposed system is "more than adequate". In fact it might be the same type of system that you have. Will you be kind enough to share the details of your system to us, as we are always looking for better and more improved options.
Maybe you didn't understand the question, I am not concerned about my septic field it operates fine. But my concern is the additional ground / drinking water contamination from having the additional 80+ homes dumping into it. Will the developer be held responsible for ANY degradation of our well water quality that I have tested frequently? It is our understanding Public Health reviews on site septic systems with the objective of protecting water quality in the entire area. Given Public Health's statement with respect to the septic systems to be used at Grasswood Estates, we are confident they have considered and consider the impact of the system on the local water supply to be safe.

The amount of noise from construction, traffic and from the extra residences. Please note that as a part of the development process, we hired an engineering firm to undertake a Traffic Impact Assessment. The assessment resulted in the conclusion that a right turn lane is warranted for the corner of Highway #11 at Baker Road. Please note that the Ministry of Highways and Infrastructure have had a plan to complete this turning lane for the last two years. The R.M. of Corman Park is also aware of the all studies and opinions that we have been made aware of, and we will follow all directions from the authorities concerning the roadways. We would like to see a speed reduction and or proper signage around the school area to make motorists aware of the "school zone".
See below

The extra hundreds of vehicles traveling up and down Baker road. Same as above.
This still does not address the concern on the additional traffic noise. The RM can't seem to maintain Baker Road now and keep on top of filling holes in it.. how is it going to be once it is getting 5 or 6 times the traffic on it?
Appreciate your issue, however roads are public and perhaps will improve with more tax payers.

The huge mess of blowing dirt from the excavation in our back yard. We understand that construction that is nearby is a temporary issue. We are hopeful that the disruption will be minimal.
Temporary is a weekend or maybe a week or two, NOT a year or two.

Our property value will drop substantially with 40-80 homes in our back yard I am certain. That is an interesting thought, as our experts have told us that the development will enhance the neighbouring areas and we understand the opposite to what you feel will occur.
Well OUR EXPERTS have told us the exact opposite.
I guess our advisors have different opinions.

Regards,

Rod Newlove
15 South Point Lane
668-5219

Maggie Schwab

From: Maggie Schwab
Sent: Thursday, April 26, 2012 1:37 PM
To: Barb Lawless
Subject: RE: Comments regarding Grasswood Estates Proposed Subdivision

Hello Barb,

I forwarded your questions on to the developer. Please see below for their responses (in red).

Kindest regards,

Maggie Schwab, M.A.
CROSBY HANNA & ASSOCIATES
407 1st Avenue North
Saskatoon, SK S7K 1X5
T (306) 665-3441
F (306) 652-9613
E mschwab@crosbyhanna.ca
www.crosbyhanna.ca

From: Barb Lawless [mailto:barb.lawless@yourlink.ca]
Sent: Sunday, April 22, 2012 11:00 PM
To: Maggie Schwab
Subject: Comments regarding Grasswood Estates Proposed Subdivision

I would like to share some of my comments regarding this new proposed subdivision:

I am totally in support of growth and future subdivisions around my community. It betters the community and with our location so close to the city, we have to expect it.

This community would be a great support for the South Corman Park School and its location makes sense. Extra enrollment would be beneficial to the school as there is room for extra students. I would strongly recommend that when marketing this subdivision to state how fantastic this school is and that new families moving in should support it. As a family that has children attend this school, we often see that because of SCPS's close proximity to Saskatoon, SCP is in competition with many schools in the city and unfortunately loses potential students to city schools. Thank you for the comments concerning the school. We aware of the school and the excellent reputation that it has. We have received written communication from the School Division indicating the need for more children and their support for our project.

The main roadways that we currently have (Clarence Avenue and Baker Road) are in really rough shape and increased traffic on this road will make it worse. How can the RM improve these roads when they already don't have a decent budget for roads currently? Also, at the intersection of Highway 11 and Baker Road there is no separate turning lane off the highway but rather a shoulder and it's a dangerous intersection already. 80 more acreages will further impact the performance of this intersection. As well, 80 more acreages will increase the amount of traffic in our area especially close to the school. There is no fence protecting the SCP playground from Baker Road and speed limits are in excess of 80 km. We have sourced out "Traffic Studies" to our engineers and also to the provincial department of highways. The RM of Corman Park is aware of the all studies and opinions that we have been made aware of and we will follow all directions from the authorities concerning the roadways. We would like to see a speed reduction and or proper signage around the school area to make motorists aware of the "school zone".

Strict building restrictions should be in place and enforced to keep in sync with the existing luxury homes. I would like to see high end homes, otherwise it will affect my property value. I would be fully in support if the homes were of a higher caliber, but would be less supportive if home were of a lower caliber. As well, time restrictions should also be in place so owners finish their landscaping in a timely fashion. We will have extensive building restrictions and the homes will be of the size and caliber seen in Casa Rio East. The RM will not be responsible to enforce the restrictions as it will be done by the developer.

It would be fantastic if this subdivision would contribute funds towards the Community Association! The existing building is desperate for repairs. What agreement would be in place to make sure this is executed? We have committed a payment of $250,000 towards the South Corman Park Community Association. The commitment is premised on the full approval of 83 acreage lots, in a timely manner.

How would 80 more septic fields affect water and contamination? Especially for those who have well-water. Is there room to have a septic field on such a small acreage lot? I believe that some of the lots are as small as an acre. We have referred our proposed septic system to the Saskatoon Department of Health and we have been advised that it is "more than adequate". We understand that the RM is aware of the usage of the state of the art system in many other jurisdictions and is recognized as being environmentally safe and sound.

When asked what price point these lots would be, the owners couldn't answer that. It's difficult for neighbours to provide comments on a subdivision when we don't know how much the lots are. A price point would demonstrate the caliber of lots (lower end or higher end). When we were ask pricing we were non committal as there are a number of factors taken into account when pricing, marketing and selling the lots. We expect the lots to retail in the range of $200k-$300k.

I would appreciate it if you could forward a site plan to me by email.

Thanks for having the Open House.

Warm Regards,

Barb Lawless – 30 Mandalay Drive

Appendix E
Saskatoon Health Region

Saskatoon Health Region

Public Health Services
Safe Communities Department
#101-310 Idylwyld Drive North
SASKATOON SK S7L 0Z2
Phone: 655-4605 Fax: 655-4498

April 1, 2009

Mr. Neil Ketilson
Bay 2, Main Floor
502 45th St. West
Saskatoon, SK S7L 6H2

Dear Mr. Ketilson:

Re: Review of Hydrogeological Study for Proposed Casa Grande Subdivision
Rural Municipality of Corman Park, No. 344
West ½ 26-35-5-W3M

This letter is to confirm that our department has reviewed the hydrogeological study you've submitted for your proposed Casa Grande Subdivision. I would like to note the following points addressed in the report which are relevant to an assessment of the proposed land location for adequate sewage treatment and disposal:

- 133 water withdrawal wells and five water test hole records within a one mile radius of the site
- Depth to water table identified as being between 2 - 6.75 m, showing the minimum separation distance of 1.5m can be met
- Soil textures classifications of 5 soil samples show range from clay loam to sandy loam, all of which are suitable for subsoil effluent treatment/disposal, depending on square footage of disposal field built
- "The soil loading rate used to size the selected system should be determined based on the lowest soil loading rate of any of the materials encountered in the upper 900mm of soil (excluding topsoil)"
- Nitrate levels from water samples obtained from 2 boreholes show low natural levels of nitrates in the groundwater (<0.1 - 2.5 mg/L)

I agree with the conclusions given on page 8 where the following types of sewage disposal would be considered acceptable for your proposed development, depending on the site specific soil conditions in the individual disposal areas:

- Holding tanks
- Two chambered septic tanks with pressure absorption/chamber systems
- Two chambered septic tanks with type II (pressurized) mound systems

- Three chambered septic tanks (package treatment plants) with pressure absorption/chamber systems
- Three chambered septic tanks (package treatment plants) with type II (pressurized) mound systems

I understand, through consultations you've had with our office that you are considering package treatment plants as a preferred method of sewage disposal. If so, our office would consider that more than acceptable.

It is important to note that this letter does not negate the need to go through the proper regulatory channels for assessment of your proposed subdivision (i.e. Municipal Affairs – Community Planning Branch).

If I can be of other assistance, please let me know.

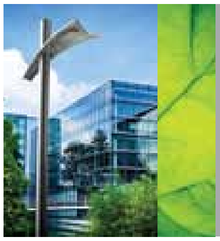
Sincerely,

Michael Newell
Interim Supervisor, Safe Communities

cc: District/Regional File

Appendix F

Low Light Pollution Fixtures



LEONIS

SERIES

Product Overview and Technical information »

PHILIPS
LUMEC

»

LUMINAIRE > LEN5

POWERED BY
LifeLED™

LEN / LED

LEN / HID

LEONIS
SERIES

Landmark of a new world / On all continents and in every discipline, people are creating the environments that we'll inhabit tomorrow. The Leonis is the culmination of years of effort from design professionals dedicated to improving the outdoor lighting environment so that the future will not only be ecologically sound but also aesthetically pleasing. >>


»
LUMINAIRE > LEN5

BEAUTY

A well-designed product transcends fashion and has a long life because its form is continuously appreciated and contributes to the beautification of its surroundings. The Leonis is not only a technological marvel, it is a work of art that will stand, and withstand, the test of time. Leonis adds value to any project, large or small, simply by being what it is: A landmark of a new world.

INTELLIGENCE

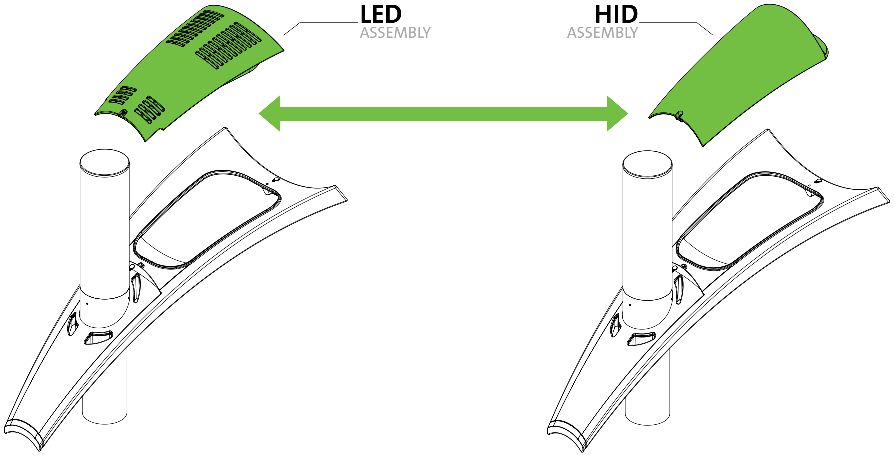
Philips Lumec has created the Leonis with beauty, sustainability and durability in mind. Environmental responsibility is part of the Philips Lumec company culture and is demonstrated through the Leonis by its efficiency and state-of-the-art light sources as well as its low life-cycle cost. The Leonis allows you to create a beautiful, durable project while providing energy savings and safety. For Philips Lumec, that is the definition of Intelligence. The choice is yours: the outcome is beauty, visible quality, and considerable energy savings. »

BENEFITS

- Reduced energy costs and maintenance costs.
- Reduced light pollution.
- Modular design allows HID to LED system upgrade.
- Highly optimized light distribution performance.
- Increased design life with its pure lines and dynamic shapes.

VERSATILITY

Thanks to a forward thinking design team, the polyvalent Leonis can be fitted with either LED or HID lighting technologies. And if you opt for the latter, a LifeLED module can be retrofitted into your existing Leonis and easily replace your HID optics when you are ready to take advantage of our award-winning LED engine.

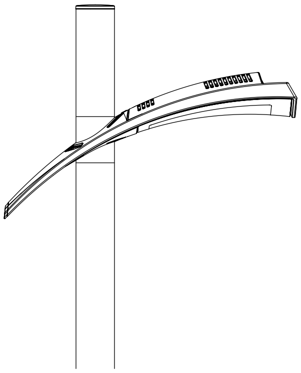


LIFESPAN

The sturdy and high-quality materials chosen when manufacturing the Leonis make it a durable and dependable luminaire. But what will truly make it stand out, even in a few decades, is its aesthetics. The curves and lines of its unique design, the eloquent simplicity of its looks, and the futuristic elegance of its shape ensure the Leonis a long-term presence in public spaces.

ENVIRONMENTAL RESPECT

Designed with the environment in mind, the Leonis truly changes the way the game is played when it comes to sustainability. This luminaire offers exceptional photometric performances, while casting no light up to help preserve the Dark Sky, and will allow for unparalleled energy savings when powered by LifeLED. Furthermore, because it is made in aluminum, the luminaire is 94% recyclable when it reaches the end of its life.



=

POWERED BY LIFELED

The LifeLED light engine represents Philips Lumec's pioneering contribution to the world of lighting. Still unmatched in terms of performance, photometry, and pricing, it is engineered to power a variety of luminaires and has been specially adapted to seamlessly blend into the Leonis' sleek assembly.

The LifeLED offers more than 70,000 hours of operational lifespan, far surpassing any other lighting technology, and guarantees perfect photometric light distribution, greater pole spacing, as well as far superior light quality. Because it has been so meticulously engineered, the LifeLED will consume less electricity while still delivering the target lumens you need.

The LifeLED is equipped with an advanced aluminum heat sink and mounted on a specialized aluminum circuit board, ensuring optimal heat dissipation and management, and allowing it to function at peak performance levels.

The high-end technology of the LifeLED will reduce energy consumption, maintenance cost, and the environmental footprint of the Leonis.

BETTER PHOTOMETRIC PERFORMANCE

+

OPTIMAL THERMAL MANAGEMENT

=

REDUCED ENERGY CONSUMPTION

REDUCED MAINTENANCE COST

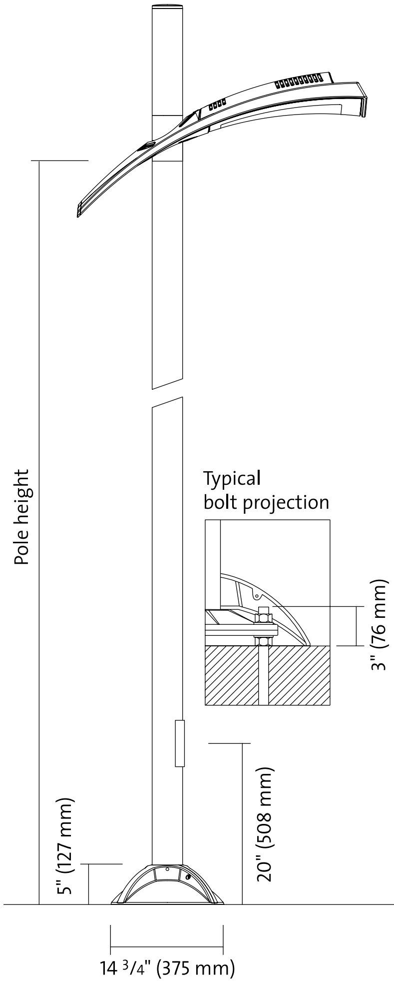
REDUCED ENVIRONMENTAL FOOTPRINT

70,000 HOURS OF OPERATIONAL LIFESPAN

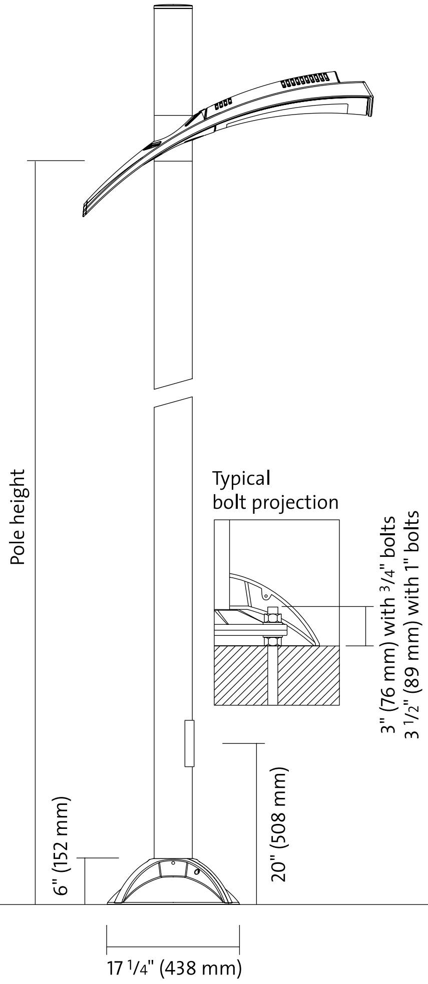
LEONIS
SERIES

LUMINAIRES / LED

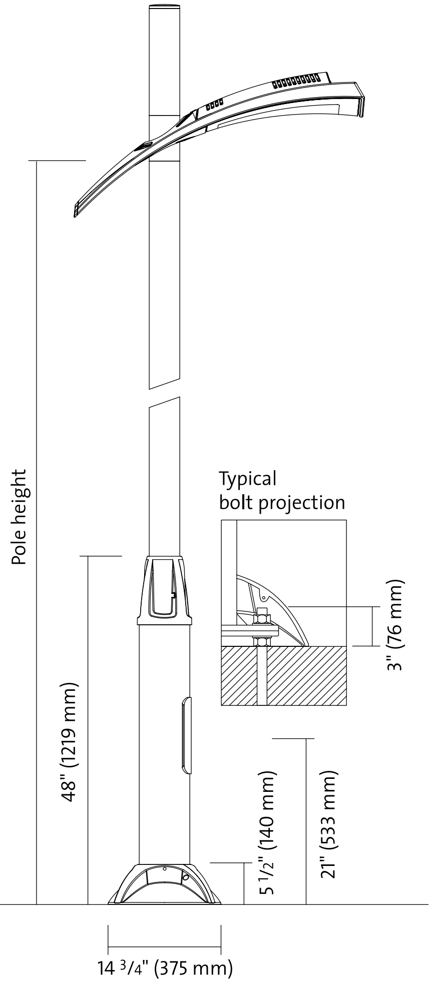
*Conforme aux normes **UL 1598** et **CSA C22.2 n° 250.0-08.***



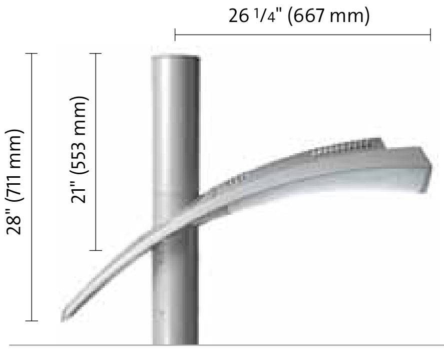
LEN4

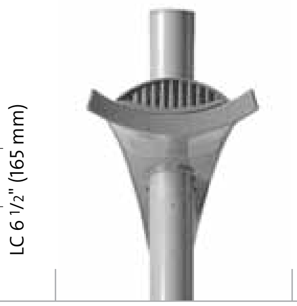


LEN5



LEN6





Weight : 55 lbs (25 kgs)

OPTIONAL DECORATIVE LUMINOUS ELEMENT

> LEDW

> LEDA

> LEDB

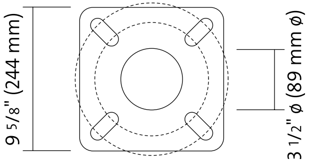
> LEDG

> LEDR

*Philips Lumec se réserve le droit d'apporter des modifications aux caractéristiques de ses produits dans le cadre de son programme permanent de développement, et ce, sans préavis. Pour la dernière mise à jour, consultez **www.lumec.com.***

ANCHOR PLATES

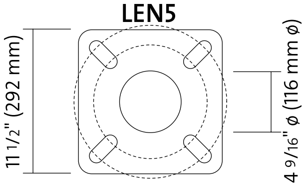
LEN4



ALUMINUM
Bolt circle : 8 1/2" (216 mm)
B.C. from : 6 3/4" to 10" (171 to 254 mm)
Anchor bolts :
3/4" - 20" (19 - 508 mm)

STEEL (S)
Bolt circle : 8 1/2" (216 mm)
B.C. from : 6 3/4" to 10 1/2" (171 to 267 mm)
Anchor bolts :
3/4" - 20" (19 - 508 mm)

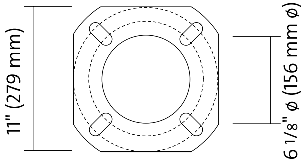
LEN5



ALUMINUM
Bolt circle : 12 1/2" (318 mm)
B.C. from : 9 1/4" to 12 3/4" (235 to 324 mm)
Anchor bolts :
3/4" - 20" (19 - 508 mm)

STEEL (S)
Bolt circle : 12 1/2" (318 mm)
B.C. from (BLN 3/4") : 8" to 12 1/2" (203 to 324 mm)
B.C. from (BLN 1") : 8" to 12 7/8" (203 to 327 mm)
Anchor bolts :
1" - 36" (25 - 914 mm)

LEN6



ALUMINUM
Bolt circle : 10 1/2" (267 mm)
B.C. from : 8 3/4" to 11" (222 to 279 mm)
Anchor bolts :
3/4" - 20" (19 - 508 mm)

STEEL (S)
Bolt circle : 10 1/2" (267 mm)
B.C. from : 8 3/4" to 11 1/8" (222 to 283 mm)
Anchor bolts :
3/4" - 20" (19 - 508 mm)

LEN4 / LED

Wind speed (mph)	Maximum pole height (ft.)	
	ALUMINUM	STEEL (S)
90	18	20
110	18	20
120	18	20
150	16	20

LEN5 / LED

Wind speed (mph)	Maximum pole height (ft.)	
	ALUMINUM	STEEL (S)
90	20	22
110	20	22
120	20	22
150	20	22

LEN6 / LED

Wind speed (mph)	Maximum pole height (ft.)	
	ALUMINUM	STEEL (S)
90	20	22
110	20	22
120	20	22
150	20	22

SPECIFICATIONS

Lens
Tempered soda lime etched glass lens, permanently sealed onto the lower housing.

Lamp (included) ***see photometric section at the end of document***
3500, 5000 or 6300 Lumens LED (light emitting diode) package (40,65 or 90 Watt). Composed of 49 High intensity white LEDs 4000K +/-300K with a CRI of 70, operating 70 000 hours after which 50% still have over 70% original lumen output. Supplied with a minimum of 100 lumens per watt LED technology.

Light engine the LifeLED is composed of 3 main components :

Optical system : (IP66) has an individual pre oriented lens to achieve desired distribution.

Upper housing : Made of gravity die cast 356 aluminum alloy c/w an extruded silicone gasket (duro 60 shore A) and a cast aluminum heat sink optimising the LEDs efficiency and life.

Driver
High power factor of 90%. Electronic driver with full range input 120V-277V, operating range 50 60 Hz. Lamp starting capacity -40F(-40C) degrees. Shall be rated by UL1310 for Class 2 operation with constant current output. Weathertightness rating IP66. Assembled on a unitized removable tray with quick disconnect plug.

Housing
The lower housing is made of gravity die cast 356 Aluminum alloy 0.180” (4.6 mm) minimum thickness. Welded to the luminaire central adaptor.

Luminaire Options
Luminous decorative element integrating light emitting diodes (LED). Powered by an independant driver.

Luminaire Central Adaptor
Made of aluminum 6061 T6, 4” (102 mm) (LEN4 / LEN6) or 5” (127 mm) (LEN5) outside diameter, complete with a tenon penetrating 9” (229 mm) inside the pole. The tenon shall be mechanically fastened to the pole by two sets of three set screws at 120 degrees around the pole.

***LEN4 pole shaft**
Made from a 4” (102 mm) round extruded 6061 T6 aluminum tubing, having a 0.226” (5.7 mm) wall thickness, welded to both the bottom and top of the anchor plate.

SPECIFICATIONS (continued)

***LEN5 pole shaft**
Made from a 5” (127 mm) round extruded 6061 T6 aluminum tubing, having a 0.219” (5.6 mm) wall thickness, welded to both the bottom and top of the anchor plate.

***LEN6 pole shaft**
Made from a one piece, seamless 4” round (102 mm) tube of extruded-aluminum welded over and in a 6 5/8” round (168 mm) extruded-aluminum pole base. The assembly is welded to both the top and bottom of a cast-aluminum anchor plate.

Maintenance Opening
2” x 4 1/2” (51 mm x 114 mm) (LEN4 / LEN5) or 4 1/2” x 10” (114 mm x 254 mm) (LEN6) maintenance opening centered 20” (508 mm) (LEN4 / LEN5) or 21” (533 mm) (LEN6) from the bottom of the anchor plate, complete with a weatherproof aluminum cover and a copper ground lug.

Base Cover
Two piece base cover made from cast 356 aluminum, mechanically fastened with stainless steel screws.

Finish
“Hot dip” chemical etching preparation. Lumital™ polyester powder coat finish. Excellent color retention as per #ASTM D2244, and outstanding salt-spray resistance according to #ASTM D2247 testing procedures.

Note
EPA recommendations are calculated according to AASHTO 2001 standards.

**** steel pole also available with the option (S).***

ORDERING INFORMATION

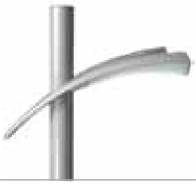
PRODUCT	LAMP[5]	OPTIC	VOLTAGE	LUMINAIRE OPTIONS	LEN4	LEN5	LEN6	POLE OPTIONS	FINISH[3]		
					POLE HEIGHT[2]						
LEN4	40W49LED4K	2	120	LEDA (amber)[1,4]	8 to 20	8 to 22	8 to 22	PH (photocell)	BE2/TX	GN/TX	RD4/TX
LEN5	65W49LED4K	3	208	LEDB (blue)[1,4]					BE6/TX	GN4/TX	WH/TX
LEN6	90W49LED4K	4	240	LEDG (green)[1,4]					BE8/TX	GN6/TX	NP
		5	277	LEDR (red)[1,4]					BG2/TX	GN8/TX	TG
			347[6]	LEDW (white)[1]					BK/TX	GY3/TX	TS
			480[6,7]						BR/TX	RD2/TX	

[1] *Unselected option : offered without decorative illumination.*
[2] *Pole height is in 6 inches increments.*
[3] *Consult Philips Lumec’s color chart.*
[4] *See LED visual effects towards the end of document.*
[5] *See more LED lamps details towards the end of document.*
[6] *Not available with 40W49LED4K and 65W49LED4K lamps.*
[7] *Decorative luminous element not available with this voltage.*

ORDERING SAMPLE

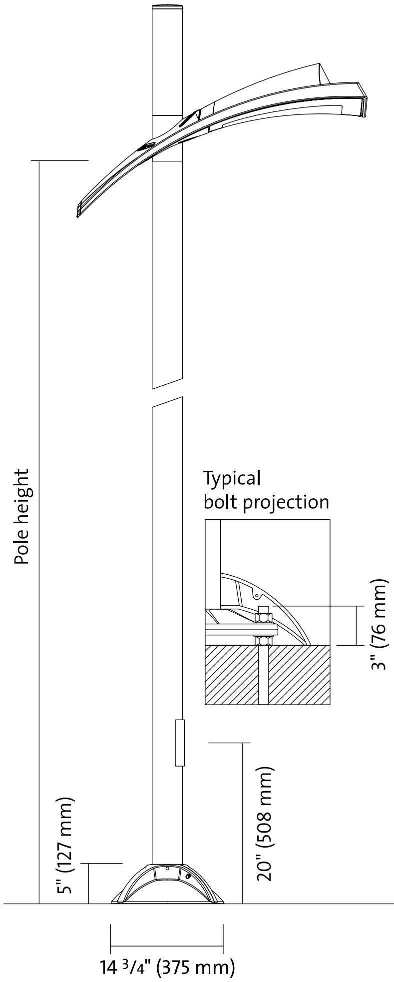
PRODUCT	LAMP	OPTIC	VOLTAGE	LUMINAIRE OPTION	POLE HEIGHT	POLE OPTIONS	FINISH
LEN5	65W49LED4K	2	208	LEDB	16	—	NP

LEONIS
SERIES

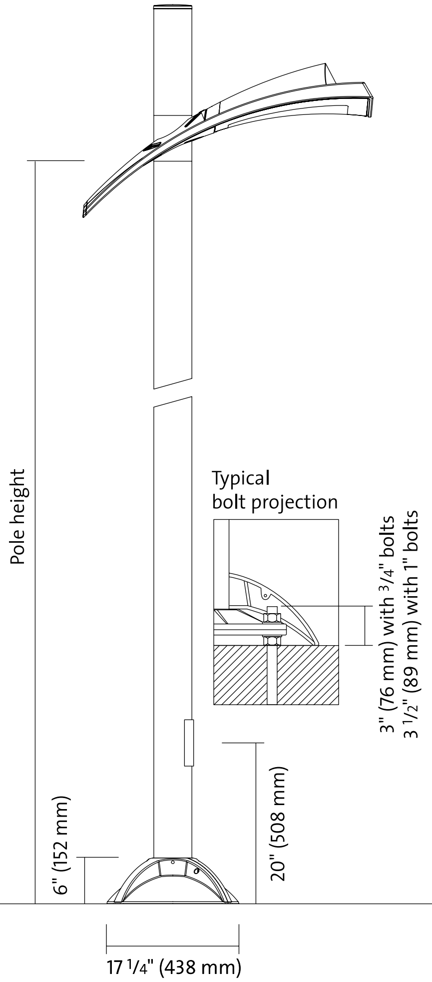


LUMINAIRES / HID

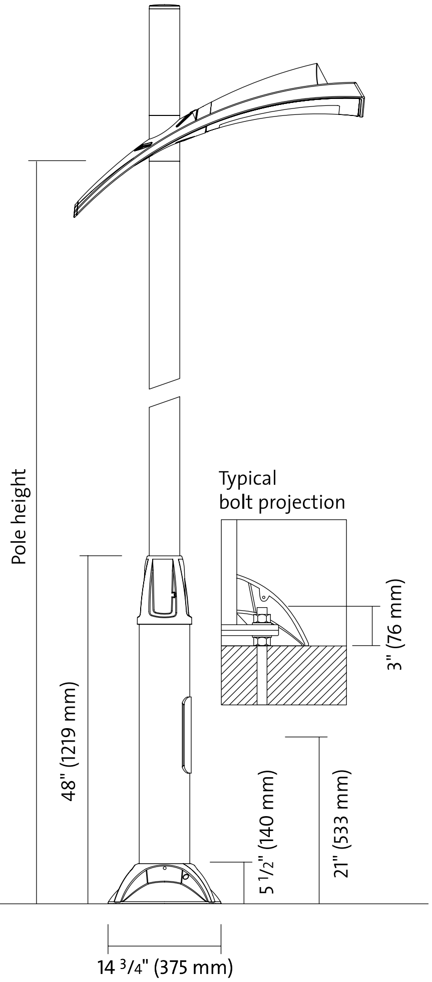
*Conforme aux normes **UL 1598** et **CSA C22.2 n° 250.0-08.***



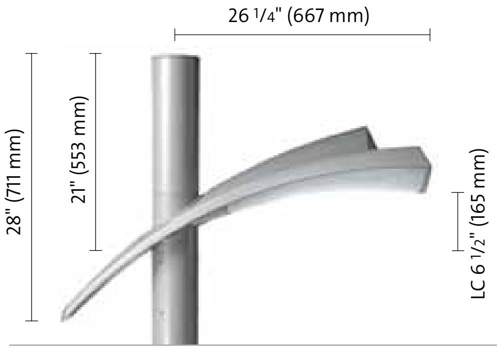
LEN4

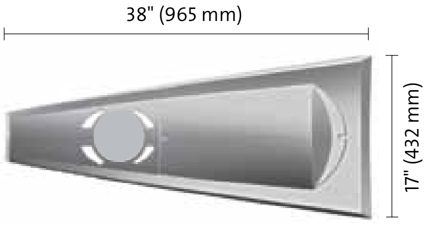


LEN5



LEN6





Weight : 50 lbs (22.7 kgs)

OPTIONAL
DECORATIVE
LUMINOUS
ELEMENT

> LEDW

> LEDA

> LEDB

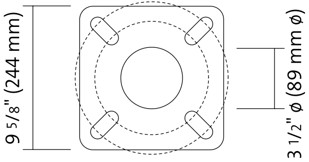
> LEDG

> LEDR

PHILIPS
LUMEC

ANCHOR PLATES

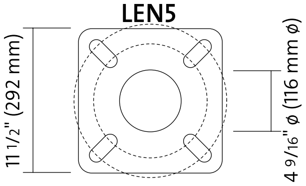
LEN4



ALUMINUM
Bolt circle : 8 1/2" (216 mm)
B.C. from : 6 3/4" to 10" (171 to 254 mm)
Anchor bolts :
3/4" - 20" (19 - 508 mm)

STEEL (S)
Bolt circle : 8 1/2" (216 mm)
B.C. from : 6 3/4" to 10 1/2" (171 to 267 mm)
Anchor bolts :
3/4" - 20" (19 - 508 mm)

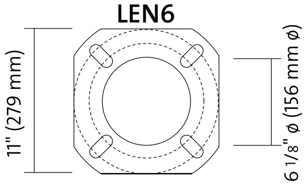
LEN5



ALUMINUM
Bolt circle : 12 1/2" (318 mm)
B.C. from : 9 1/4" to 12 3/4" (235 to 324 mm)
Anchor bolts :
3/4" - 20" (19 - 508 mm)

STEEL (S)
Bolt circle : 12 1/2" (318 mm)
B.C. from (BLN 3/4") : 8" to 12 1/2" (203 to 324 mm)
B.C. from (BLN 1") : 8" to 12 7/8" (203 to 327 mm)
Anchor bolts :
1" - 36" (25 - 914 mm)

LEN6



ALUMINUM
Bolt circle : 10 1/2" (267 mm)
B.C. from : 8 3/4" to 11" (222 to 279 mm)
Anchor bolts :
3/4" - 20" (19 - 508 mm)

STEEL (S)
Bolt circle : 10 1/2" (267 mm)
B.C. from : 8 3/4" to 11 1/8" (222 to 283 mm)
Anchor bolts :
3/4" - 20" (19 - 508 mm)

LEN4 / HID

Wind speed (mph)	Maximum pole height (ft.)	
	ALUMINUM	STEEL (S)
90	18	20
110	18	20
120	18	20
150	16	20

LEN5 / HID

Wind speed (mph)	Maximum pole height (ft.)	
	ALUMINUM	STEEL (S)
90	20	22
110	20	22
120	20	22
150	20	22

LEN6 / HID

Wind speed (mph)	Maximum pole height (ft.)	
	ALUMINUM	STEEL (S)
90	20	22
110	20	22
120	20	22
150	20	22

SPECIFICATIONS

Lens

Tempered soda lime etched glass lens, permanently sealed onto the lower housing.

Optical system: Smartseal™ System (IP66) composed of 2 main components :

> **Upper housing:** Made of gravity die cast 356 aluminum alloy c/w an extruded silicone gasket (duro 60 shore A).
>
> **Multi faceted reflector:** Made of hydroformed 3002-0 aluminum alloy chemically brightened and anodized (5 micron min).

Ballast

High power factor of 90%. Lamp starting capacity 20°F(30°C) degrees. Assembled on a unitized removable tray with quick disconnect plug.

Housing

The lower housing is made of gravity die cast 356 Aluminum alloy 0.180” (4.6 mm) minimum thickness. Welded to the luminaire central adaptor.

Luminaire Options

Luminous decorative element integrating light emitting diodes (LED). Powered by an independant driver.

Luminaire Central Adaptor

Made of aluminum 6061 T6, 4” (102 mm) (LEN4 / LEN6) or 5” (127 mm) (LEN5) outside diameter, complete with a tenon penetrating 9” (229 mm) inside the pole. The tenon shall be mechanically fastened to the pole by two sets of three set screws at 120 degrees around the pole.

*LEN4 pole shaft

Made from a 4” (102 mm) round extruded 6061 T6 aluminum tubing, having a 0.226” (5.7 mm) wall thickness, welded to both the bottom and top of the anchor plate.

*LEN5 pole shaft

Made from a 5” (127 mm) round extruded 6061 T6 aluminum tubing, having a 0.219” (5.6 mm) wall thickness, welded to both the bottom and top of the anchor plate.

*LEN6 pole shaft

Made from a one piece, seamless 4” round (102 mm) tube of extruded-aluminum welded over and in a 6 5/8” round (168 mm) extruded-aluminum pole base. The assembly is welded to both the top and bottom of a cast-aluminum anchor plate.

Maintenance Opening

SPECIFICATIONS (continued)

2” x 4 1/2” (51 mm x 114 mm) (LEN4 / LEN5) or 4 1/2” x 10” (114 mm x 254 mm) (LEN6) maintenance opening centered 20” (508 mm) (LEN4 / LEN5) or 21” (533 mm) (LEN6) from the bottom of the anchor plate, complete with a weatherproof aluminum cover and a copper ground lug.

Base Cover
Two piece base cover made from cast 356 aluminum, mechanically fastened with stainless steel screws.

Finish
“Hot dip” chemical etching preparation. Lumital™ polyester powder coat finish. Excellent color retention as per #ASTM D2244, and outstanding salt-spray resistance according to #ASTM D2247 testing procedures.

Note
EPA recommendations are calculated according to AASHTO 2001 standards.

**** steel pole also available with the option (S).***

ORDERING INFORMATION

PRODUCT	LAMP	REFLECTOR	VOLTAGE	LUMINAIRE OPTIONS	POLE HEIGHT[3]			POLE OPTIONS	FINISH[1]	
					LEN4	LEN5	LEN6			
LEN5	50MH 50HPS	2H	120	LEDA (amber)[1]	8 to 20	8 to 22	8 to 22	PH (photocell))	BE2/TX	RD4/TX
LEN6	70MH 70HPS	4H	208	LEDB (blue)[1]				S (steel)	BE6/TX	WH/TX
	100MH 100HPS		240	LEDG (green)[1]					BE8/TX	NP
	150MH 150HPS		277	LEDR (red)[1]					BG2/TX	TG
	35HPS		347[4]	LEDW (white)[1]					BK/TX	TS
LEN4	18CF								BR/TX	GN8/TX
LEN5	26CF	4H		HS (house shield)					GN/TX	GY3/TX
LEN6	32CF								GN4/TX	RD2/TX
	42CF								GN6/TX	
LEN5	60 CW	2H	240							
	90CW	4H	277							
	140CW									

[1] *Unselected option : offered without decorative illumination.*
[2] *Pole height is in 6 inches increments.*
[3] *Consult Philips Lumec’s color chart.*
[4] *347 Voltage not available for LEN4.*

> *Medium base socket / ED17 lamp for HID (lamp not included).*
> *Socket: GX24Q-2 (18W), GX24Q-3 (26W)(32W), GX24Q-4 (42W), triple tube for compact fluorescent (lamp not included).*

ORDERING SAMPLE

PRODUCT	LAMP	REFLECTOR	VOLTAGE	LUMINAIRE OPTIONS	POLE HEIGHT	POLE OPTIONS	FINISH
LEN5	100MH	2H	120	LEDW	20	S	NP

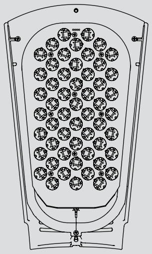
PHOTOMETRY

LED: High-Intensity Light-Emitting Diode

2

Type II
Asymmetrical distribution spreads light forward and on both sides.

Recommended applications
- Pedestrian walkway/bicycle path
- Building entryway
- Narrow roadway
- Interior and exterior pedestrian malls



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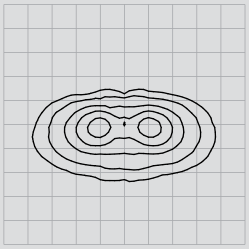
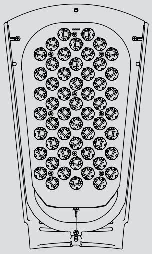


3

Type III
Asymmetrical distribution spreads light forward and on both sides.

Recommended applications
- Pedestrian walkway/bicycle path
- Building entryway
- Narrow roadway
- Interior and exterior pedestrian malls



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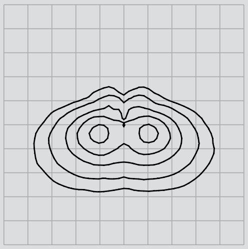
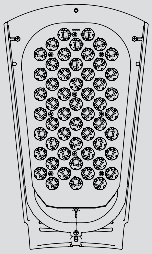


4

Type IV
Asymmetrical distribution spreads light forward.

Recommended applications
- Parking lot
- Interior and exterior pedestrian malls
- Building perimeter (security)
- Roadway



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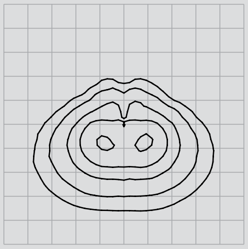
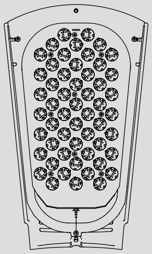


5

Type V
Symmetrical distribution spreads light in a square pattern.

Recommended applications
- Middle of parking lot
- Interior and exterior pedestrian malls
- Building entryway
- Parks



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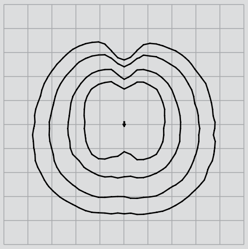


LAMP CODE DEFINITION / 40W 49LED 4K

Lamp wattage
Number of diodes (LED)
Color temperature

LAMP	RATED LIFE HRS[1]	INITIAL LUMENS	CRI	COLOR TEMPERATURE[2]	WATTAGE	
					LAMP	SYSTEM[3]
40W49LED4K	70000	4600	70	4000K	42	47
65W49LED4K	70000	5890	70	4000K	65	72
90W49LED4K	70000	6860	70	4000K	90	102

[1] *Rated life represents the time it takes for the LED system to reach 70% of initial lumen output.*
[2] *On average.*
[3] *System wattage includes the lamp and the LED driver.*

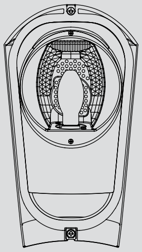
> Lamp lumen depreciation factor : 85%

HID: High-Intensity Discharge Sources

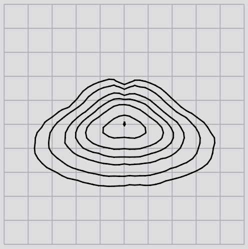
2H

Type II
Asymmetrical distribution spreads light forward and on both sides.

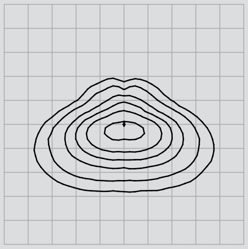
Recommended applications
- Pedestrian walkway/bicycle path
- Building entryway
- Narrow roadway
- Interior and exterior pedestrian malls



> 2H



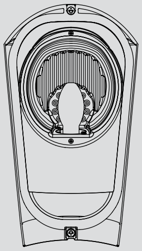
> 2HS



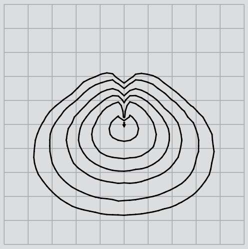
4H

Type IV
Asymmetrical distribution spreads light forward.

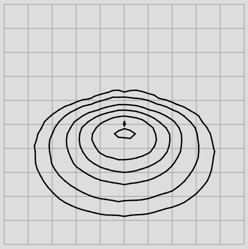
Recommended applications
- Parking lot
- Interior and exterior pedestrian malls
- Building perimeter (security)
- Roadway



> 4H



> 4HS

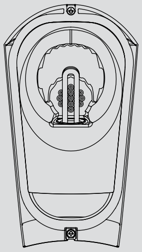


Compact Fluorescent

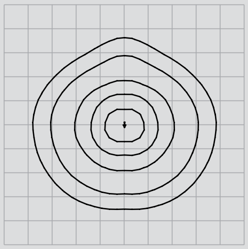
4H

Type IV
Asymmetrical distribution spreads light forward.

Recommended applications
- Interior and exterior pedestrian malls
- Building entryway
- Entry hall and drop-off area



>4H



»
LUMINAIRE > LEN5

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T : (5255) 5564.5242
F : 450.971.2816

For the details of our different agents and representatives, please consult the **Contact us** section of our Website.

(Hg)/ Some luminaires use fluorescent or high intensity discharge (HID) lamps that contain small amounts of mercury. Such lamps are labeled "Contains Mercury" and/or with the symbol "Hg." Lamps that contain mercury must be disposed of in accordance with local requirements. Information regarding lamp recycling and disposal can be found at **www.lamprecycle.org**

» The choice to not print paper brochures anymore but to make them available on-line is an example of the positive environmental actions that Philips Lumec has decided to undertake. This not only considerably reduces our paper consumption but also guarantees the exactitude of the information our clients receive.

Appendix G
Dundurn Rural Water Utility Correspondence

DUNDURN RURAL WATER UTILITY
P.O. BOX 442
DUNDURN, SK S0K 1K0
Phone: (306) 492-2566
Fax: (306) 492-2564
E-mail: drwu@sasktel.net

May 1, 2012

Grasswood Property Estates Ltd.
217 Sturgeon Place
Saskatoon, SK S7K 4C5

ATTN.: Darren Hagen

Dear Darren,

RE: Grasswood Estates / Urban Elements

Further to our letter of November 30, 2011, this letter is to clarify information regarding your rural water project with the Dundurn Rural Water Utility. There is potable water adjacent to this property and the Utility is able to provide water to this sub-division comprising of eighty-three (83) lots located at W 1/2 26 – 35 – 5 W3. You are still considered a part of the Phase III Expansion Project and a part of the project under the grant price with the following conditions:

- Your Roads and pins must be in as early as possible in the Spring of 2012 but no later than July 31, 2012. There will be some leeway to this date but it is important to remember that this water line needs to be completely installed prior to freeze-up in 2012. Please keep in mind that in order for us to complete this, the Utility will require time for tendering, finding a contractor and getting the work completed. Also, in order to qualify for the grant, all work must be completed before the end of December of 2012.

If further information is required, please do not hesitate to contact me.

Yours truly,

DUNDURN RURAL WATER UTILITY

Rosalind L. Arndt
Administrator

/rla

Appendix H
Geotechnical Report

Subdivision Development Investigation
Casa Grande
(NW & SW 26-35-5 W3M)
Grasswood, Saskatchewan

File S1607 29 August 2008

Table of Contents i

1.0 Introduction

1.1 Background

This report presents results of the investigation conducted for the proposed Casa Grande subdivision located south of Saskatoon on Preston Avenue. A site location plan is presented in Drawing No. S1607-01. The legal description of the area is NW and SW26-35-5-W3M. The proposed subdivision would consist of 70 – 80 lots ranging in size from 1 – 5 acres on both quarters being considered for development. The site is primarily used as pastureland. There are currently two residences located on each quarter section.

No previous geotechnical and hydrogeological investigations have been performed at the proposed Casa Grande subdivision development.

1.2 Objectives

The objectives of the subdivision investigation were to evaluate slope stability, determine wastewater disposal characteristics, and to provide preliminary foundation and construction recommendations based on a geotechnical investigation.

The investigation is to provide a preliminary assessment of site conditions which will be a first step in developing data to support subsequent applications to regulators. The level of detail is intended to provide basic site characterization. Further detail may be required for regulators such as Saskatchewan Health or Saskatchewan Environment.

1.3 Scope of Work

The scope of the investigation included:

- Compilation of local and regional geological information for the area;
- Assessment of the stratigraphy and hydrology at the site;
- Visual investigation of the site and aerial photograph analysis for evidence of slope instability;
- Preliminary geotechnical and hydrogeological investigations to assist with permit applications for installation and construction of wastewater disposal systems;

- Foundation recommendations and restrictions arising from the geotechnical investigation; and,
- Reporting, including stratigraphic cross-sections identifying the geology and definition of the piezometric surface of the site.

1.4 Existing Information

Various sources of information are available which were used to develop a general assessment of the geological and hydrogeological features of the subject site and its surrounding area. The following information was used for an assessment of the area around this site:

- Christiansen, E.A., 1970. Physical Environment of Saskatoon, Canada
- Saskatchewan Geomatics aerial photographs, 1990
- SaskWater Well Data provided by SaskWater

2.0 Physical Environment

2.1 Regional Geology

The bedrock surface in the region consists of the Cretaceous Bearpaw Formation which is overlain by a succession of Quaternary deposits of till and stratified drift from the Saskatoon Group. The Bearpaw Formation is the youngest bedrock in the area, and has a varying thickness near the study area of 45 to 62 m thick. It is a non-calcareous, silt and clay. The uppermost glacial deposit consist of the Saskatoon Group that includes the Floral and Battleford Formations and the surficial stratified drift deposits. In the area the Floral Formation is absent along with the Sutherland Group. The Saskatoon Group Formation is approximately 100 m to 110 m thick and consists of clay till. The surficial stratified drift deposits consist of stratified silt, clay, sands and gravels.

2.2 Regional Hydrogeology

The mapped aquifers are mainly surficial stratified deposits. The Moose Woods Flats Aquifer is the most extensive aquifer in the region. The aquifer at the site is approximately 37 m bgs. A search of the SaskWater Corporation Database (current to May 2007) indicated 133 water withdrawal well and five water test hole records within a one mile radius of the site. These records provided a good sample of water use for the area. The majority of the boreholes were complete below 5.5 m bgs in surficial deposits and sand layers and lenses present in the Saskatoon Group. The borehole lithology logs showed that the stratigraphy in the area consisted primarily of sand, silt and clay layers.

3.0 Field and Laboratory Investigation

Subsurface geology was investigated by a total of 19 test borings on the site, designated as Bore Holes 101 to 119. The locations of bore holes are shown on Drawing No. S1607-02. Bore holes were drilled to a depth of 6 m to 20 m. Drilling was conducted on 17 January and 8 February 2008 using a truck-mounted Brat drill rig and 125 mm solid stem continuous flight auger. Bore holes were logged and sampled at a 1.5 m interval.

Piezometers were installed in Bore Holes 101, 104, 108, and 111. Water levels in piezometers were measured on 25 February 2008.

Moisture contents were determined for all samples, and Unified Soil Classifications and particle size analyses were performed on select representative samples.

Observations made during the field investigations, visual descriptions and the results of laboratory tests are recorded in the Bore hole Logs and Summary of Sampling and Laboratory Test Data, and are appended to this report. An explanation of the symbols and terms used in the bore hole logs is included in the Symbols and Terms section of this report.

3.1 Stratigraphy

The site is located on a glacial lake basin, with subsurface soil consisting primarily of sand and silt with some clay. Some dune sand is present along the southern edge of SW26.

Stratigraphy consisted of stratified sand, silt and clay. Table 3.1 provides a summary of index properties of soil encountered, including moisture content and results of Atterberg limits and Unified Soil Classification testing. Silty sand covered the majority of the site to varying depth. Sand was generally moist and compact, with standard penetration testing ‘N’ values of 9 to 16 blows for 300 mm penetration.

Clay strata varied in thickness, and generally possessed medium to high plasticity. It was moist and stiff to very stiff in consistency, with an undrained shear strength of about 160 kPa.

Silt and clayey silt strata with some sand were encountered in some areas.

Table 3.1
Index Properties of Representative Samples

Sample Tested	Natural Water Content (%)	Plastic Limit	Liquid Limit	Plasticity Index	Unified Soil Classification*
BH101 @ 0.8 to 1.0 m	5.3	NP	NP	NP	SM
BH101 @ 1.5 to 1.8 m	25.8	23.9	68.2	44.3	CH
BH101 @ 2.3 to 2.4 m	9.8	NP	NP	NP	SM
BH101 @ 4.6 to 4.8 m	17.8	NP	NP	NP	SM
BH101 @ 7.5 to 7.6 m	34.0	23.6	57.9	34.3	CH
BH101 @ 10.6 to 10.7 m	38.9	28.7	77.9	49.2	CH
BH101 @ 12.1 to 12.2 m	34.6	24.0	74.6	50.6	CH
BH104 @ 0.7 to 0.8 m	9.2	NP	NP	NP	SM
BH104 @ 1.4 to 1.5 m	11.8	19.5	43.3	23.8	CL
BH104 @ 2.2 to 2.3 m	16.5	18.9	49.1	30.2	CL
BH104 @ 3.1 to 3.4 m	23.4	26.4	63.7	37.3	CH
BH104 @ 4.6 to 4.8 m	9.1	NP	NP	NP	SM
BH104 @ 7.5 to 7.6 m	28.7	NP	NP	NP	SM
BH108 @ 1.4 to 1.5 m	36.0	NP	NP	NP	SM
BH108 @ 2.2 to 2.3 m	6.7	NP	NP	NP	SM
BH108 @ 3.0 to 3.1 m	22.4	19.9	33.7	13.8	CL
BH108 @ 6.6 to 6.7 m	35.1	16.4	51.9	37.3	CH

*CL – low plasticity clay, CH- high plasticity clay, SM – silty sand, NP- non-plastic

3.2 Groundwater

Groundwater levels were measured on 25 February 2008. The water elevation in each piezometer is presented in Table 3.2 and on Drawing No. S1604-02. Groundwater elevations were utilized to determine the horizontal hydraulic gradient. The groundwater flow direction at the site was determined to be towards the southeast.

Table 3.2
Water Elevations

Piezometer	Water Elevation (m)	Ground Elevation (m)	Casing Elevation (m)	Depth to Water (m)
BH101	482.572	487.448	488.412	4.88
BH104	482.262	489.012	489.896	6.75
BH108	482.400	486.440	487.390	4.04
BH111	485.264	487.281	488.094	2.02

4.0 Slope Stability

Landforms in the area were defined on the basis of aerial photography. An aerial photograph showing the site is presented in Drawing No. S1607-2. This area was part of Glacial Lake Saskatoon during the last deglaciation. While under water, sand, silt and clay was deposited. Sand dunes are present along the southern edge of the area being developed. The site has approximately 5 m of relief. Large scale landsliding is not an issue in this area.

5.0 Wastewater Disposal

5.1 Scope

The site was assessed in terms of the geotechnical and hydrogeological site characteristics required to install wastewater disposal systems as per the regulations and guidelines set out in the *Saskatchewan Onsite Wastewater Disposal Guide* (First Edition, 2007, Saskatchewan Health), and the *Onsite Wastewater Management: Review Process for Developments and Subdivisions* (Saskatoon Health Region, Public Health Services). These documents will be referenced as SOWDG and OWM, respectively, for the purposes of this report.

5.2 Regulatory Requirements

The proposed development falls within the High Sensitivity Area section as per the OWM. As such, only holding tanks, pressure chamber systems, package sewage treatment plants and Type II Mounds will be permitted at the Casa Grande site due to the proposed size and number of lots on each quarter section. It also states that any existing wastewater disposal systems in use or intended for use would need to be upgraded to comply with current requirements for high sensitivity developments.

The SOWDG states that there should be a minimum isolation distance of 1.5 m between a wastewater disposal system and the water table. All setback requirements listed in the SOWDG must also be met. Replacement disposal areas, if ever needed, should be located adjacent to the existing disposal area.

The SOWDG states that a Type II mound may be constructed on a natural slope provided that:

- The slope is less than 3% and the percolation rate is not slower than 60 minutes per 25 mm to a depth of at least 600 mm below the sand layer;
- The slope is less than 6% and the percolation rate is not slower than 30 minutes per 25 mm to a depth of at least 600 mm below the sand layer;
- The slope does not exceed 12% regardless of percolation rate.

A chamber system may also be constructed on a slope provided that distribution devices or step-downs are used.

Package sewage treatment plants such as three-cell septic tanks provide a greater level of treatment therefore may allow for a reduction in the treatment area required; however, they are not mandatory in a High Sensitivity Area.

5.3 Soil Loading Rates

As per the SOWDG, wastewater disposal systems are sized based on the soil loading rate. Soil loading rates are determined either via percolation testing or soil texture classification. Soil texture classification was used to determine appropriate soil loading rates for the various surficial soil types encountered at the proposed Casa Grande subdivision.

5.3.1 Soil Texture Classification

The results of the particle size analysis and hydrometer testing performed on select samples that are representative of the material in the upper strata are presented in Table 5.1. Based on the percentage of silt and clay versus sand, the soil was classified as per the Soil Texture Classification Triangle in Appendix 15 of the SOWDG.

Table 5.1
Summary of Particle Size Analysis
and Soil Texture Classification of Upper Soil Units

Soil Type	Sample Number	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Soil Texture as per SOWDG
Sand	KB13	0.0	76.7	13.2	10.1	Sandy Loam
Silty Clay	KB41	0.0	14.9	16.3	23.8	Silt Loam
Clay	KB82	0.0	25.4	36.2	38.5	Clay Loam
Silt	MN19	0.0	32.3	50.4	17.2	Loam
Sand	MN25	0.0	74.6	12.6	12.8	Sandy Loam

The corresponding loading rates as per Appendix 15 of the SOWDG can be applied to size the wastewater disposal systems:

Clay Loam (Clay)	10.78 L/m^2
Silt Loam (Silty Clay)	13.72 L/m^2
Loam (Silt)	17.15 L/m^2
Sandy Loam (Sand)	22.05 L/m^2

It is important to note that the soil texture classifications provided in this report are based upon a single hydrometer test for each surficial soil unit encountered. Also, the classifications do not account for secondary structure within the soil unit such as fracturing, which can greatly increase the permeability of a soil.

5.4 Groundwater

Water level measurements taken at the site (Table 3.2) indicate that the water table at the site ranges from 6.75 m to 2.02 m below ground surface, which ranges in elevation from 485.26 m to 482.26 m.

Assuming an average water table location of about 2 to 5 m below ground surface, the minimum separation distance of 1.5 m will be met.

A water sample was taken from the standpipe piezometers in BH101 and 108 and analyzed for routine water chemistry to obtain background groundwater data. The results are presented in Appendix A.

5.5 Conclusions

The following recommended wastewater disposal systems for the proposed development are described in relation to the soil type of the disposal area:

- Type II mound systems with two-cell septic tanks would provide adequate wastewater disposal for areas where the surficial material is sand, silt, or clay.
- Type II mound systems, with three-cell septic tanks would provide adequate wastewater disposal for areas where the surficial material is sand, silt, or clay.

The soil loading rate used to size the selected system should be determined based on the lowest soil loading rate of any of the materials encountered in the upper 900 mm of soil (excluding topsoil).

6.0 Foundation Design and Construction Recommendations

It is our understanding that the subdivision will primarily consist of single family dwellings. Structures will likely be one or two storeys over a full basement with a grade supported concrete floor. Geotechnical issues associated with this type of structure are foundations to support the proposed structures and construction of a grade supported floor on a variable subgrade that could be silt, sand or high plasticity clay. Groundwater levels measured were 2.0 m to 6.8 m below existing ground surface (Table 3.2), and vary in elevation from 485.26 m to 482.26 m. Groundwater levels can be expected to vary with time, and may increase as a result of development.

Although fill material was not noted during this field investigation, its presence and condition should be noted during construction since it is not desirable to place foundations or floors on fill material of unknown composition and consistency. Foundations or floors should not be constructed on organic topsoil or organic soil.

6.1 Waterproofing and Subdrainage

The quantity of seepage and groundwater levels will vary seasonally, with precipitation or snowmelt, and with development due to irrigation and other factors. Rates of flow can be relatively high through sand and sandy strata. Groundwater levels are variable across the site, and were at least 2.0 m below ground surface.

Typically, basement floors will be about 1.5 m to 2.0 m below finished grade. On this basis, it is not likely that hydrostatic pressures will develop on basement walls and floors. However, basement walls can be waterproofed to accommodate any future increases in groundwater levels that could lead to seepage into basements. At a minimum, walls must be damp-proofed; floors should be damp-proofed.

A perimeter subdrainage system should be installed at the base of the footing. This requirement can be reviewed depending on specific conditions for any home. The excavation should be backfilled with a free draining granular soil to within about 0.6 m of surface to ensure that water can freely drain to a perimeter weeping tile system. Free draining means that there is less than 3 percent silt and clay particles. Clay or clayey soil can be placed on the surface to reduce the amount of infiltration.

6.2 Foundations

The proposed structures may be supported on shallow spread footings or augered cast-in-place concrete piles. Lightly loaded structures supported on shallow spread footings on medium to high plasticity clay will experience some vertical movement associated with changes in soil moisture. Total vertical movement is estimated to be as much as 150 mm for foundations on medium to high plasticity clay, with differential movement less than half of the total vertical movement. The anticipated vertical movement for foundations on sand will typically be less than about 25 mm.

Assuming that the basement or crawlspace will be insulated, the footing must be constructed below the anticipated depth of frost, estimated to be about 1.8 m in this area. This depth can be reduced on the basis of local experience and on the performance of similar foundations in the area. The foundation should not be allowed to freeze, particularly during construction, as frost heave may occur.

The allowable bearing capacity for a shallow spread footing will depend on the type of soil at the footing elevation. The information provided in this report is for preliminary purposes, only, and should not be relied upon for detailed design due to the variation in conditions across the site. Site specific investigations are recommended for buildings on this development. Foundation conditions, soil type, and allowable bearing capacity should be confirmed for specific sites. For preliminary design, the allowable bearing capacity for a spread footing constructed on compact sand will be 100 kPa (2,100 lb/ft^2). For shallow spread footings constructed on stiff clay, the same value can be used. Sand encountered at the foundation elevation should be well compacted to minimize the potential for settlement. If sand or sandy soil is wet and excessive pumping is encountered during compaction, the sand may be subcut 300 mm or more and replaced with a well graded, pit run material. A geotextile may be used as a separator at the base of the fill to reduce pumping of fines up into the fill, while allowing water to escape.

Structures can be supported on augered cast-in-place concrete piles designed on the basis of skin friction. However, standup conditions in sand will not be good and sleeving will likely be necessary to keep excavations open for concreting. Settlement of piles is expected to be less than 5 mm for a properly designed and constructed pile foundation. The skin friction contribution of the upper 2.0 m of pile below finished grade should be ignored in the determination of pile capacity for perimeter piles supporting a grade beam. This can be reduced to 1.0 m for interior piles.

An allowable skin friction value of 25 kPa may be used for design of piles in clay. A value of 15 kPa may be used where sand is encountered. The minimum length of pile should be 5 m. Grade beams should be constructed with a minimum 100 mm void space so that any heaving of the subgrade soil does not exert an upward force on piles, which can result in separation of the grade beam from the pile and distortion of the structure.

For augered piles, concrete should be placed within 2 hrs of excavation to minimize softening of clay or silt which can reduce pile capacity, or excessive sloughing and squeezing of soil, which can result in necking of the pile. The aspect ratio of a pile, defined as the ratio between length and diameter, should not exceed about 30. This should ensure that good contact is maintained between the concrete and soil and that no voids are created.

The use of water to facilitate excavation of piles should be avoided, since this will result in softening of the soil in contact with the concrete, reducing pile capacity. Inspection during construction is suggested to ensure compliance with specifications.

Landscaping around the structures should consider potential effects on foundation performance. Plantings of trees and large shrubs immediately adjacent the foundation should be avoided. Grading around the building should ensure positive drainage. Care should be taken to ensure that downspouts divert water away from the foundation.

6.3 Floors

Floors placed on a medium to high plasticity clay subgrade will experience some vertical movement associated with heave or shrinkage due to changes in soil moisture. The presence of fill material of unknown or variable type and consistency may result in differential settlement of a grade supported floor. It is estimated that as much as 150 mm of heave may occur for floors constructed on medium to high plasticity clay. Little vertical movement is expected for a well constructed floor constructed on a sand subgrade.

The specification for compaction of clay subgrade soil should specifically indicate that the water content should be at optimum to optimum + 2 percent, since clay compacted wet of optimum will have a lower potential for heave. This will not, however, eliminate the potential for heave.

6.4 Potential for Sulphate Attack

The water soluble sulphate content of soil was measured to be 0.01 percent by dry weight of soil in sand and 0.14 percent in clay. On this basis, the potential for sulphate attack will be moderate to severe for concrete in contact with clay. Sulphate resistant (Type 50 or HS) cement must be specified for all concrete in contact with clay soil. Recommendations regarding sulphate resistant cement may be found in CSA A23.1.

7.0 Closure

This report was prepared by Clifton Associates Ltd. for the use of Mr. Neil Ketilson and his agents for specific application to the proposed Casa Grande subdivision south of Saskatoon. The material in it reflects Clifton Associates Ltd. best judgment available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Clifton Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report has been prepared in accordance with generally accepted engineering practice common to the local area. No other warranty, expressed or implied is made

Our conclusions and recommendations are preliminary and based upon the information obtained from the referenced subsurface exploration. The boreholes and associated laboratory testing indicate subsurface and groundwater conditions only at the specific locations and times investigated, only to the depth penetrated and only for the soil properties tested. The subsurface conditions may vary between the boreholes and with time. The subsurface interpretation provided is a professional opinion of conditions and not a certification of the site conditions. The nature and extent of subsurface variation may not become evident until construction or further investigation. If variations or other latent conditions do become evident, Clifton Associates Ltd. should be notified immediately so that we may re-evaluate our conclusions and recommendations. Although subsurface conditions have been explored, we have not conducted analytical laboratory testing on samples obtained nor evaluated the site with respect to the potential presence of contaminated soil or groundwater conditions.

The enclosed report contains the results of our investigations as well as certain recommendations arising out of such investigations. Our recommendations do not constitute a design, in whole or in part, of any of the elements of the proposed work. Incorporation of any or all of our recommendations into the design of any such element does not constitute us as designers or co-designers of such elements, nor does it mean that such design is appropriate in geotechnical terms. The designers of such elements must consider the appropriateness of our recommendations in the light of all design criteria known to them, many of which may not be known to us. Our mandate has been to investigate and recommend which we have completed by means of this report. We have had no mandate to design, or review the design of, any elements of the proposed work and accept no responsibility for such design or design review.

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Symbols and Terms

Soil Descriptive Terms

A soil description for geotechnical applications includes a description of the following properties:

- texture
- color, oxidation
- consistency and condition
- primary and secondary structure

Texture

The soil texture refers to the size, size distribution and shape of the individual soil particles which comprise the soil. The Unified Soil Classification System (ASTM D2487-00) is a quantitative method of describing the soil texture. The basis of this system is presented overleaf. The following terms are commonly used to describe the soil texture.

Particle Size (ASTM D2487-00)

Boulder	300 mm plus
Cobble	75 - 300 mm
Gravel	4.75 - 75 mm
Coarse	19 - 75 mm
Fine	4.75 - 19 mm
Sand	0.075 - 4.75 mm
Coarse	2 - 4.75 mm
Medium	0.425 - 2 mm
Fine	0.075 - 0.425 mm
Silt and Clay	Smaller than 0.075 mm

Relative Proportions (CFEM, 3rd Ed., 1992)

Trace	1 - 10 %
Some	10 - 20 %
Gravelly, sandy, silty, clayey, etc.	20 - 35 %
And	>35 %
Gravel, Sand, Silt, Clay	>35 % and main fraction

Gradation

Well Graded	Having a wide range of grain sizes and substantial amount of all intermediate sizes.
Uniform or Poorly Graded	Possessing particles of predominantly one size.
Gap Graded	Possessing particles of two distinct sizes.

Particle Shape

Angular	Sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Similar to 'angular' but have rounded edges.
Subrounded	Well-rounded corners and edges, nearly plane sides.
Rounded	No edges and smoothly curved sides.

Also may be flat, elongated or both.

The term “TILL” may be used as a textural term to describe a soil which has been deposited by glaciers and contains an unsorted, wide range of particle sizes.

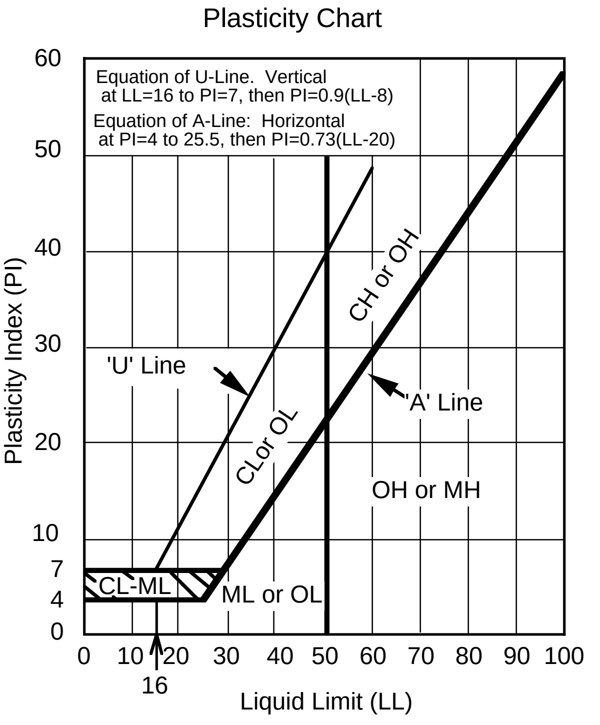
Color And Oxidation

The soil color at its natural moisture content is described by common colors and, quantitatively, in terms of the Munsell color notation; (eg. 5Y 3/1). The notation combines three variables, hue, value and chroma to describe the soil color. The hue indicates its relation to red, yellow, green, blue and purple. The value indicates its lightness. The chroma indicates its strength of departure from a neutral of the same lightness.

Departure of the soil color from a neutral color indicates the soil has been oxidized. Oxidation of a soil occurs in a oxygen rich environment where most commonly metallic iron, oxidizes and turns a neutral colored soil 'rusty' or reddish brown. Oxidized manganese gives a purplish tinge to the soil. Oxidation may occur throughout the entire soil mass or on fracture/joint/fissure surfaces.

Classification of Soils for Engineering Purposes

ASTM Designation D 2487-00 (Unified Soil Classification System)

Major divisions			Group Symbols	Typical names	Classification criteria			
Coarse-grained soils More than 50% retained on No. 200 sieve* (>0.075 mm)	Gravels More than 50% of coarse fraction retained on No. 4 sieve(≥4.75 mm)	Clean gravels <5% fines	GW	Well-graded gravel	If ≥ 15% sand add "with sand" to group name	Classification on basis of percentage of fines Less than 5% pass No. 200 sieve......GW, GP, SW, SP More than 12% pass No. 200 sieve.....GM, GC, SM, SC 5 to 12% pass No. 200 sieve.......Borderline classifications requiring use of dual symbols	$C_u = \frac{D_{60}}{D_{10}} \geq 4$; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravel			Not meeting either C_u or C_c criteria for GW	
		Gravels with fines >12% fines	GM	Silty gravel			Atterberg limits below "A" line or PI less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols If fines are organic add "with orgnic fines" to group name
			GC	Clayey gravel			Atterberg limits on or above "A" line and PI > 7	
	Sands 50% or more of coarse fraction passes No. 4 sieve(<4.75 mm)	Clean sands <5% fines	SW	Well-graded sand	If ≥ 15% gravel add "with gravel to group name		$C_u = \frac{D_{60}}{D_{10}} \geq 6$; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sand			Not meeting either C_u or C_c criteria for SW	
		Sands with fines >12% fines	SM	Silty sand			Atterberg limits below "A" line or PI less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols If fines are organic add "with orgnic fines" to group name
			SC	Clayey sand			Atterberg limits on or above "A" line and PI > 7	
Fine-grained soils 50% or more passes No. 200 sieve* (≤0.075 mm)	Silts and Clays Liquid limit <50%	Inorganic	ML	Silt	If 15 to 29% coarse-grained, add "with sand" or "with gravel" as appropriate If > 30% coarse-grained , add "sandy" or "gravelly" as appropriate Class as organic when oven dried liquid limit is < 75% of undried liquid limit			
			CL	Lean Clay -low plasticity				
		Organic	OL	Organic clay or silt (Clay plots above 'A' Line)				
	Silts and Clays Liquid limit ≥50%	Inorganic	MH	Elastic silt				
			CH	Fat Clay -high plasticity				
		Organic	OH	Organic clay or silt (Clay plots above 'A' Line)				
	Highly organic soils		PT	Peat, muck and other highly organic soils				

*Based on the material passing the 3 in.(75 mm) sieve, if field samples contain cobbles or boulders, add "with cobbles or boulders" to group name

Consistency And Condition

The consistency of a cohesive soil is a qualitative description of its resistance to deformation and can be correlated with the undrained shear strength of the soil. The condition of a coarse grained soil qualitatively describes the soil compactness and can be correlated with the standard penetration resistance (ASTM D1586-99).

Consistency Of Cohesive Soil (CFEM, 3rd Edit., 1992)

Consistency	Undrained Shear Strength (kPa) (CFEM, 3rd Edt., 1992)	Field Identification (ASTM D 2488-00)
Very Soft	<12	Thumb will penetrate soil more than 25 mm.
Soft	12-25	Thumb will penetrate soil about 25 mm.
Firm	25-50	Thumb will indent soil about 6 mm.
Stiff	50-100	Thumb will indent, but penetrate only with great effort (CFEM).
Very Stiff	100-200	Readily indented by thumbnail (CFEM).
Hard	>200	Thumb will not indent soil but readily indented with thumbnail.
Very Hard	N/A	Thumbnail will not indent soil.

Condition Of Coarse Grained Soil (CFEM, 3rd Edt., 1992)

Compactness Condition	SPT N - Index (Blows/300mm)
Very Loose	0 - 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very Dense	over 50

Moisture Conditions (ASTM D2488-00)

Description	Criteria
Dry	Absence of moisture, dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible, free water, usually soil is below water table

Structure

The soil structure is the manner in which the individual soil particles are assembled to form the soil mass. The primary soil structure is the arrangement of soil particles as originally deposited. The secondary soil structure refers to any rearrangement of the soil such as deformation and cracking which has taken place since deposition.

Primary Soil Structure (Depositional)

A. Geometry

Stratum - A single sedimentary 'layer', greater than 10 mm in thickness, visibly separable from other strata by a discrete change in lithology and/or sharp physical break.

Homogeneous - Same color and appearance throughout.

Stratified - Consisting of a sequence of layers which are generally of contrasting texture or color.

Laminated - Stratified with layer thicknesses between 2 mm and 10 mm.

Thinly laminated - Stratified with layer thickness less than 2 mm.

Bedded - Stratified with layer thicknesses greater than 10 mm.

Very Thinly Bedded (Flaggy) - Stratified with layer thicknesses between 10 and 50 mm.

Thinly Bedded (Slabby) - Stratified with layer thicknesses between 50 and 600 mm.

Thickly Bedded (Blocky) - Stratified with layer thicknesses between 600 and 1200 mm.

Thick-Bedded (Massive) - Stratified with layer thicknesses greater than 1200 mm.

Lensed - Inclusions of small pockets of different soils, such as small lenses of sand material throughout a mass of clay.

B. Bedding Structures

Cross-bedding - Internal 'bedding' inclined to the general bedding plane.

Ripple-bedding - Internal 'wavy bedding'.

Graded-bedding - Internal gradation of grain size from coarse at base to finer at top of bed.

Horizontal bedded - Internal bedding is parallel and flat lying

Secondary Soil Structure (Post-Depositional)

A. Accretionary Structures

Includes nodules, concretions, crystal aggregates, veinlets, color banding and

Cementation - Chemically precipitated material, commonly calcite ($CaCO_3$), binds the grains of soil, usually sandstone. Described as weak, moderate, strong (ASTM D2488-00).

Salt Crystals - Groundwater flowing through the soil/rock often precipitates visible amounts of salts. Calcite ($CaCO_3$), glauber salts ($Na_2Ca(SO_4)_2$), and gypsum ($CaSO_4*2H_2O$) are common.

B. Fracture Structures

Fracture - A break or discontinuity in the soil or rock mass caused by stress exceeding the materials strength.

Joint - A fracture along which no displacement has occurred.

Fissure - A gapped fracture, which may open and close seasonally. Usually an extensive network of closely spaced fractures, giving the soil a 'nuggetty' structure.

Slickensides - Fractures in a clay that are slick and glossy in appearance, caused by shear movements.

Brecciated - Contains randomly oriented angular fragments in a finer mass, usually associated with shear displacements in soils.

Fault - A fracture or fracture zone along which there has been displacement.

Blocky - A cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Symbols Used on Bore Hole Logs

Lithology Type

- ▤ CLAY
- SILT
- ▒ SAND
- GRAVEL
- COBBLES
- TILL-oxidized
- TILL-unoxidized
- PEAT
- TOPSOIL or ORGANIC SOIL
- ▒ COAL
- FILL (Undifferentiated)
- CONCRETE
- ■ ASPHALT
- ☰ CLAY SHALE
- SANDSTONE
- MUDSTONE
- BEDROCK (Undifferentiated)

Borehole Completion and Backfill Materials

- ■ Bentonite
- Concrete
- ▦ Cover
- Cuttings
- Grout
- ▒ Sand
- ▧ Slough
- ▯ Solid Pipe
- Slotted Pipe

Soil Sample Type

- ■ Thin Walled Tube
- Driven Spoon
- ▤ Disturbed
- ▥ Core (any type)
- ▨ No Recovery

Groundwater Symbols

▼ Piezometric elevation as determined by a piezometer installation

▽ Water levels measured in borings at the time and under the conditions noted

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Bore Hole Logs
and
Laboratory Test Data

Geotech BH m Elev CAL v03.ldf

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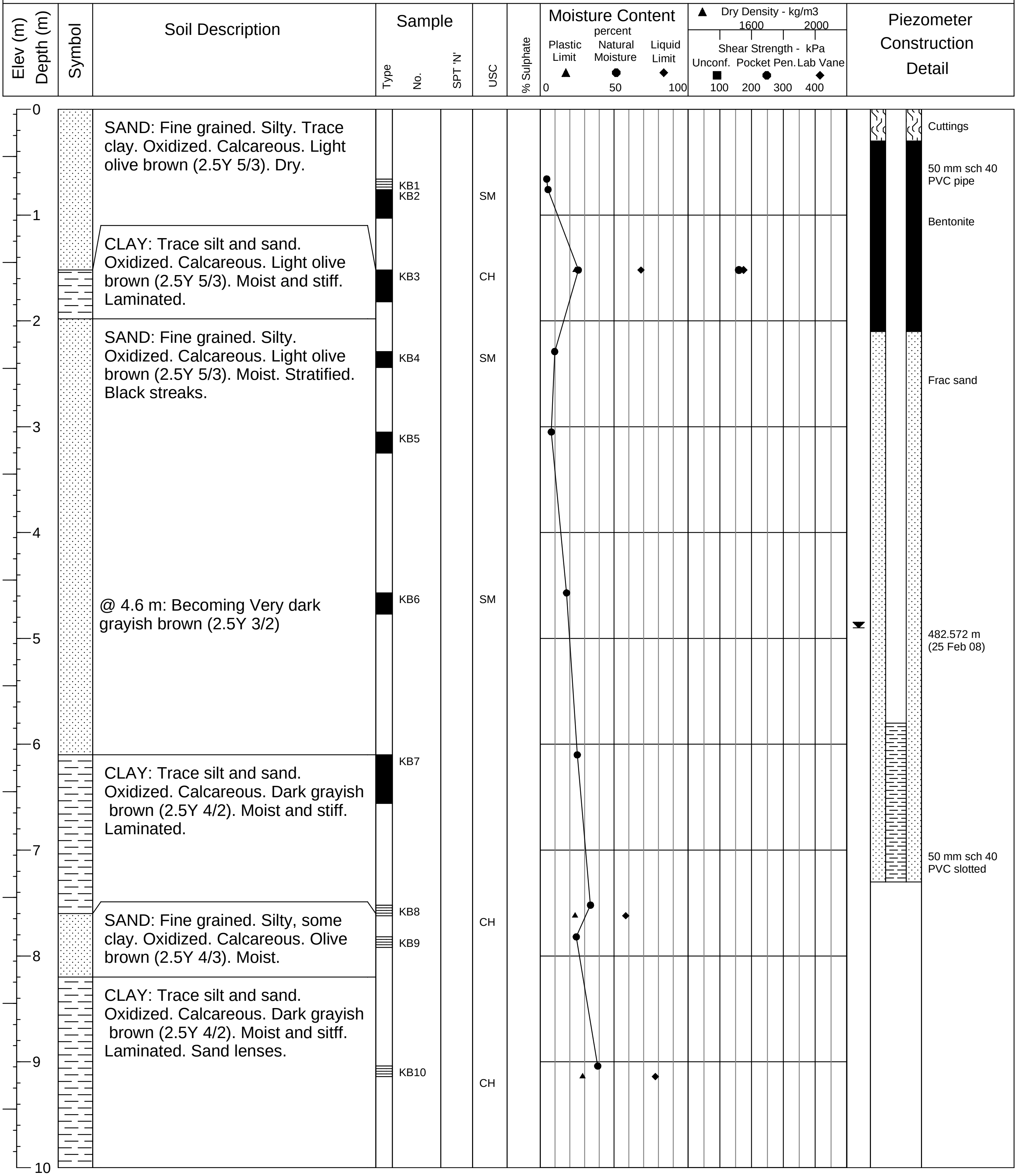
BORE HOLE LOG

Bore Hole: 101
Page: 1 of 2

Client:	Neil Ketilson	Northing:	5,765,376.985 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	388,679.686 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.448 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	488.412 m	Logged by:	KB



SAND: Fine grained. Silty. Trace clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Dry.

CLAY: Trace silt and sand. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist and stiff. Laminated.

SAND: Fine grained. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Stratified. Black streaks.

@ 4.6 m: Becoming Very dark grayish brown (2.5Y 3/2)

CLAY: Trace silt and sand. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist and stiff. Laminated.

SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist.

CLAY: Trace silt and sand. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist and sitff. Laminated. Sand lenses.

Geotech BH m Elev CAL v03.ldf

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BORE HOLE LOG

Bore Hole: 101
Page: 2 of 2

Client:	Neil Ketilson	Northing:	5,765,376.985 (UTM)	Date Drilled:	17 January 2007
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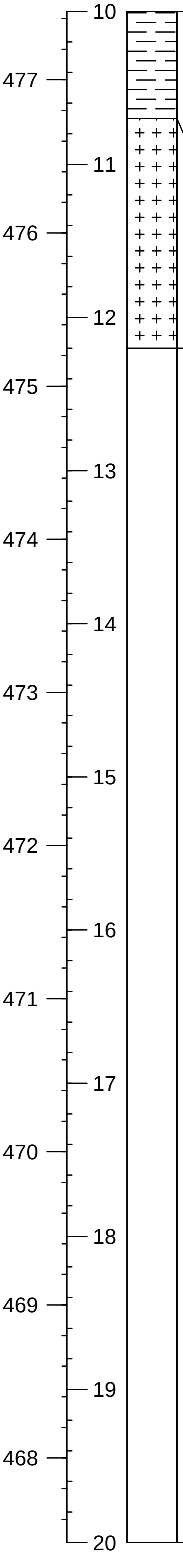
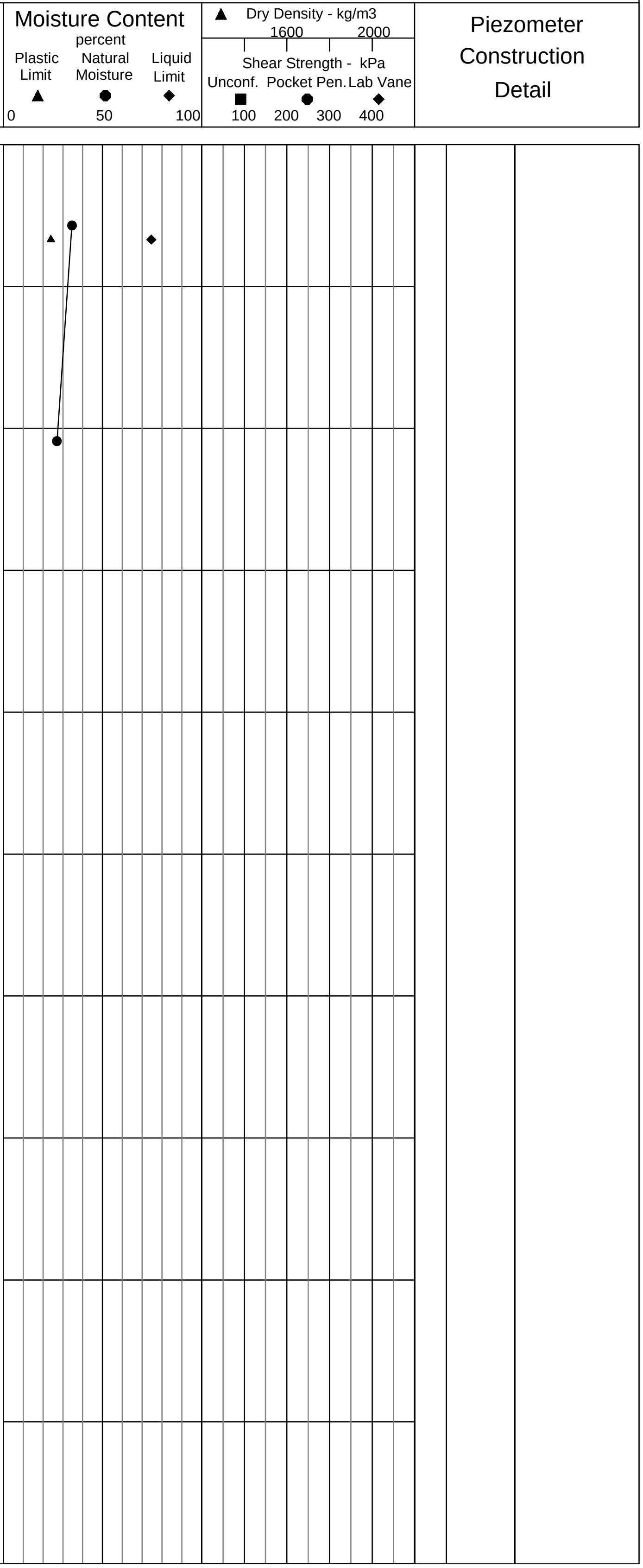


Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate
CLAY: Trace silt and sand. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist and sitff. Laminated. Sand lenses.		KB11		CH	
SILT: Sandy, trace clay. Oxidized. Calcareous. Very dark grayish brown (2.5Y 3/2). Moist and stiff. Dilatant.		KB12			
NOTES: 125 mm continuous flight auger used. Seepage @ 4.6 m.					



Geotech BH m Elev CAL v03.ldf

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engineering science technology

BORE HOLE LOG

Bore Hole: **102**
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,765,592.890 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	388,709.567 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	490.021 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB

Elev (m)	Depth (m)
490	0
489	1
488	2
487	3
486	4
485	5
484	6
483	7
482	8
481	9
	10

Symbol

Soil Description

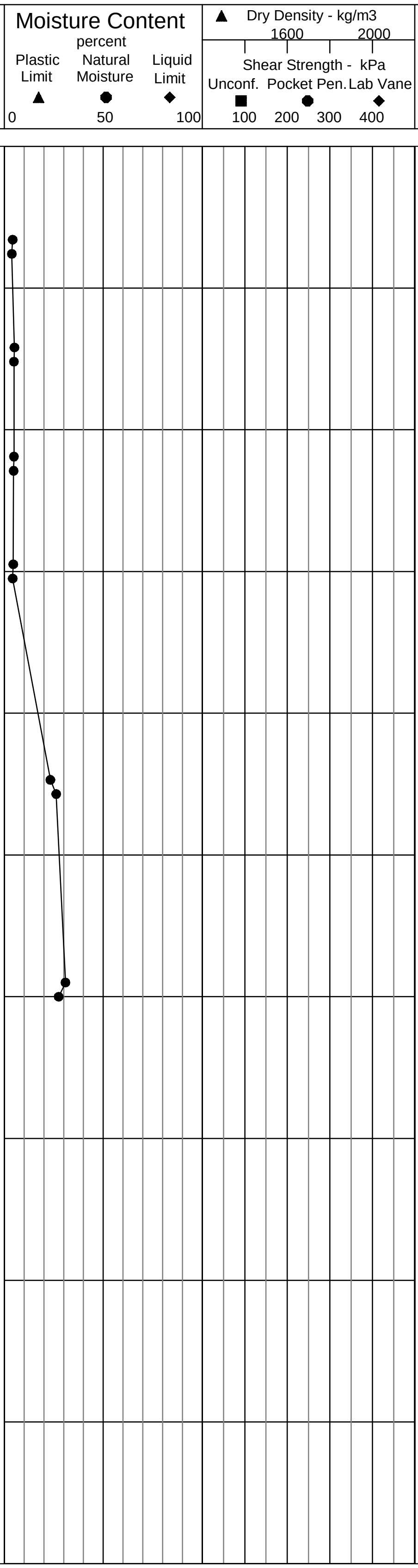
SAND: Fine grained. Silty, trace clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Dry and compact. Homogeneous.

CLAY: Trace sand and silt. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist and very stiff. Laminated. Iron staining. Silt partings. Lensed with sand.

NOTES: 125 mm continuous flight auger used. No sloughing.

Sample

Type	No.	SPT 'N'	USC	% Sulphate
	KB13			
	KB14	14		
	KB15			
	KB16	13		
	KB17			
	KB18	17		
	KB19			
	KB20	16		
	KB21			
	KB22	18		
	KB23			
	KB24			



Piezometer Construction Detail

Geotech BH m Elev CAL v03.ldf

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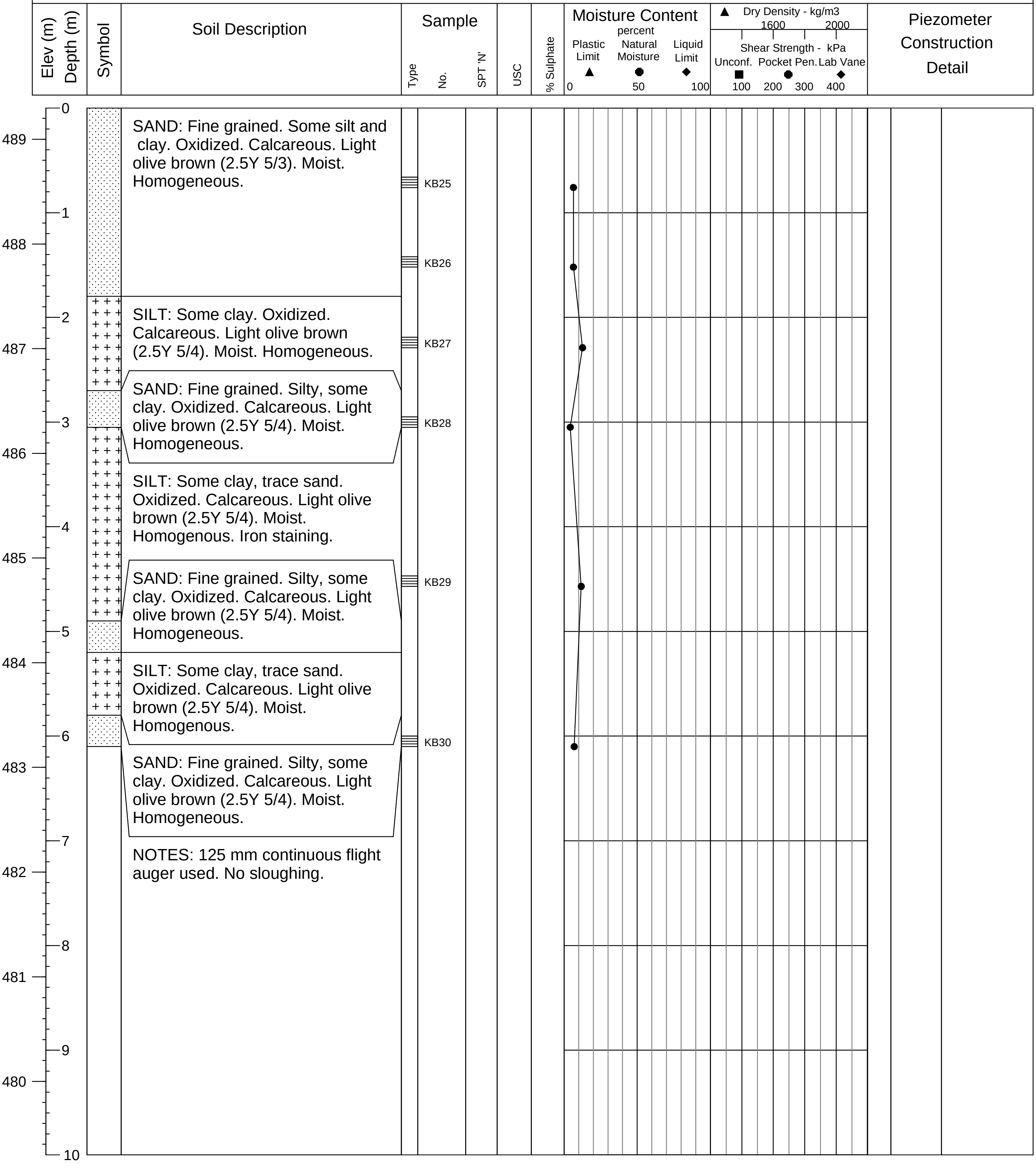
BORE HOLE LOG

Bore Hole: 103
Page: 1 of 1

Client: Neil Ketilson
Project: Casa Grande Subdivision
Location: Grasswood, SK
Project No.: S1607

Northing: 5,765,974.919 (UTM)
Easting: 388,747.079 (UTM)
Ground Elev.: 489.299 m (Geodetic)
Top Casing Elev.:

Date Drilled: 17 January 2007
Drill: Brat 22
Drilling Method: Solid Stem Auger
Logged by: KB



SAND: Fine grained. Some silt and clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Homogeneous.

SILT: Some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.

SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.

SILT: Some clay, trace sand. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogenous. Iron staining.

SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.

SILT: Some clay, trace sand. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogenous.

SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.

NOTES: 125 mm continuous flight auger used. No sloughing.

Geotech BH m Elev CAL v03.ldf

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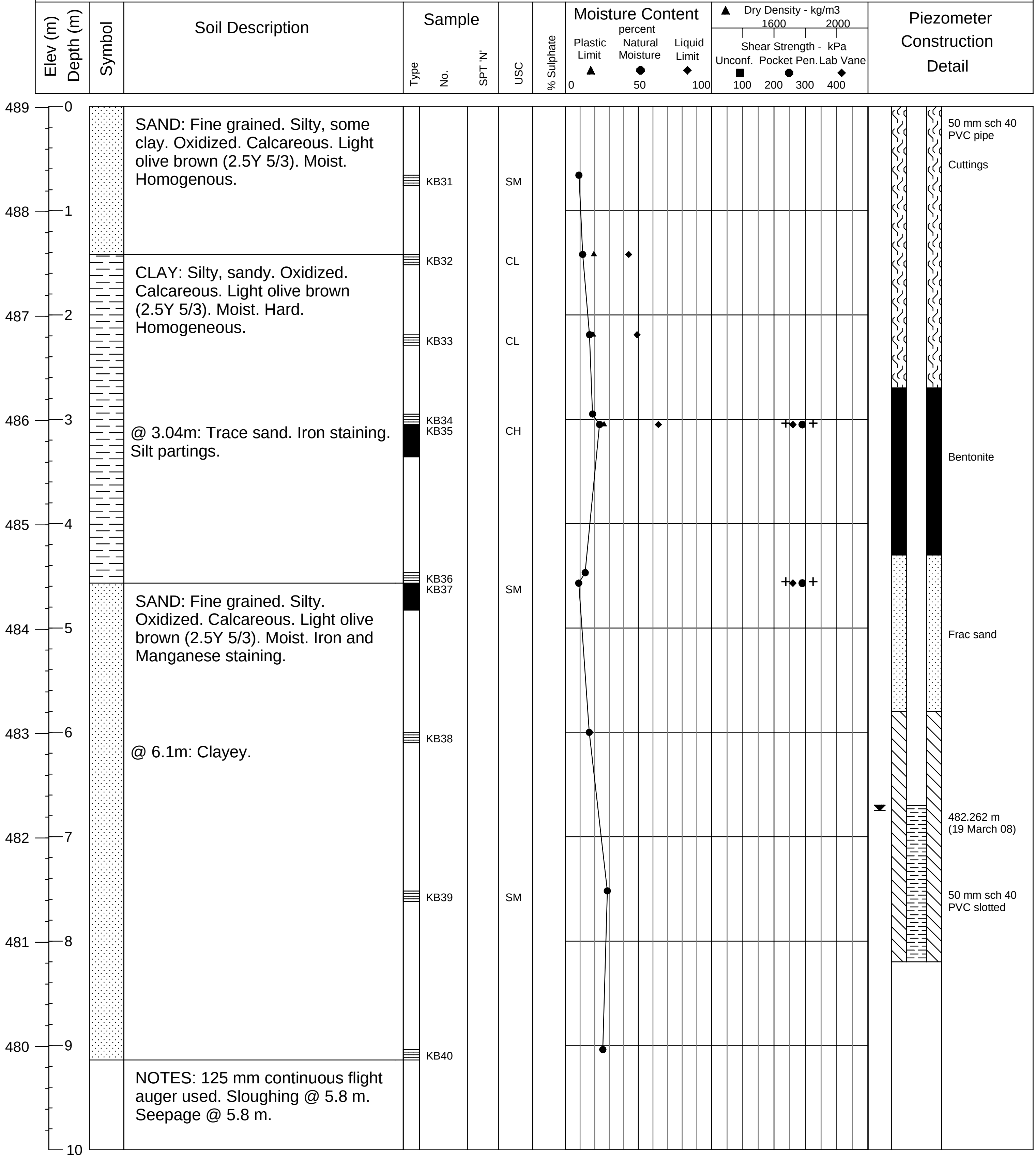
BORE HOLE LOG

Bore Hole: 104
Page: 1 of 1

Client: Neil Ketilson
Project: Casa Grande Subdivision
Location: Grasswood, SK
Project No.: S1607

Northing: 5,766,116.545 (UTM)
Easting: 389,077.547 (UTM)
Ground Elev.: 489.012 m (Geodetic)
Top Casing Elev.: 489.896 m

Date Drilled: 17 January 2007
Drill: Brat 22
Drilling Method: Solid Stem Auger
Logged by: KB



Soil Description

SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Homogenous.

CLAY: Silty, sandy. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Hard. Homogeneous.

@ 3.04m: Trace sand. Iron staining. Silt partings.

SAND: Fine grained. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Iron and Manganese staining.

@ 6.1m: Clayey.

NOTES: 125 mm continuous flight auger used. Sloughing @ 5.8 m. Seepage @ 5.8 m.

Sample No.	SPT 'N'	USC
KB31		SM
KB32		CL
KB33		CL
KB34 KB35		CH
KB36 KB37		SM
KB38		
KB39		SM
KB40		

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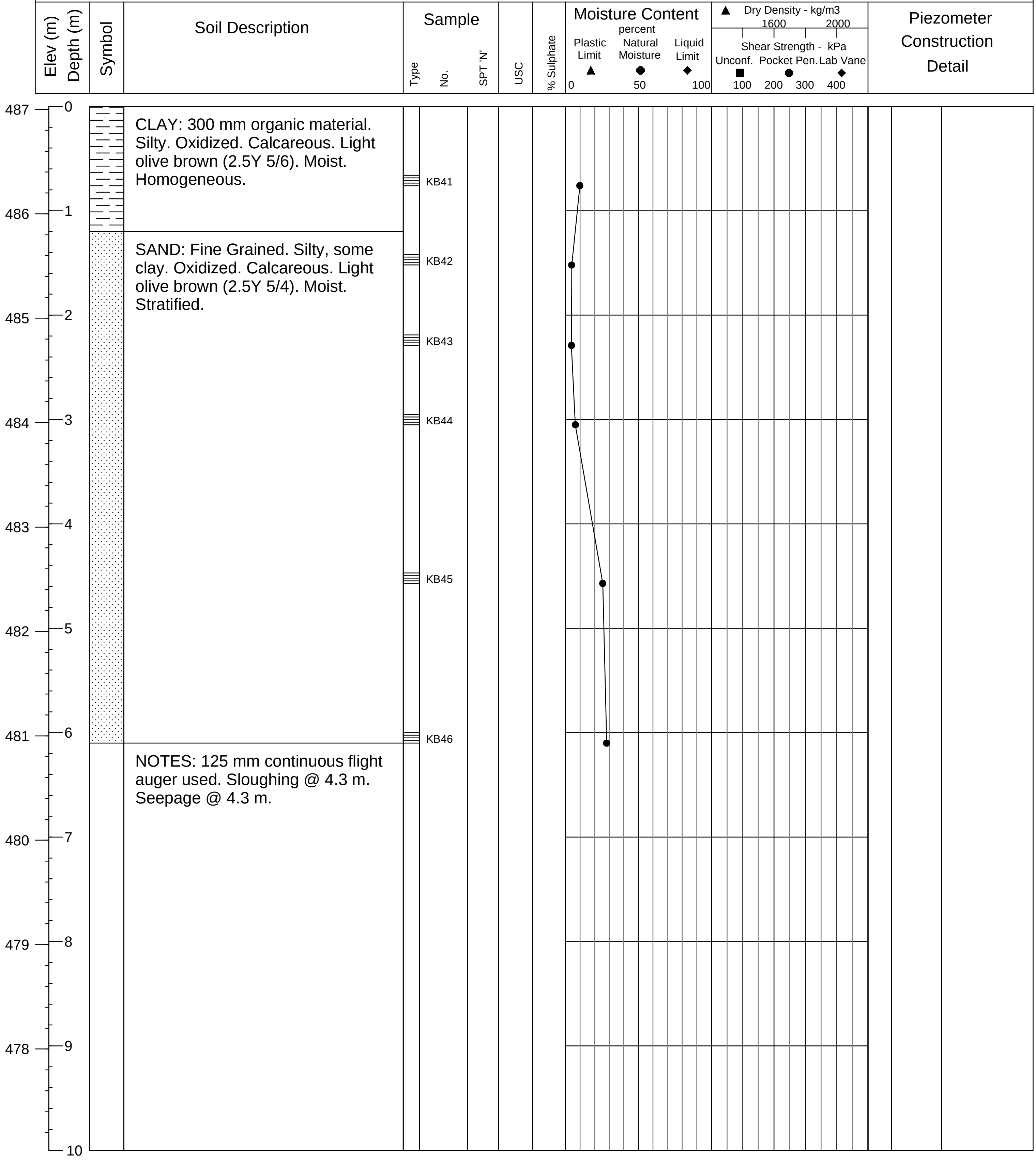
BORE HOLE LOG

Bore Hole: 105
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,765,861.154 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,077.457 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.030 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB



CLAY: 300 mm organic material. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/6). Moist. Homogeneous.

SAND: Fine Grained. Silty, some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Stratified.

NOTES: 125 mm continuous flight auger used. Sloughing @ 4.3 m. Seepage @ 4.3 m.

Geotech BH m Elev CAL v03.ldf

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BORE HOLE LOG

Bore Hole: **106**
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,765,600.569 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,053.995 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	489.115 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB

Elev (m) Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content percent	Dry Density - kg/m3 / Shear Strength - kPa	Piezometer Construction Detail

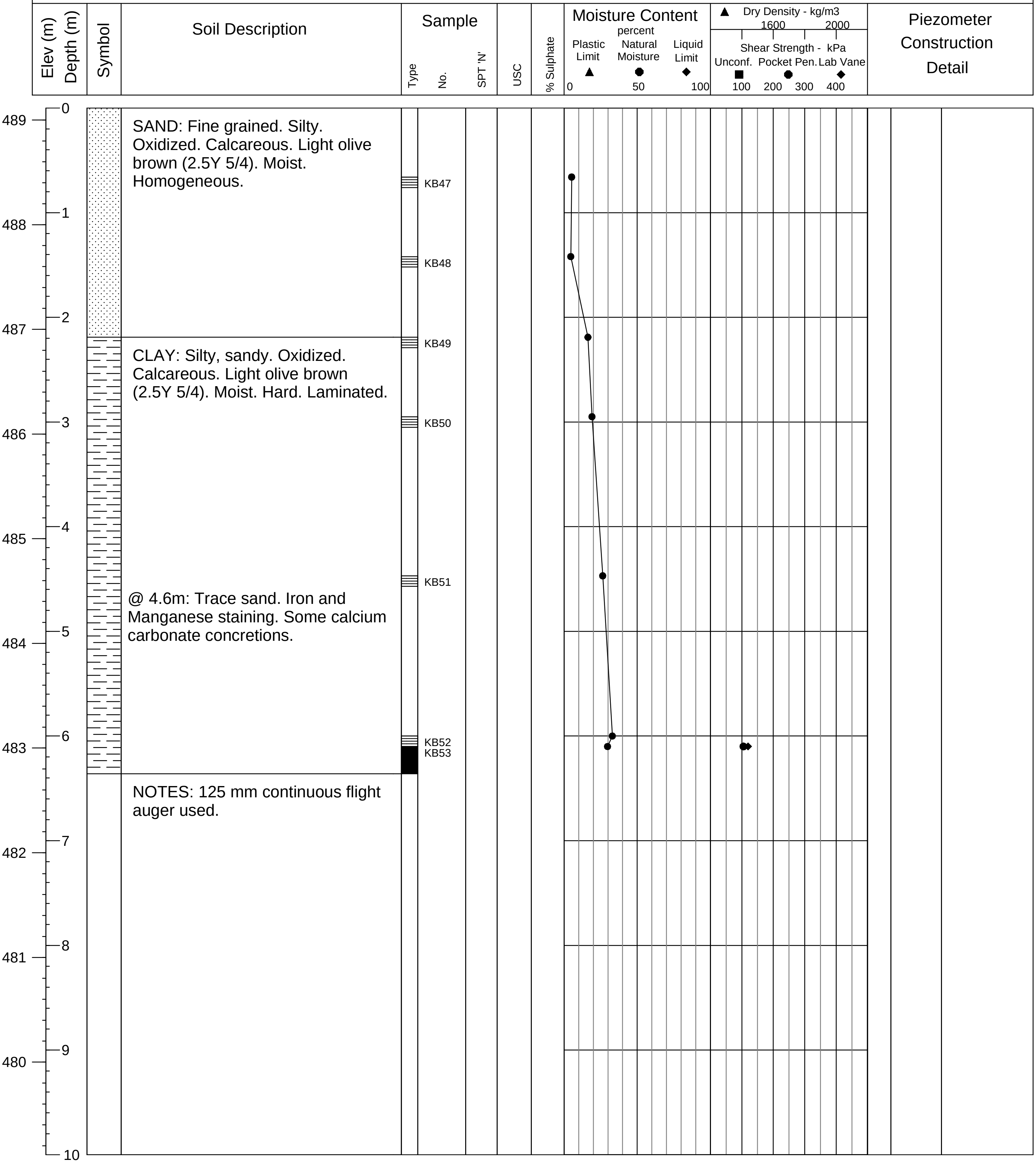
SAND: Fine grained. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.

CLAY: Silty, sandy. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Hard. Laminated.

@ 4.6m: Trace sand. Iron and Manganese staining. Some calcium carbonate concretions.

NOTES: 125 mm continuous flight auger used.

Sample	No.
▤	KB47
▤	KB48
▤	KB49
▤	KB50
▤	KB51
▤	KB52
■	KB53



Geotech BH m Elev CAL v03.ldf

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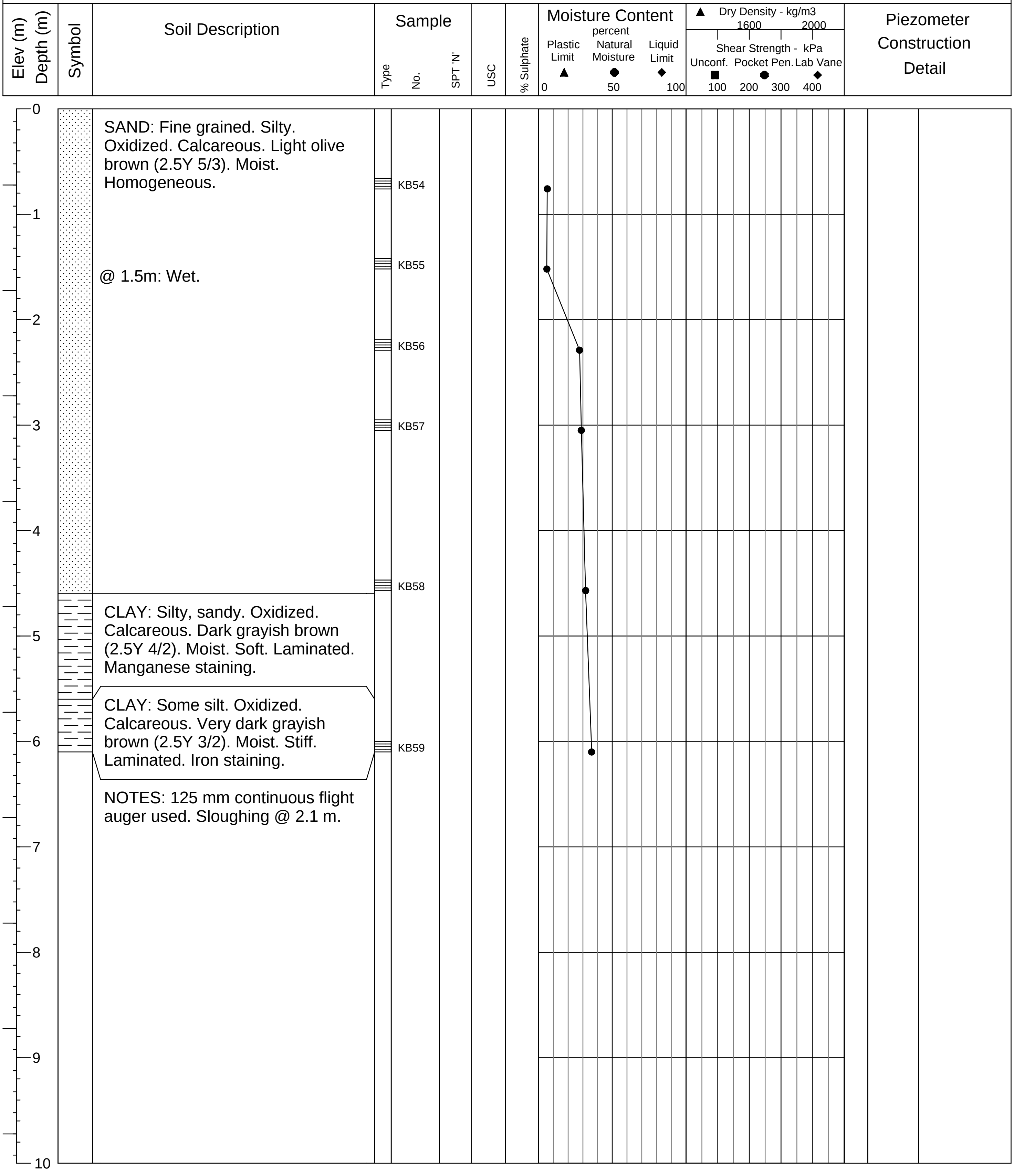
engineering science technology

BORE HOLE LOG

Bore Hole: 107
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,765,367.001 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,086.446 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	485.723 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB



SAND: Fine grained. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Homogeneous.

@ 1.5m: Wet.

CLAY: Silty, sandy. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist. Soft. Laminated. Manganese staining.

CLAY: Some silt. Oxidized. Calcareous. Very dark grayish brown (2.5Y 3/2). Moist. Stiff. Laminated. Iron staining.

NOTES: 125 mm continuous flight auger used. Sloughing @ 2.1 m.

Geotech BH m Elev CAL v03.ldf

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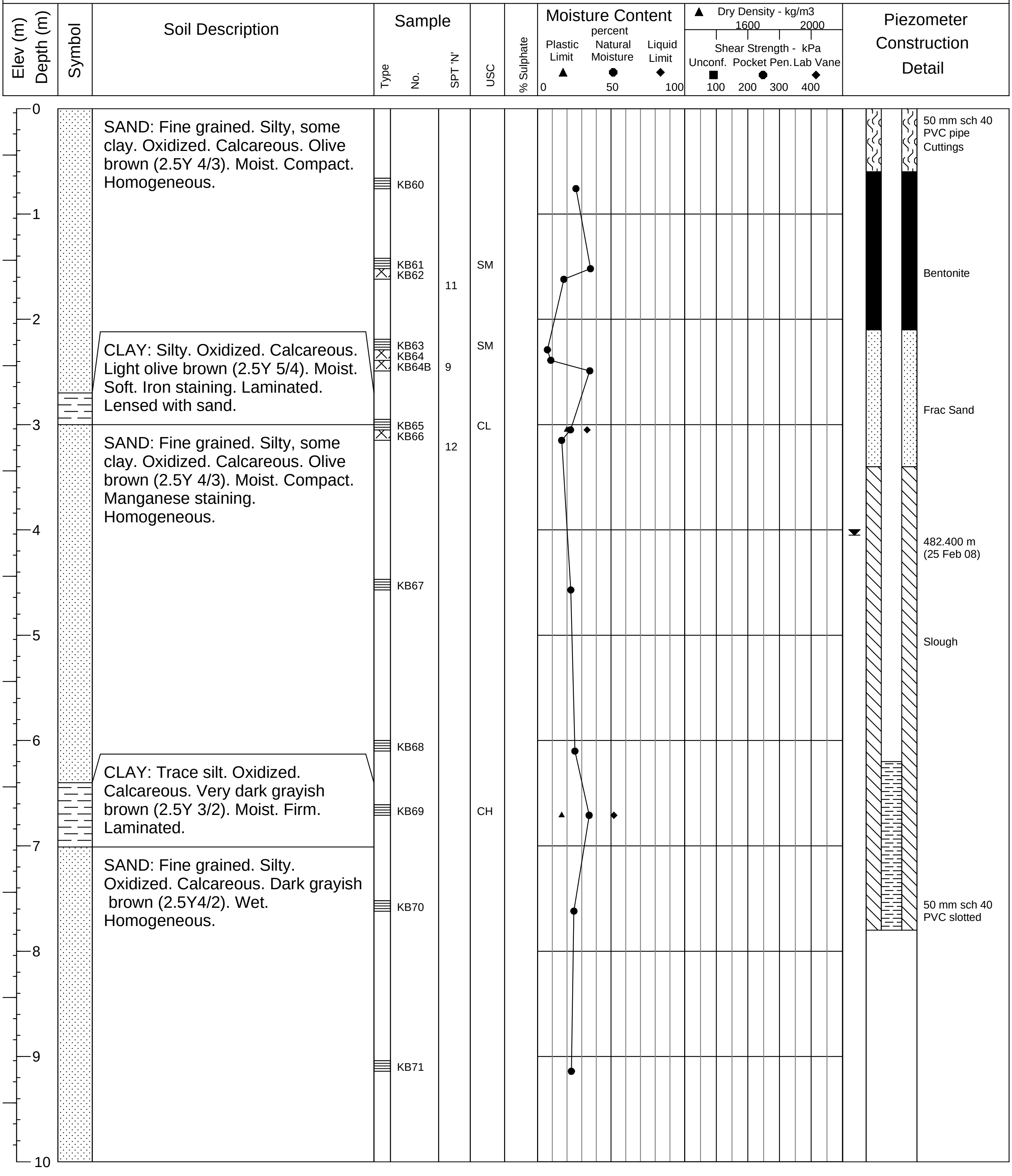
engineering science technology

BORE HOLE LOG

Bore Hole: 108
Page: 1 of 2

Client:	Neil Ketilson	Northing:	5,765,324.170 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,461.073 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.440 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	487.390 m	Logged by:	KB



SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Compact. Homogeneous.

CLAY: Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Soft. Iron staining. Laminated. Lensed with sand.

SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Compact. Manganese staining. Homogeneous.

CLAY: Trace silt. Oxidized. Calcareous. Very dark grayish brown (2.5Y 3/2). Moist. Firm. Laminated.

SAND: Fine grained. Silty. Oxidized. Calcareous. Dark grayish brown (2.5Y4/2). Wet. Homogeneous.

No.	SPT 'N'	USC
KB60		
KB61		SM
KB62	11	
KB63		SM
KB64		
KB64B	9	
KB65		CL
KB66	12	
KB67		
KB68		
KB69		CH
KB70		
KB71		

Geotech BH m Elev CAL v03.ldf

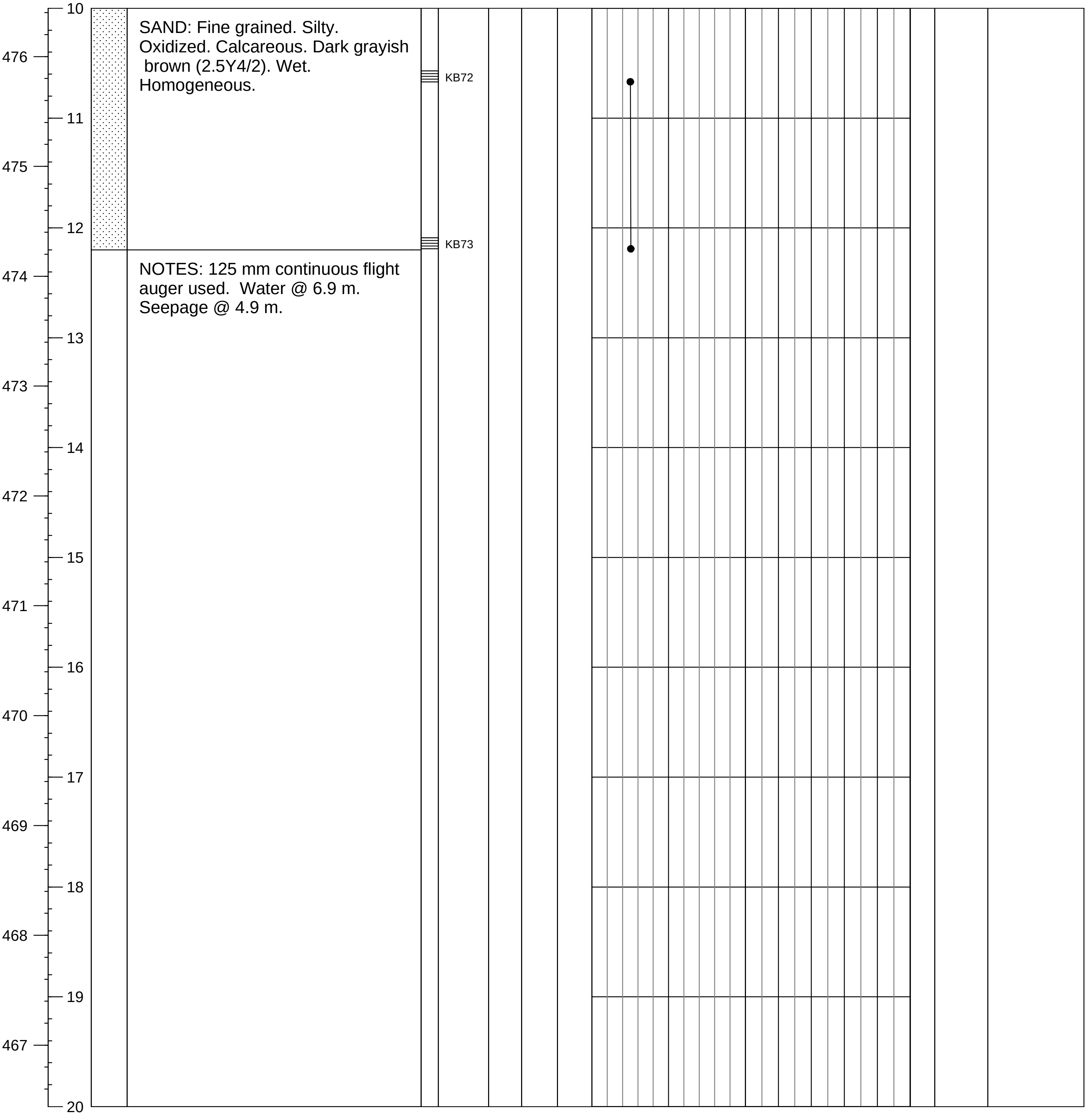
Clifton Associates Ltd.
engineering science technology

BORE HOLE LOG

Bore Hole: **108**
Page: 2 of 2

Client:	Neil Ketilson	Northing:	5,765,324.170 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,461.073 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.440 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	487.390 m	Logged by:	KB

Elev (m) Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content percent: Plastic Limit ▲, Natural Moisture ●, Liquid Limit ◆ (0 – 50 – 100)	▲ Dry Density - kg/m3 (1600, 2000); Shear Strength - kPa: Unconf. ■, Pocket Pen. ●, Lab Vane ◆ (100, 200, 300, 400)	Piezometer Construction Detail



SAND: Fine grained. Silty. Oxidized. Calcareous. Dark grayish brown (2.5Y4/2). Wet. Homogeneous.

KB72

KB73

NOTES: 125 mm continuous flight auger used. Water @ 6.9 m. Seepage @ 4.9 m.

Geotech BH m Elev CAL v03.ldf

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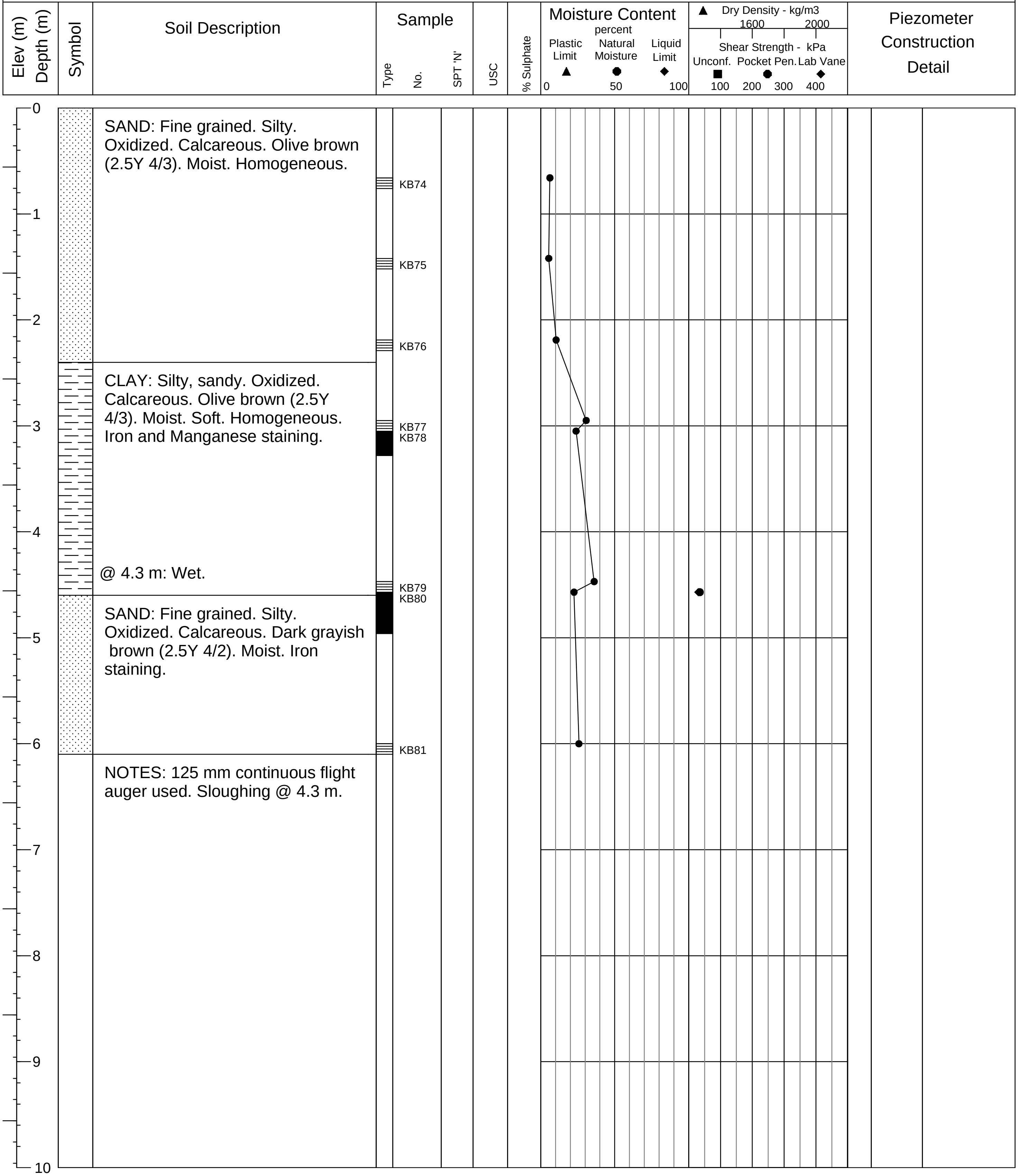
engineering science technology

BORE HOLE LOG

Bore Hole: **109**
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,765,594.201 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,458.870 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.558 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB



SAND: Fine grained. Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous.

CLAY: Silty, sandy. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Soft. Homogeneous. Iron and Manganese staining.

@ 4.3 m: Wet.

SAND: Fine grained. Silty. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist. Iron staining.

NOTES: 125 mm continuous flight auger used. Sloughing @ 4.3 m.

Geotech BH m Elev CAL v03.ldf

Clifton Associates Ltd.
engineering science technology

BORE HOLE LOG

Bore Hole: 110
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,765,865.177 (UTM)	Date Drilled:	17 January 2008
Project:	Casa Grande Subdivision	Easting:	389,397.072 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.043 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB

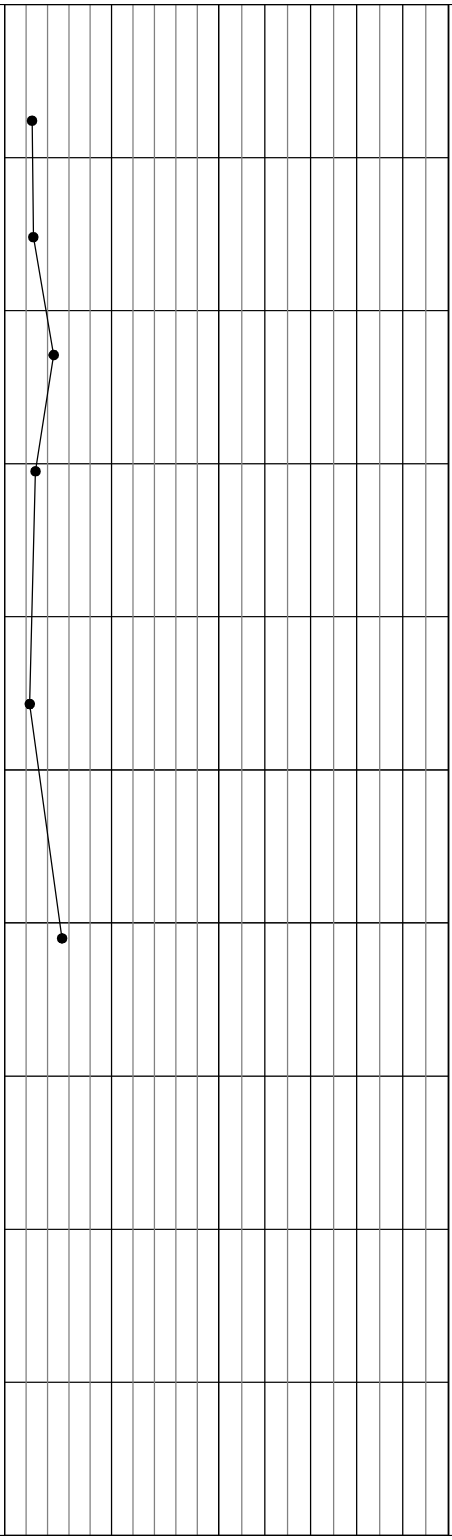
Elev (m)	Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate
487	0		CLAY: Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.		KB82			
486	1		SAND: Silty. Oxidized. Calcareous. Dark olive brown (2.5Y 3/3). Moist. Homogeneous.		KB83			
485	2		CLAY: With silt. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Firm. Laminated. Iron staining.		KB84 KB85			
484	3							
483	4		SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous.		KB86			
482	5							
481	6				KB87			
			NOTES: 125 mm continuous flight auger used. Sloughing @ 4.3 m.					
480	7							
479	8							
478	9							
	10							

Moisture Content
percent
Plastic Limit ▲ Natural Moisture ● Liquid Limit ◆
0 50 100

▲ Dry Density - kg/m3
1600 2000

Shear Strength - kPa
Unconf. ■ Pocket Pen. ● Lab Vane ◆
100 200 300 400

Piezometer Construction Detail



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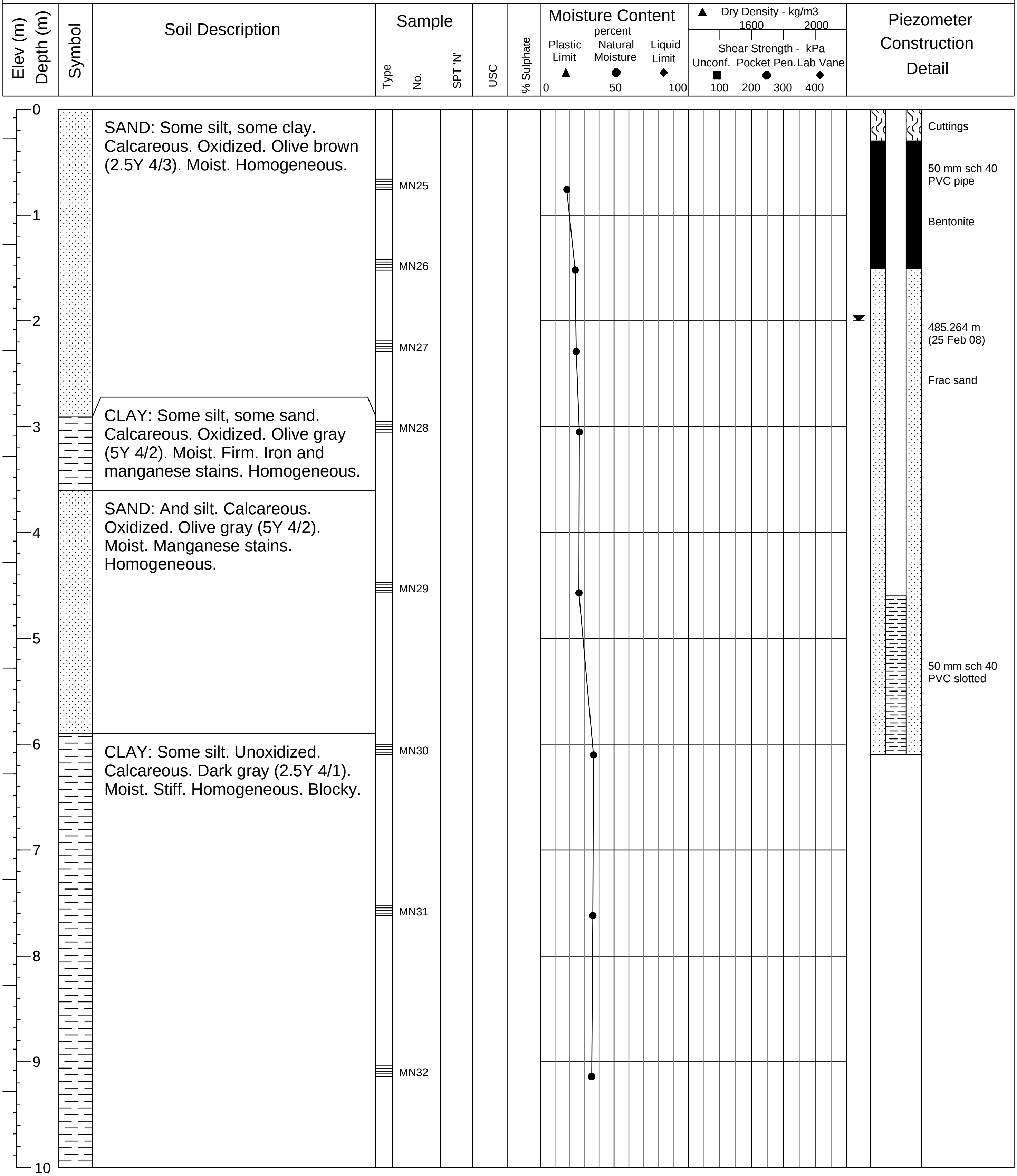
engineering science technology

BORE HOLE LOG

Bore Hole: 111
Page: 1 of 2

Client:	Neil Ketilson	Northing:	5,766,906.065 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,475.333 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.281 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	488.094 m	Logged by:	MN



SAND: Some silt, some clay. Calcareous. Oxidized. Olive brown (2.5Y 4/3). Moist. Homogeneous.

CLAY: Some silt, some sand. Calcareous. Oxidized. Olive gray (5Y 4/2). Moist. Firm. Iron and manganese stains. Homogeneous.

SAND: And silt. Calcareous. Oxidized. Olive gray (5Y 4/2). Moist. Manganese stains. Homogeneous.

CLAY: Some silt. Unoxidized. Calcareous. Dark gray (2.5Y 4/1). Moist. Stiff. Homogeneous. Blocky.

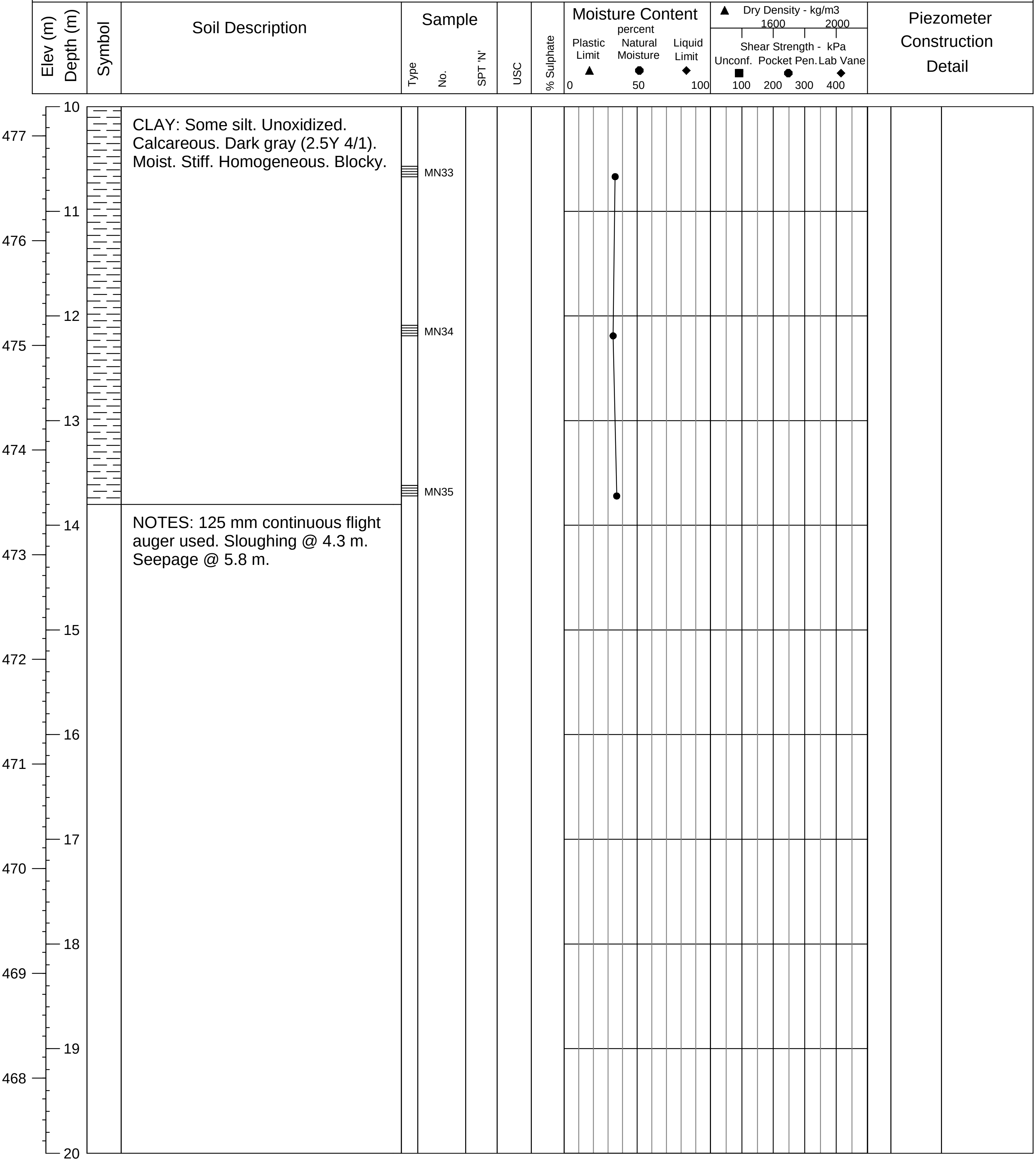
Geotech BH m Elev CAL v03.ldf

Clifton Associates Ltd.
engineering science technology

BORE HOLE LOG

Bore Hole: 111
Page: 2 of 2

Client:	Neil Ketilson	Northing:	5,766,906.065 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,475.333 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.281 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	488.094 m	Logged by:	MN



CLAY: Some silt. Unoxidized. Calcareous. Dark gray (2.5Y 4/1). Moist. Stiff. Homogeneous. Blocky.

NOTES: 125 mm continuous flight auger used. Sloughing @ 4.3 m. Seepage @ 5.8 m.

Geotech BH m Elev CAL v03.ldf

Clifton Associates Ltd.
engineering science technology

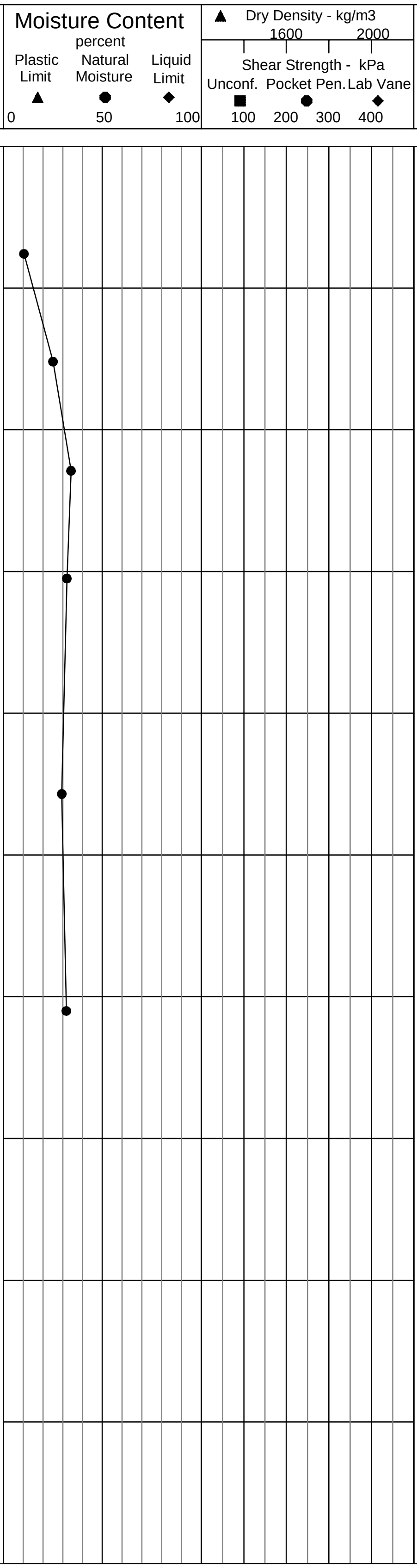
BORE HOLE LOG

Bore Hole: 112
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,766,912.968 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,067.950 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.154 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate
0 – 2.2		SAND: Fine grained. Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/4). Moist. Homogeneous. @ 1.5 m: And silt. Light olive brown (2.5Y 5/4). Salt inclusions.		MN13 MN14			
2.2 – 5.1		CLAY: Silty. Trace sand. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Homogeneous. Iron staining. @ 4.3 m: Wet.		MN15 MN16 MN17			
5.1 – 6.1		CLAY: Some silt. Unoxidized. Calcareous. Dark gray (2.5Y 4/1). Moist. Stiff. Homogeneous. Blocky.		MN18			
		NOTES: 125 mm continuous flight auger used. Seepage @ 4.3 m.					

Elev (m): 487, 486, 485, 484, 483, 482, 481, 480, 479, 478
Depth (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10



Piezometer Construction Detail

Geotech BH m Elev CAL v03.ldf

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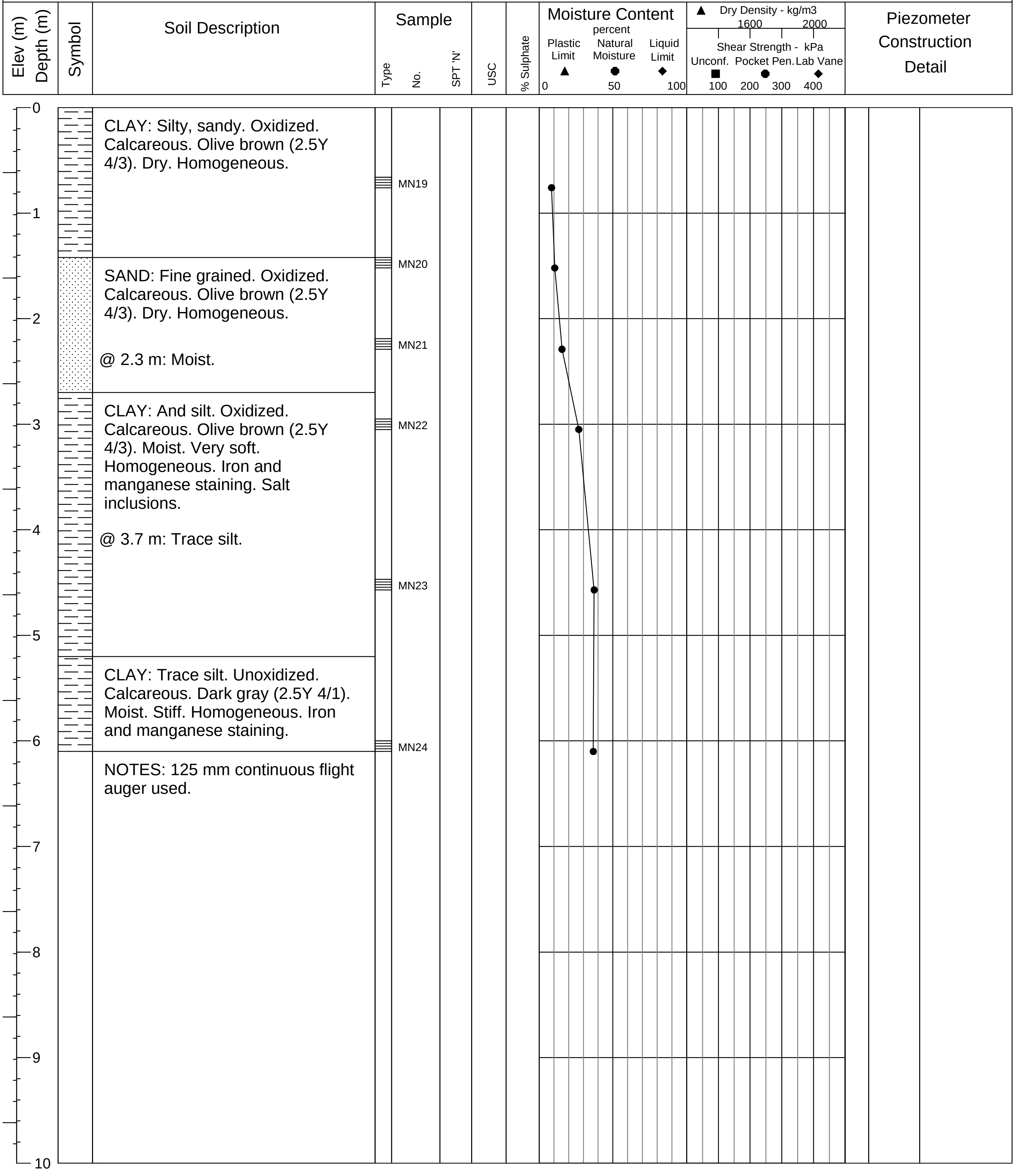
engineering science technology

BORE HOLE LOG

Bore Hole: 113
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,766,642.442 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,078.575 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.616 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN



CLAY: Silty, sandy. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Dry. Homogeneous.

SAND: Fine grained. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Dry. Homogeneous.

@ 2.3 m: Moist.

CLAY: And silt. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Very soft. Homogeneous. Iron and manganese staining. Salt inclusions.

@ 3.7 m: Trace silt.

CLAY: Trace silt. Unoxidized. Calcareous. Dark gray (2.5Y 4/1). Moist. Stiff. Homogeneous. Iron and manganese staining.

NOTES: 125 mm continuous flight auger used.

Geotech BH m Elev CAL v03.ldf

Clifton Associates Ltd.
engineering science technology

BORE HOLE LOG

Bore Hole: **114**
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,766,644.763 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,462.535 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.131m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate
486 / 0		SAND: Fine grained. Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous.		MN36			
485 / 1		@ 1.5 m: Iron staining.		MN37			
484 / 2		CLAY: Silty, trace sand. Oxidized. Calcareous. Light olive brown (2.5y 5/3). Moist. Stiff. Homogeneous. Blocky. Iron and manganese staining.		MN38 MN38A MN39 MN40			
481 / 5		SAND: Fine grained. Silty. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Wet. Very soft. Homogeneous.		MN41			
480 / 6		NOTES: 125 mm continuous flight auger used.					

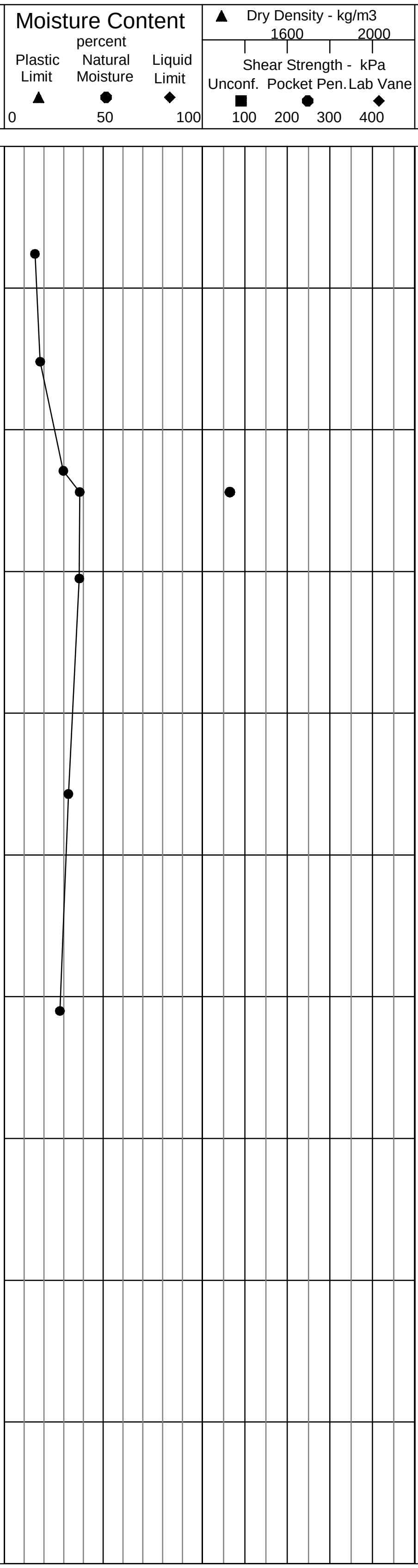
Moisture Content percent

Plastic Limit ▲ Natural Moisture ● Liquid Limit ◆

▲ Dry Density - kg/m3

Shear Strength - kPa
Unconf. ■ Pocket Pen. ● Lab Vane ◆

Piezometer Construction Detail



Geotech BH m Elev CAL v03.ldf

Clifton Associates Ltd.
engineering science technology

BORE HOLE LOG

Bore Hole: 115
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,766,653.031 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	388,734.367 m (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.645 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) Depth (m) | Symbol | Soil Description | Sample: Type, No. | SPT 'N' | USC | % Sulphate | Piezometer Construction Detail

SAND: Fine grained. Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous.

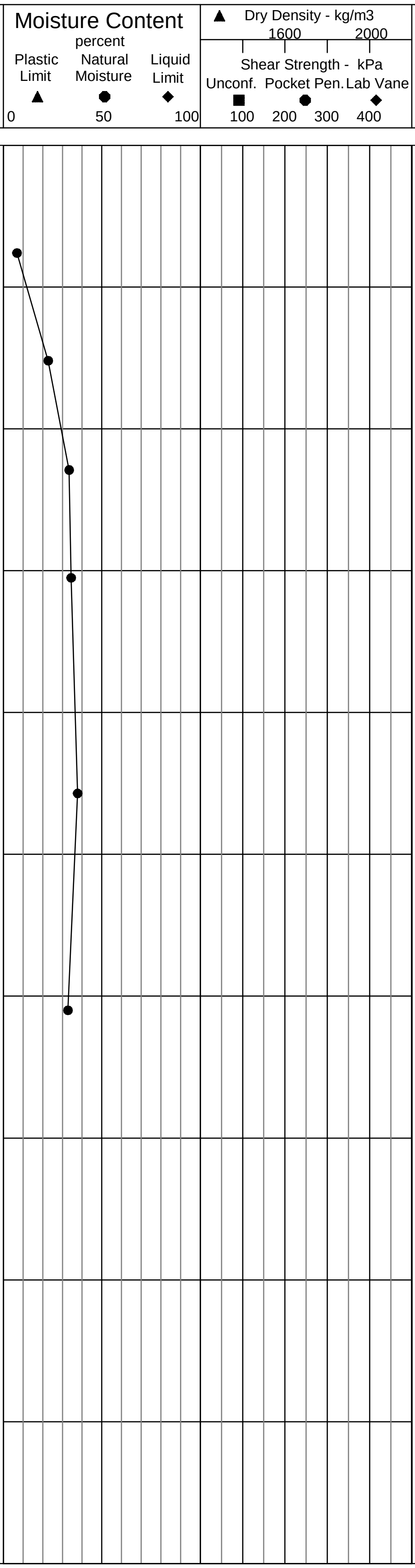
CLAY: Silty. Trace sand. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist. Stiff. Homogeneous. Iron staining. Salt inlcusions.

@ 2.19 m: Light olive brown (2.5Y 5/3). Very stiff. Blocky.

NOTES: 125 mm continuous flight auger used.

No.	% Sulphate
MN58	0.01
MN59	0.14
MN60	
MN61	
MN62	
MN63	

Depth (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Elev (m): 487, 486, 485, 484, 483, 482, 481, 480, 479, 478



Geotech BH m Elev CAL v03.ldf

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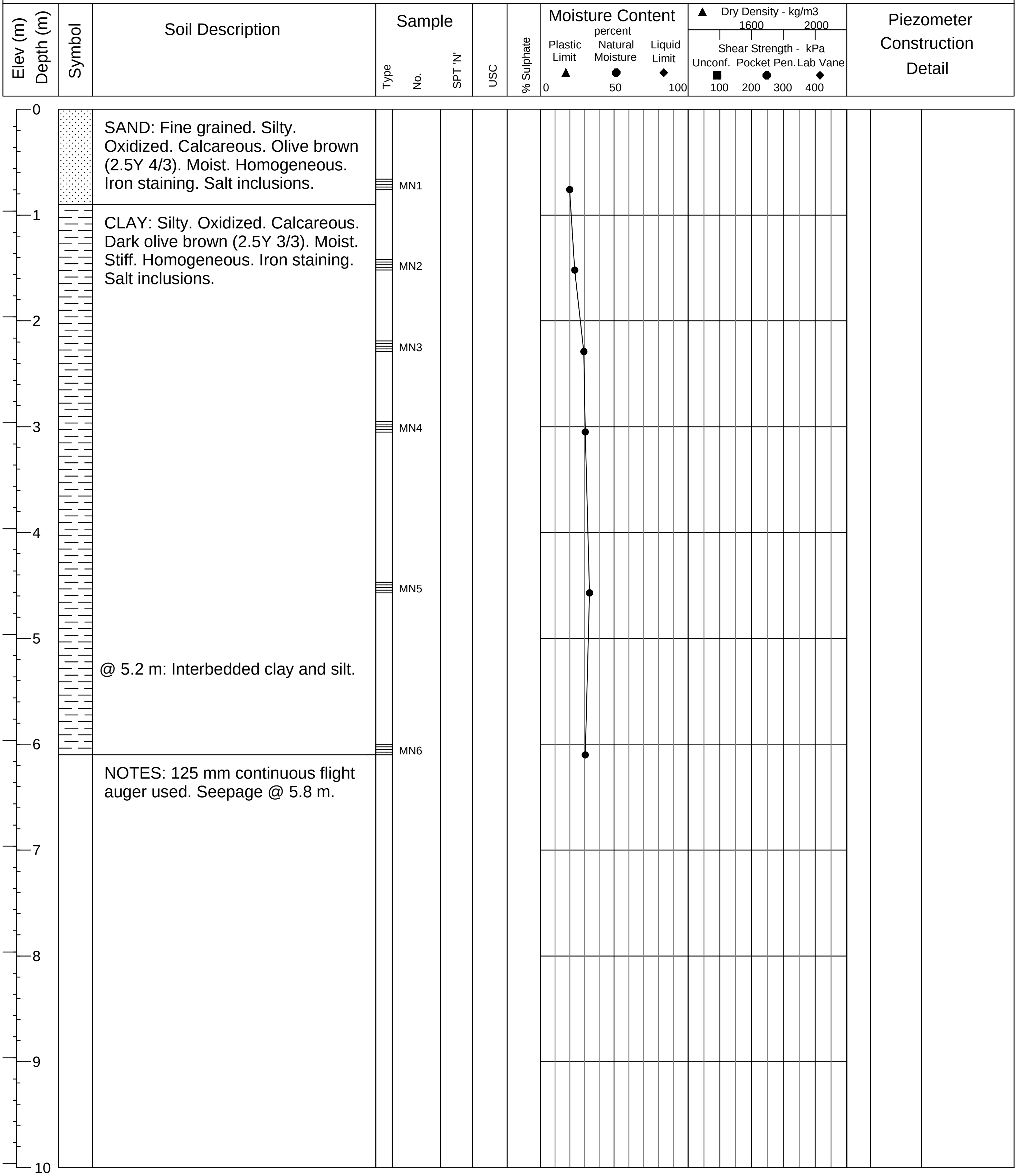
BORE HOLE LOG

Bore Hole: **116**
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,765,643.118 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,291.604 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.963 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN



SAND: Fine grained. Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous. Iron staining. Salt inclusions.

CLAY: Silty. Oxidized. Calcareous. Dark olive brown (2.5Y 3/3). Moist. Stiff. Homogeneous. Iron staining. Salt inclusions.

@ 5.2 m: Interbedded clay and silt.

NOTES: 125 mm continuous flight auger used. Seepage @ 5.8 m.

Geotech BH m Elev CAL v03.ldf

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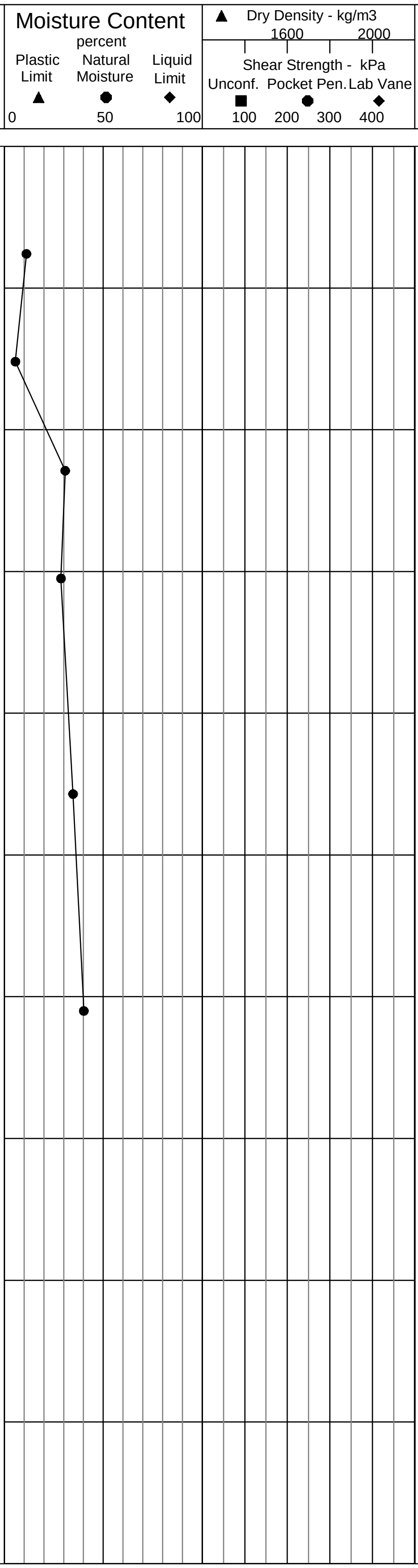
BORE HOLE LOG

Bore Hole: 117
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,765,569.269 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	388,792.867 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.094 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m)	Depth (m)
486	0
485	1
484	2
483	3
482	4
481	5
480	6
479	7
478	8
477	9
	10

Symbol	Soil Description	Sample Type	No.	SPT 'N'	USC	% Sulphate	Piezometer Construction Detail
▨	SAND: 900 mm organic material. Silty, trace clay. Oxidized. Calcareous. Olive brown (2.5Y 4/4). Moist. Homogeneous.	☰ ☰	MN7 MN8				
☰	CLAY: Some silt. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous. Iron staining. Salt inclusions. Blocky. @ 4.6 m: Very dark grayish brown (2.5Y 3/2). @ 5.5 m: Sand lense. Wet.	☰ ☰ ☰ ☰	MN9 MN10 MN11 MN12				
	NOTES: 125 mm continuous flight auger used.						



Geotech BH m Elev CAL v03.ldf

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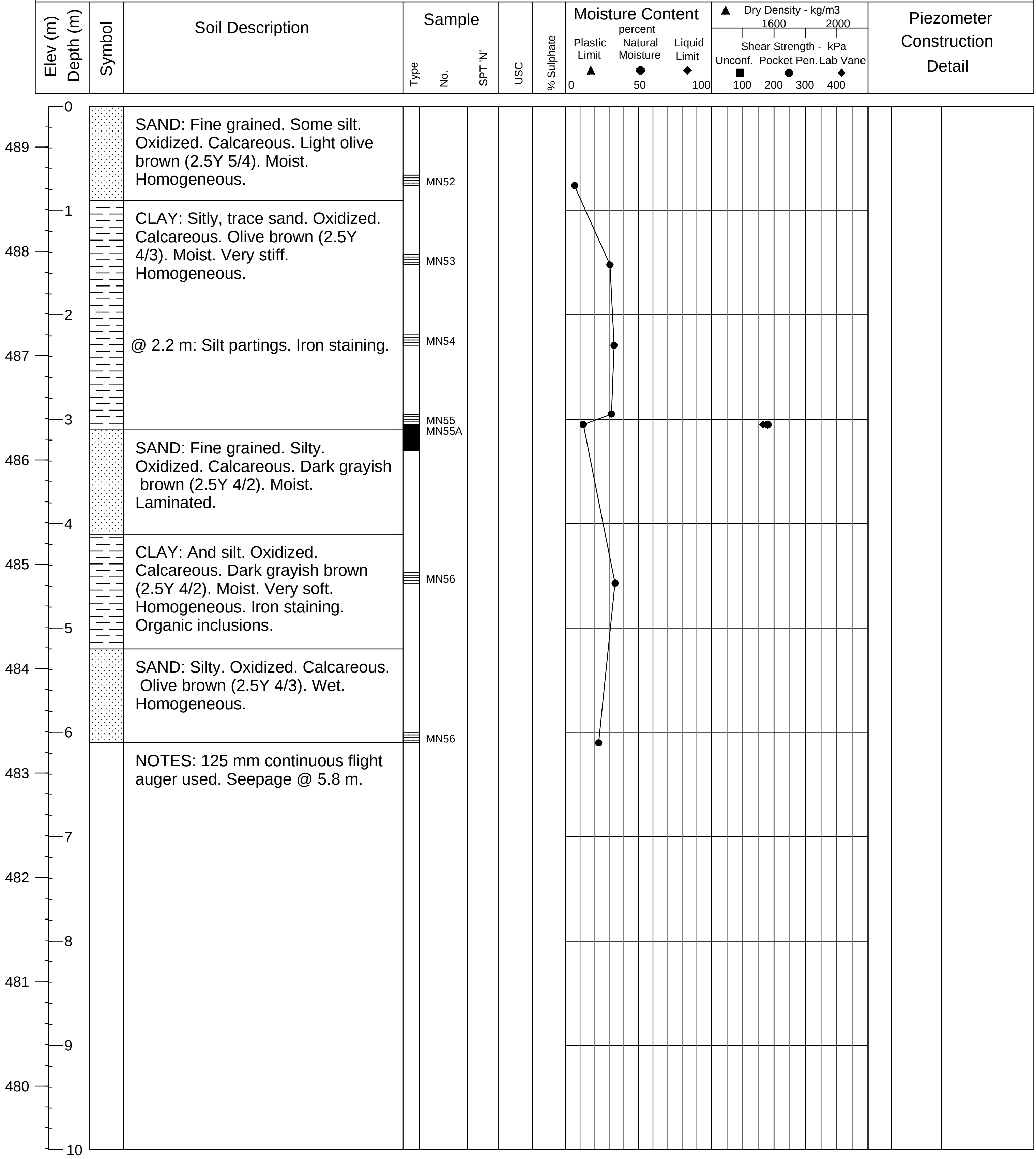
BORE HOLE LOG

Bore Hole: 118
Page: 1 of 1

Client:	Neil Ketilson	Northing:	5,766,549.263 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	388,851.487 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	489.390 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN



SAND: Fine grained. Some silt. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.

CLAY: Sitly, trace sand. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Very stiff. Homogeneous.

@ 2.2 m: Silt partings. Iron staining.

SAND: Fine grained. Silty. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist. Laminated.

CLAY: And silt. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist. Very soft. Homogeneous. Iron staining. Organic inclusions.

SAND: Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Wet. Homogeneous.

NOTES: 125 mm continuous flight auger used. Seepage @ 5.8 m.

Geotech BH m Elev CAL v03.ldf

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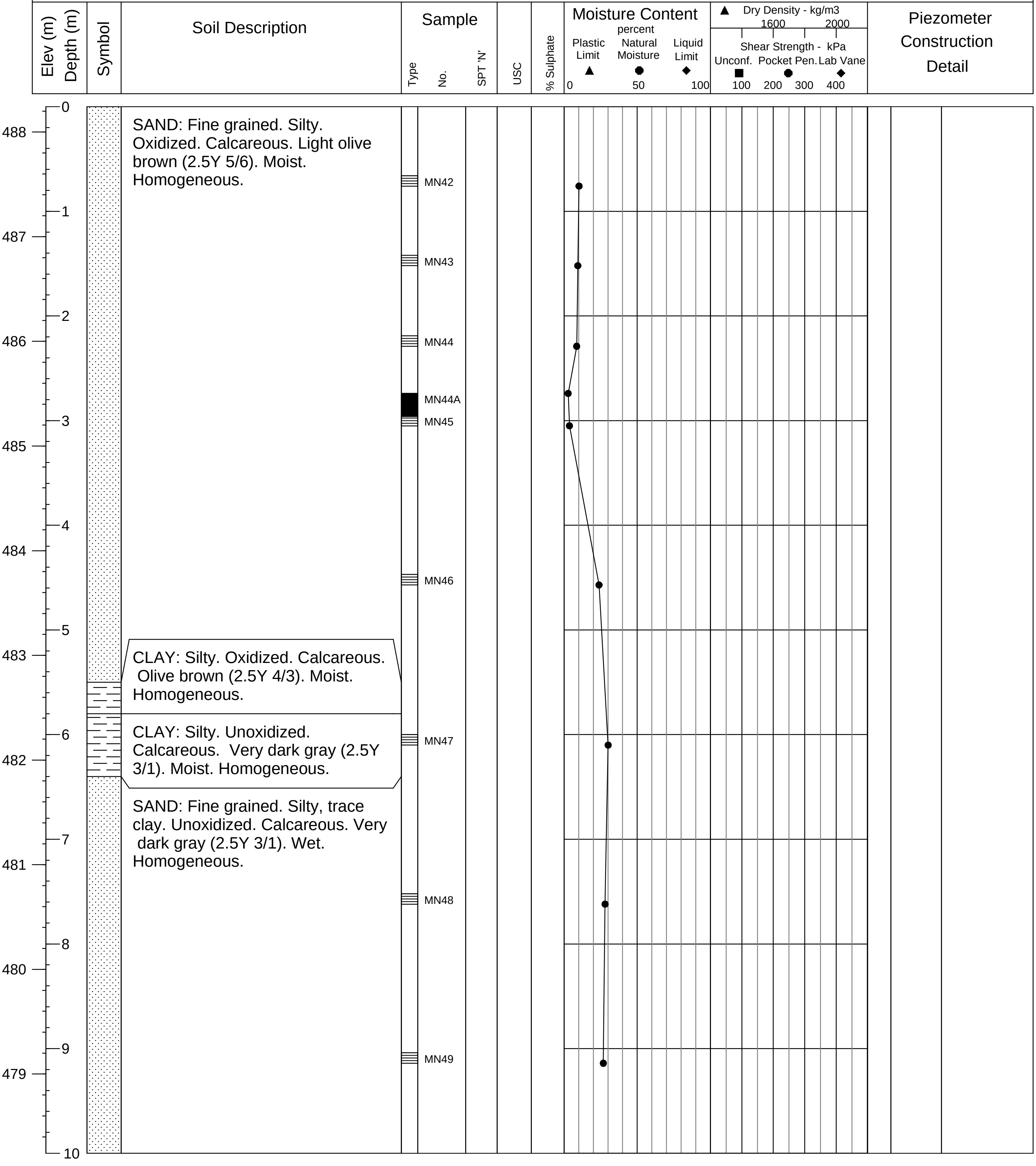
BORE HOLE LOG

Bore Hole: 119
Page: 1 of 2

Client:	Neil Ketilson	Northing:	5,766,577.427 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,262.166 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	488.243 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN



SAND: Fine grained. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/6). Moist. Homogeneous.

CLAY: Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous.

CLAY: Silty. Unoxidized. Calcareous. Very dark gray (2.5Y 3/1). Moist. Homogeneous.

SAND: Fine grained. Silty, trace clay. Unoxidized. Calcareous. Very dark gray (2.5Y 3/1). Wet. Homogeneous.

Geotech BH m Elev CAL v03.ldf

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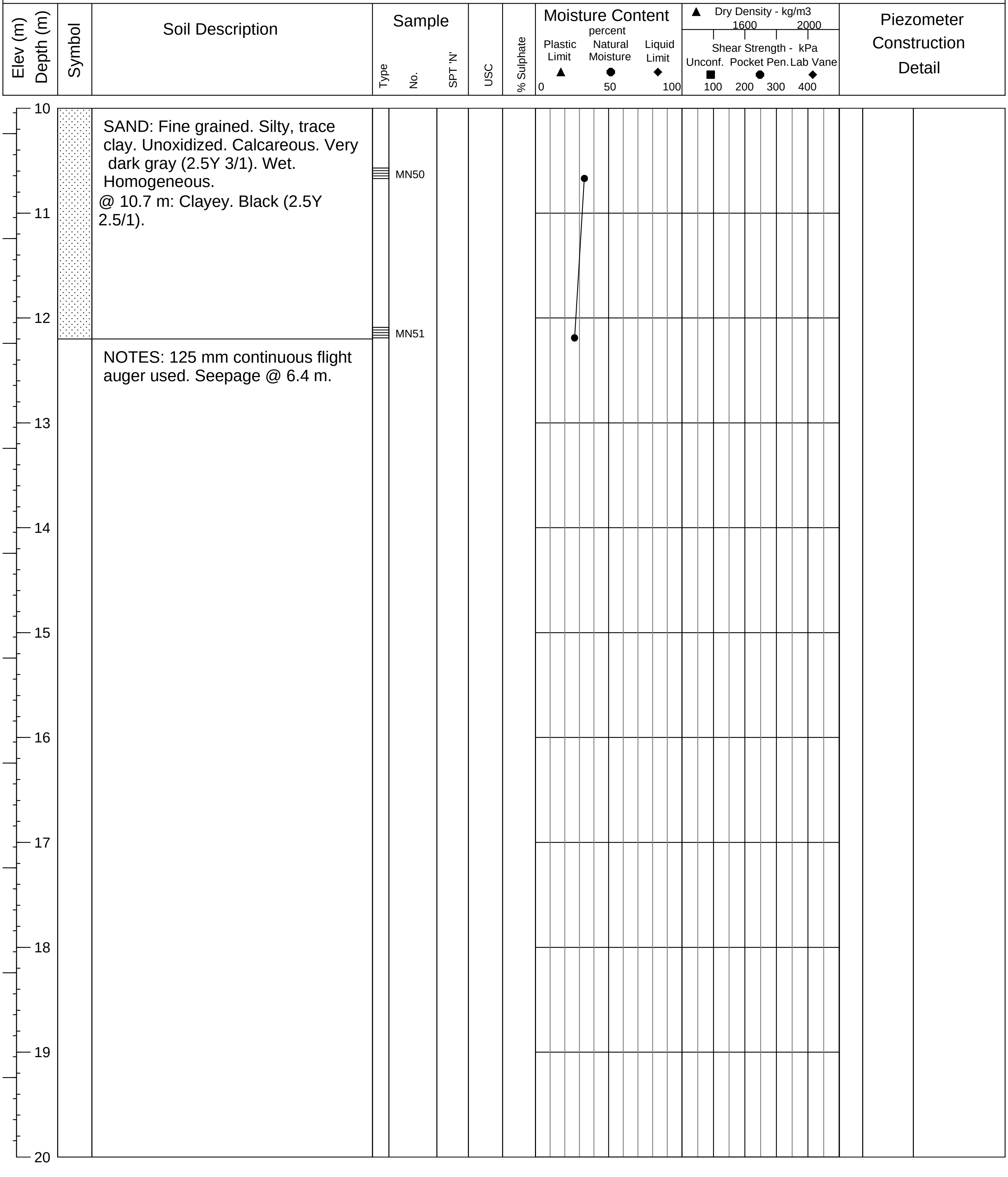
BORE HOLE LOG

Bore Hole: 119
Page: 2 of 2

Client:	Neil Ketilson	Northing:	5,766,577.427 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,262.166 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	488.243 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN



SAND: Fine grained. Silty, trace clay. Unoxidized. Calcareous. Very dark gray (2.5Y 3/1). Wet. Homogeneous.
@ 10.7 m: Clayey. Black (2.5Y 2.5/1).

NOTES: 125 mm continuous flight auger used. Seepage @ 6.4 m.

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB1	BAG		4.4													
0.76	KB2	SY	270	5.3			NP	SM	0.0	84.2	16.8				N/A	N/A	
1.52	KB3	SY	300	25.8	23.9	68.2	44.3	CH	0.0	1.4	98.6				175	160	
2.29	KB4	SY	150	9.8			NP	SM	0.0	712.0	28.0				N/A	N/A	
3.05	KB5	SY	200	7.5											N/A	N/A	
4.57	KB6	SY	200	17.8			NP	SM	0.0	85.9	14.1				N/A	N/A	
6.10	KB7	SY	460	25.1													
7.62	KB8	BAG		34.0	23.6	57.9	34.3	CH	0.0	8.3	91.7						
7.92	KB9	BAG		24.4													
9.14	KB10	BAG		38.9	28.7	77.9	49.2	CH	0.0	1.7	98.3						
10.67	KB11	BAG		34.6	24.0	74.6	50.6	CH	0.0	1.8	98.2						
12.19	KB12	BAG		27.0													

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PROJECT	Casa Grande Subdivision
LOCATION	Grasswood, Saskatchewan
PROJECT NO.	S1607

BORE HOLE NO.

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SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB13	BAG		4.2					0.0	76.7	13.2	10.1					
0.76	KB14	SPT		3.8													
1.52	KB15	BAG		5.1													
2.29	KB16	SPT		4.9													
3.05	KB17	BAG		4.9													
4.57	KB18	SPT		4.7													
6.10	KB19	BAG		4.5													
7.62	KB20	SPT		4.2													
7.92	KB21	BAG		23.3													
9.14	KB22	SPT		26.2													
10.67	KB23	BAG		30.9													
12.19	KB24	SPT		27.5													

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PROJECT	Casa Grande Subdivision
LOCATION	Grasswood, Saskatchewan
PROJECT NO.	S1607

BORE HOLE NO.

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SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB25	BAG		6.4													
1.52	KB26	BAG		6.4													
2.29	KB27	BAG		12.6													
3.05	KB28	BAG		4.2													
4.57	KB29	BAG		11.7													
6.10	KB30	BAG		6.9													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

103

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB31	BAG		9.2			NP	SM	0.0	55.4	44.6						
1.52	KB32	BAG		11.8	19.5	43.3	23.8	CL	0.0	36.0	64.0						
2.29	KB33	BAG		16.5	18.9	49.1	30.2	CL	0.0	17.7	82.3						
3.05	KB34	BAG		18.6													
3.05	KB35	SY	310	23.4	26.4	63.7	37.3	CH	0.0	1.0	99.0				260+	290+	
4.57	KB36	BAG		13.5													
4.57	KB37	SY	260	9.1			NP	SM	0.0	57.0	43.0				260+	290+	
6.10	KB38	BAG		16.3													
7.62	KB39	BAG		28.7			NP	SM	0.0	77.3	22.7						
9.14	KB40	BAG		25.6													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

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SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB41	BAG		9.8					0.0	14.9	16.3	23.8					
1.52	KB42	BAG		4.3													
2.29	KB43	BAG		4.1													
3.05	KB44	BAG		6.8													
4.57	KB45	BAG		25.5													
6.10	KB46	BAG		28.2													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

105

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB47	BAG		5.2													
1.52	KB48	BAG		4.6													
2.29	KB49	BAG		16.3													
3.05	KB50	BAG		19.1													
4.57	KB51	BAG		26.4													
6.10	KB52	BAG		33.0													
6.10	KB53	SY	260	29.7											120	105	

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PROJECT	Casa Grande Subdivision
LOCATION	Grasswood, Saskatchewan
PROJECT NO.	S1607

BORE HOLE NO.

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SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB54	BAG		5.9													
1.52	KB55	BAG		5.6													
2.29	KB56	BAG		27.8													
3.05	KB57	BAG		29.0													
4.57	KB58	BAG		31.9													
6.10	KB59	BAG		36.0													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.
107

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB60	BAG		26.1													
1.52	KB61	BAG		36.0			NP	SM	0.0	79.2	20.8						
1.52	KB62	SPT		17.9													
2.29	KB63	BAG		6.7			NP	SM	0.0	79.8	20.2						
2.29	KB64	SPT		9.0													
2.29	KB64B	SPT		35.5													
3.05	KB65	BAG		22.4	19.9	33.7	13.8	CL	0.0	20.6	79.4						
3.05	KB66	SPT		16.4													
4.57	KB67	BAG		22.6													
6.10	KB68	BAG		25.4													
6.71	KB69	BAG		35.1	16.4	51.9	37.3	CH	0.0	3.4	96.6						
7.62	KB70	BAG		24.7													
9.14	KB71	BAG		23.0													
10.67	KB72	BAG		25.1													
12.19	KB73	BAG		25.4													

Clifton Associates Ltd.
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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

108

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB74	BAG		6.2													
1.52	KB75	BAG		5.4													
2.29	KB76	BAG		10.4													
3.05	KB77	BAG		30.7													
3.05	KB78	SY	230	23.9											N/A	N/A	
4.57	KB79	BAG		36.1													
4.57	KB80	SY	390	22.5											30	35	
6.10	KB81	BAG		25.8													

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PROJECT	Casa Grande Subdivision
LOCATION	Grasswood, Saskatchewan
PROJECT NO.	S1607

BORE HOLE NO.

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SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB82	BAG		12.8					0.0	25.4	36.2	38.5					
1.52	KB83	BAG		13.4													
2.29	KB84	BAG		22.9													
3.05	KB85	BAG		14.4													
4.57	KB86	BAG		11.7													
6.10	KB87	BAG		26.8													

Clifton Associates Ltd.
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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

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SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN25	BAG		18.0					0.0	74.6	12.6	12.8					
1.52	MN26	BAG		23.7													
2.29	MN27	BAG		24.4													
3.05	MN28	BAG		26.4													
4.57	MN29	BAG		26.2													
6.10	MN30	BAG		36.1													
7.62	MN31	BAG		35.6													
9.14	MN32	BAG		34.8													
10.67	MN33	BAG		34.9													
12.19	MN34	BAG		33.5													
13.72	MN35	BAG		36.0													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.
111

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN13	BAG		10.4													
1.52	MN14	BAG		25.1													
2.29	MN15	BAG		34.2													
3.05	MN16	BAG		32.1													
4.57	MN17	BAG		29.5													
6.10	MN18	BAG		31.8													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

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SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN19	BAG		8.4					0.0	32.3	50.4	17.2					
1.52	MN20	BAG		10.6													
2.29	MN21	BAG		15.5													
3.05	MN22	BAG		26.9													
4.57	MN23	BAG		37.3													
6.10	MN24	BAG		36.7													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

113

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN36	BAG		15.5													
1.52	MN37	BAG		18.1													
2.29	MN38	BAG		29.8													
2.44	MN39A	SY	395	38.1											65	65	
3.05	MN39B	BAG		37.9													
4.57	MN40	BAG		32.4													
6.10	MN41	BAG		28.1													

Clifton Associates Ltd.
engineering science technology

PROJECT	Casa Grande Subdivision
LOCATION	Grasswood, Saskatchewan
PROJECT NO.	S1607

BORE HOLE NO.

114

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN58	BAG		6.9									0.01				
1.52	MN59	BAG		22.8									0.14				
2.29	MN60	BAG		33.4													
3.05	MN61	BAG		34.4													
4.57	MN62	BAG		37.7													
6.10	MN63	BAG		32.8													

Clifton Associates Ltd.
engineering science technology

PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

115

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN1	BAG		19.9									0.74				
1.52	MN2	BAG		23.4									1.11				
2.29	MN3	BAG		29.5													
3.05	MN4	BAG		30.5													
4.57	MN5	BAG		33.4													
6.10	MN6	BAG		30.5													

Clifton Associates Ltd.
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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

116

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE				WATER CONTENT	CONSISTENCY				GRADATION				SULPHATE CONTENT	SHEAR STRENGTH			DRY DENSITY
DEPTH	NUMBER	TYPE	RECOVERY		PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY		COMPRESSION TEST	LAB VANE	POCKET PEN	
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN7	BAG		11.2													
1.52	MN8	BAG		5.6													
2.29	MN9	BAG		30.8													
3.05	MN10	BAG		28.6													
4.57	MN11	BAG		34.7													
6.10	MN12	BAG		40.2													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

117

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE				WATER CONTENT	CONSISTENCY				GRADATION				SULPHATE CONTENT	SHEAR STRENGTH			DRY DENSITY
DEPTH	NUMBER	TYPE	RECOVERY		PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY		COMPRESSION TEST	LAB VANE	POCKET PEN	
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN52	BAG		6.2													
1.52	MN53	BAG		30.5													
2.29	MN54	BAG		33.3													
3.05	MN55	BAG		31.5													
3.05	MN55A	SY	250	12.2											165	180	
4.57	MN56	BAG		34.0													
6.10	MN56	BAG		22.8													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

118

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN42	BAG		10.2													
1.52	MN43	BAG		9.4													
2.29	MN44	BAG		8.6													
2.74	MN44A	SY	220	2.8											N/A	N/A	
3.05	MN45	BAG		3.7													
4.57	MN46	BAG		23.9													
6.10	MN47	BAG		30.1													
7.62	MN48	BAG		28.0													
9.14	MN49	BAG		26.8													
10.67	MN50	BAG		33.4													
12.19	MN51	BAG		26.7													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.
119

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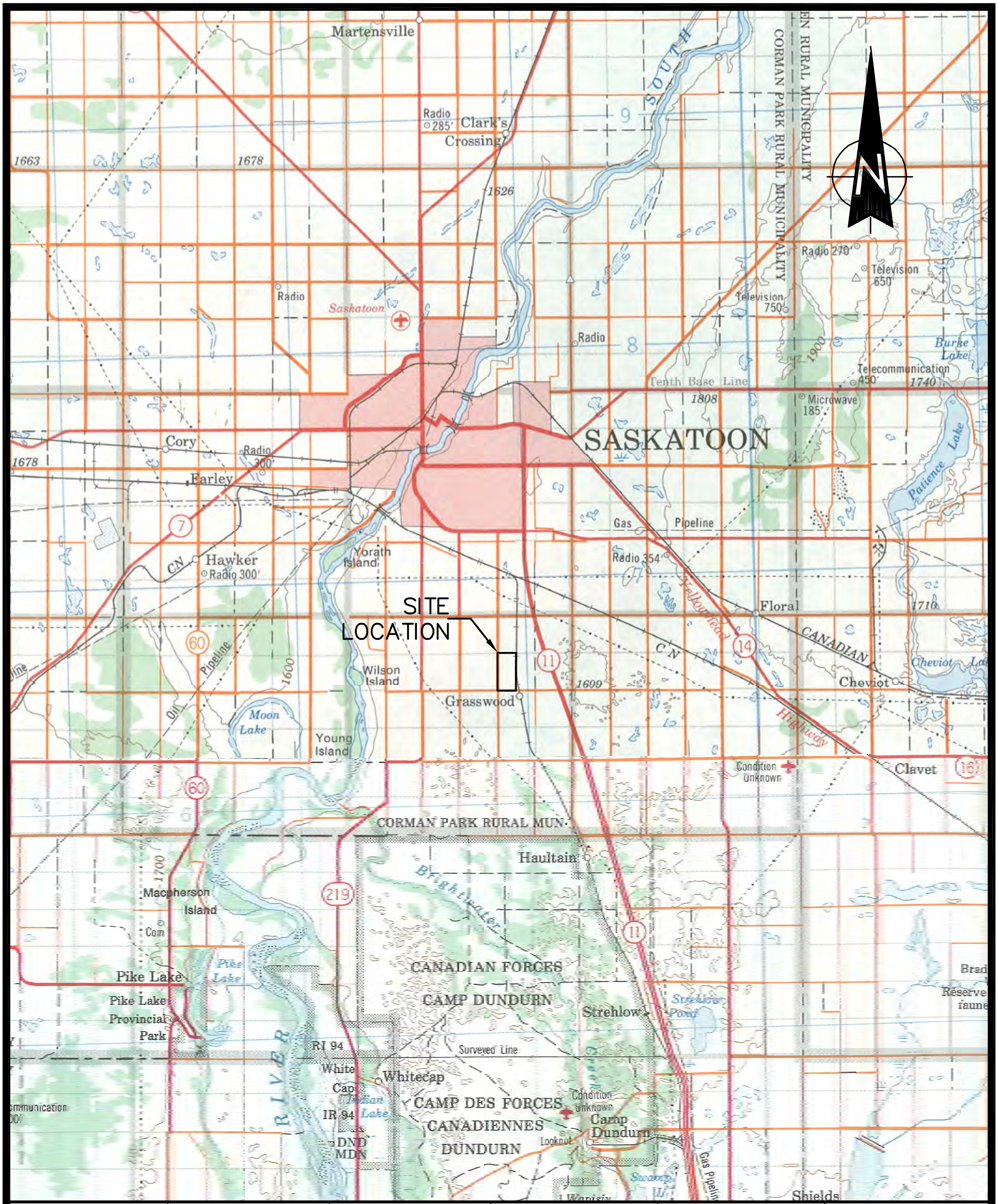
Drawings



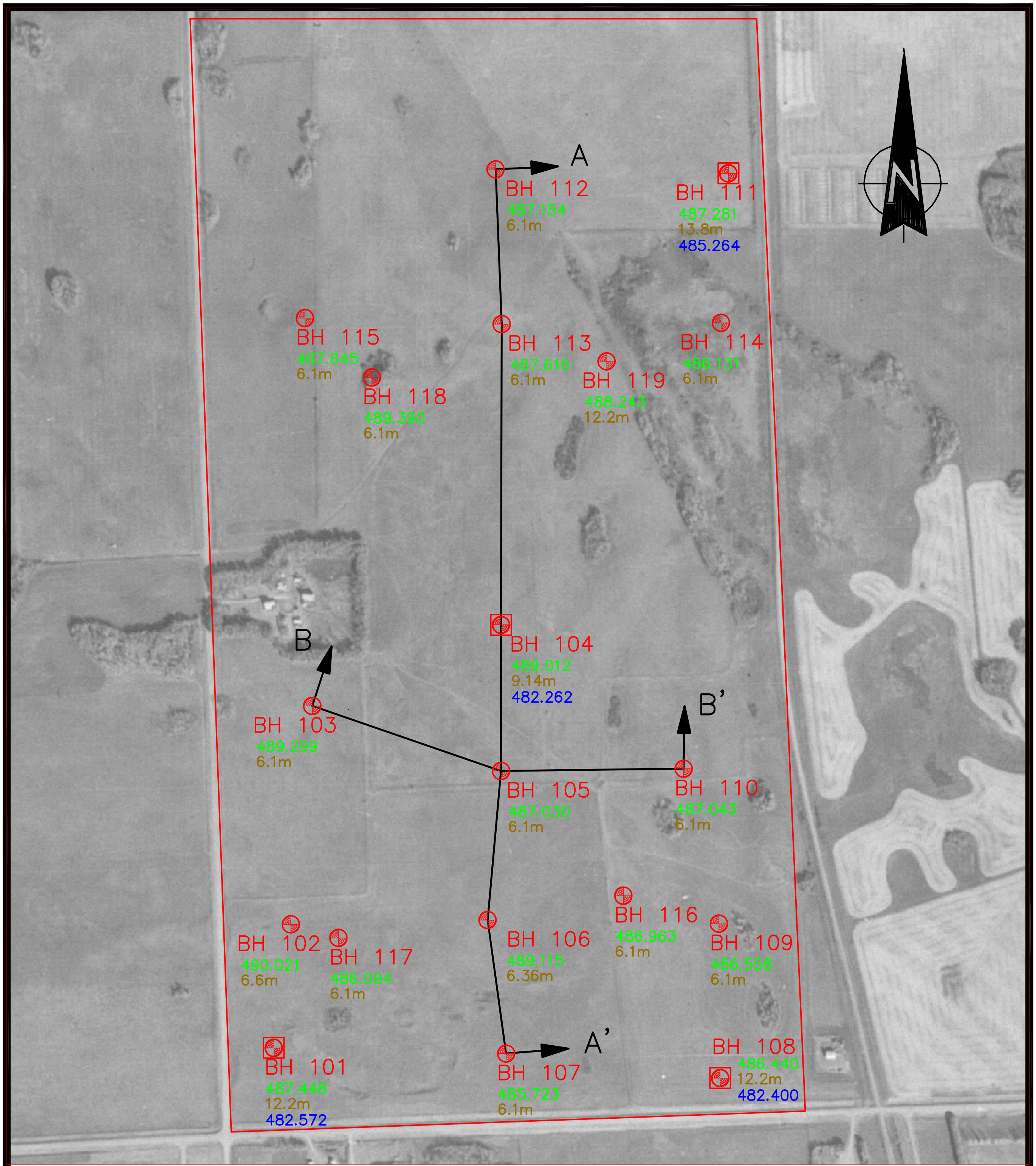
DATE	DRAWN BY	APPROVED BY	SCALE	FILE NO.	DRAWING NO.
14/03/08	LLT		NTS	S1607001	S1607–01

Clifton Associates Ltd.
engineering science technology

CLIENT NEIL KETILSON

PROJECT CASA GRANDE SUBDIVISION

TITLE SITE LOCATION PLAN



◎	BORE HOLE LOCATION	492.70	SURFACE ELEVATION
		9m	DEPTH OF BOREHOLE
▣	PIEZOMETER	489.76	GROUNDWATER ELEVATION

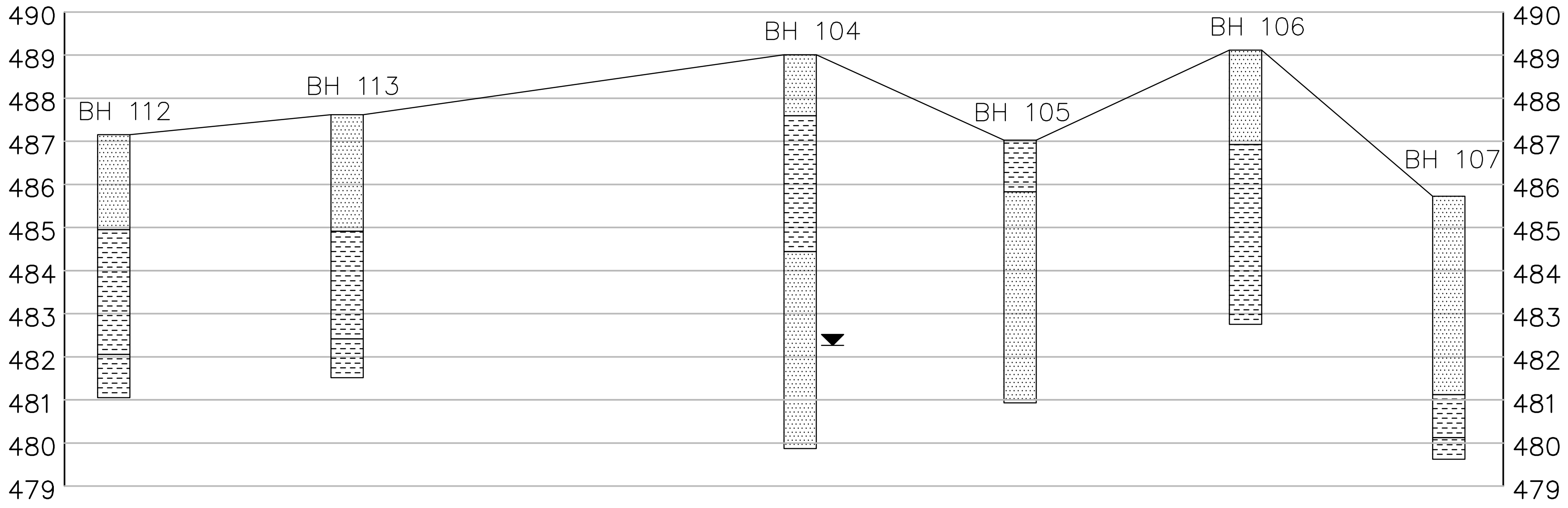
DATE	DRAWN BY	APPROVED BY	SCALE	FILE NO.	DRAWING NO.
25/03/08	LLT		1:10,000	S1607001	S1607–02

Clifton Associates Ltd.
engineering science technology

CLIENT NEIL KETILSON

PROJECT CASA GRANDE SUBDIVISION

TITLE BORE HOLE LOCATION PLAN



SCALE
VERTICAL: 1:375,000
HORIZONTAL: 1:7,500

LEGEND:

CLAY	▤
SILT	▨
SAND	░

DRAWING REVISIONS

NO	DD/MM/YY	DESCRIPTION	BY
6			
5			
4			
3			
2			
1			

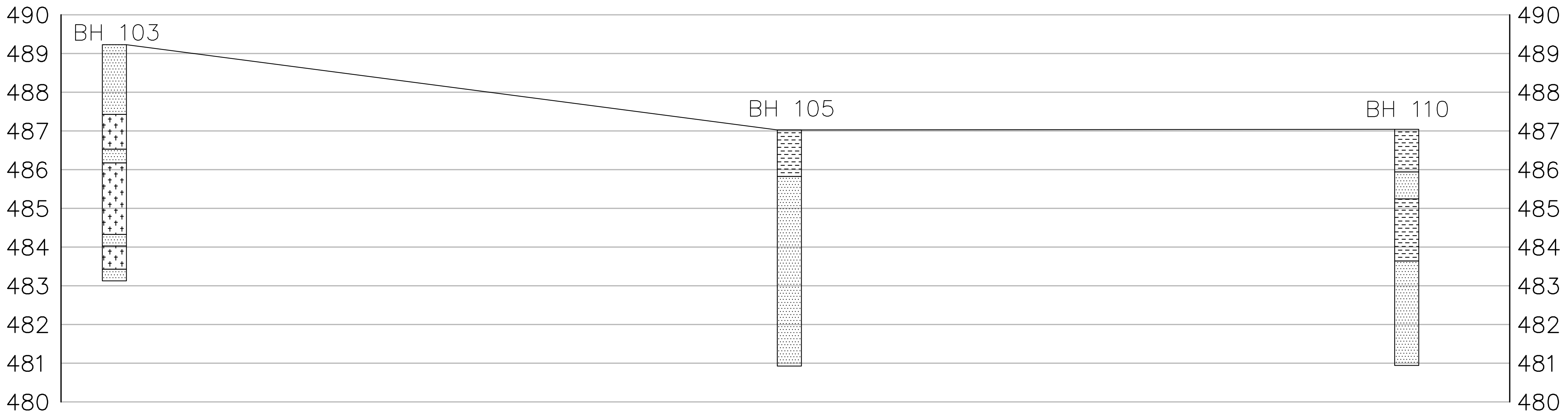
Clifton Associates Ltd.
engineering science technology

CLIENT
NEIL KETILSON

PROJECT TITLE
CASA GRANDE SUBDIVISION

DRAWING TITLE
CROSS SECTION A–A'
(NORTH–SOUTH)

PROJECT NO. S1607
FILE NO. S1607001
DATE 20/03/08
SCALE AS SHOWN
DWG. NO. S1607–03
DRAWN LLT
CHECKED



SCALE
VERTICAL: 1:50,000
HORIZONTAL: 1:2,500

LEGEND:

CLAY ▤
SILT ⊞
SAND ░

DRAWING REVISIONS

NO	DD/MM/YY	DESCRIPTION	BY
6			
5			
4			
3			
2			
1			

Clifton Associates Ltd.
engineering science technology

CLIENT
NEIL KETILSON

PROJECT TITLE
CASA GRANDE SUBDIVISION

DRAWING TITLE
CROSS SECTION B–B'
(WEST–EAST)

PROJECT NO. S1607
FILE NO. S1607001
DATE 20/03/08
SCALE AS SHOWN
DWG. NO. S1607–04
DRAWN LLT
CHECKED

Clifton Associates Ltd.
engineering science technology

Appendix A

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

ANALYTICAL REPORT

CLIFTON ASSOCIATES LTD
ATTN: KIM BONNEAU
2120 AIRPORT DR.

SASKATOON SK S7L 6M6

Reported On: 27-FEB-08 03:23 PM

Lab Work Order #: **L605119** **Date Received:** **26-FEB-08**

Project P.O. #:
Job Reference: S1607
Legal Site Desc:
CofC Numbers: C061070

Other Information:

Comments:

NICK PIDSKALNY
General Manager, Saskatoon

For any questions about this report please contact your Account Manager:

RAECHELLE KREESE

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	By	Batch
L605119-1 BH 101								
Sampled By: NOT PROVIDED on 25-FEB-08 @ 15:00								
Matrix: WATER								
Routine Water Analysis								
Alkalinity, Total								
Alkalinity, Total (as CaCO3)	287		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Bicarbonate (HCO3)	350		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Hydroxide (OH)	<5		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Carbonate (CO3)	<5		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Chloride (Cl)	90		1	mg/L	26-FEB-08	26-FEB-08	BFE	R634984
ICP Cations								
Calcium (Ca)	148		1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Potassium (K)	4.2		0.1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Magnesium (Mg)	73.4		0.1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Sodium (Na)	21		1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Sulfate (SO4)	263		4	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Ion Balance Calculation								
Ion Balance	104			%		27-FEB-08		
TDS (Calculated)	783			mg/L		27-FEB-08		
Hardness (as CaCO3)	672			mg/L		27-FEB-08		
Nitrate, Nitrite and Nitrate+Nitrite-N								
Nitrate-N	2.5		0.1	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
Nitrite-N	0.08		0.05	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
Nitrate+Nitrite-N	2.6		0.1	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
pH and Conductivity								
pH	7.5		0.1	pH	26-FEB-08	26-FEB-08	CMF	R635197
Conductivity (EC)	1220		10	uS/cm	26-FEB-08	26-FEB-08	CMF	R635197
L605119-2 BH 108								
Sampled By: NOT PROVIDED on 25-FEB-08 @ 15:30								
Matrix: WATER								
Routine Water Analysis								
Alkalinity, Total								
Alkalinity, Total (as CaCO3)	308		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Bicarbonate (HCO3)	376		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Hydroxide (OH)	<5		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Carbonate (CO3)	<5		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Chloride (Cl)	6		1	mg/L	26-FEB-08	26-FEB-08	BFE	R634984
ICP Cations								
Calcium (Ca)	91		1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Potassium (K)	3.2		0.1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Magnesium (Mg)	24.3		0.1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Sodium (Na)	15		1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Sulfate (SO4)	42		4	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Ion Balance Calculation								
Ion Balance	101			%		27-FEB-08		
TDS (Calculated)	367			mg/L		27-FEB-08		
Hardness (as CaCO3)	327			mg/L		27-FEB-08		
Nitrate, Nitrite and Nitrate+Nitrite-N								
Nitrate-N	<0.1		0.1	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
Nitrite-N	<0.05		0.05	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
Nitrate+Nitrite-N	0.1		0.1	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
pH and Conductivity								
pH	7.3		0.1	pH	26-FEB-08	26-FEB-08	CMF	R635197
Conductivity (EC)	640		10	uS/cm	26-FEB-08	26-FEB-08	CMF	R635197

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	By	Batch
L605119-2	BH 108								
Sampled By:	NOT PROVIDED on 25-FEB-08 @ 15:30								
Matrix:	WATER								
Routine Water Analysis									

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Preparation Method Reference(Based On)	Analytical Method Reference(Based On)
ALK-TOT-SK	Water	Alkalinity, Total		APHA 2320 B-Auto-Pot. Titration

Alkalinity is determined by a titration of an aliquot with standardized acid solution to a pH of 4.5. Total alkalinity, bicarbonate, carbonate(if present) and hydroxide(if present) also reported.

Reference
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 2320B.

CL-SK	Water	Chloride (Cl)		APHA 4500 CL-E

Chloride in the extract is determined colorimetrically at 660 nm by complexation with mercury (II) thiocynate. In the colorimetric method, chloride (Cl-) displaces thiocyanate which, in the presence of ferric iron, forms a highly colored ferric thiocyanate complex.

Reference
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 4500Cl-E.

ETL-ROUTINE-ICP-SK	Water	ICP Cations		APHA 3120 B-ICP-OES

These ions are determined directly y ICP-OES.

Reference
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 3120B.

IONBALANCE-SK	Water	Ion Balance Calculation		APHA 1030E
N2/N3-SK	Water	Nitrate, Nitrite and Nitrate+Nitrite-N		APHA 4500 NO3F

Nitrate is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl)ethylenediamine dihydrochloride. The resulting water-soluble dye has a magenta color, which is measured at 520nm. Original nitrite can also be determined by removing the cadmium column and following the same procedure. Nitrate-N, Nitrite-N and NO3+NO2-N are reported.

Reference
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 4500NO3-F.

PH/EC-SK	Water	pH and Conductivity		APHA 4500-H, 2510

** Laboratory Methods employed follow in-house procedures, which are generally based on nationally or internationally accepted methodologies.

Chain of Custody numbers:

C061070

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location	Laboratory Definition Code	Laboratory Location
SK	ALS LABORATORY GROUP - SASKATOON, SASKATCHEWAN, CANADA		

Reference Information

GLOSSARY OF REPORT TERMS
Surr - A surrogate is an organic compound that is similar to the target analyte(s) in chemical composition and behavior but not normally detected in environmental samples. Prior to sample processing, samples are fortified with one or more surrogate compounds.
The reported surrogate recovery value provides a measure of method efficiency. The Laboratory control limits are determined under column heading D.L.
mg/kg (units) - unit of concentration based on mass, parts per million.
mg/L (units) - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
UNLESS OTHERWISE STATED, SAMPLES ARE NOT CORRECTED FOR CLIENT FIELD BLANKS.
Although test results are generated under strict QA/QC protocols, any unsigned test reports, faxes, or emails are considered preliminary.

ALS Laboratory Group has an extensive QA/QC program where all analytical data reported is analyzed using approved referenced procedures followed by checks and reviews by senior managers and quality assurance personnel. However, since the results are obtained from chemical measurements and thus cannot be guaranteed, ALS Laboratory Group assumes no liability for the use or interpretation of the results.

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CHAIN OF CUSTODY / ANALYTICAL REQUEST FORM

CANADA TOLL FREE 1-800-668-9878

www.alsenviro.com

COC # C061070

L605119

Page 1 of 1

REPORT TO:

COMPANY: Clifton Associates

CONTACT: Kim Bonneau

ADDRESS:

PHONE: FAX:

INVOICE TO: SAME AS REPORT ? [✓ YES] NO

COMPANY:

CONTACT:

ADDRESS:

PHONE: FAX:

Lab Work Order # (lab use only)

REPORT FORMAT / DISTRIBUTION

STANDARD X OTHER

PDF EXCEL X CUSTOM FAX

EMAIL 1: Kim-bonneau@clifton.ca

EMAIL 2:

INDICATE BOTTLES: FILTERED / PRESERVED (F/P)

CLIENT / PROJECT INFORMATION:

JOB #: 51607

PO /AFE:

Legal Site Description:

QUOTE #:

SAMPLER (Initials):

SERVICE REQUESTED

☒ REGULAR SERVICE (DEFAULT)

☐ RUSH SERVICE (2-3 DAYS)

☐ PRIORITY SERVICE (1 DAY or ASAP)

☐ EMERGENCY SERVICE (<1 DAY / WEEKEND) - CONTACT ALS

ANALYSIS REQUEST

Sample #	SAMPLE IDENTIFICATION (This description will appear on the report)	DATE	TIME	SAMPLE TYPE	Reg											HAZARDOUS ?	HIGHLY CONTAMINATED ?	NUMBER OF CONTAINERS
	BH 101	Feb25/08	3:00pm	H2O	X													1
	BH 108	"	3:30	"	X													1

GUIDELINES / REGULATIONS

SPECIAL INSTRUCTIONS / HAZARDOUS DETAILS

Failure to complete all portions of this form may delay analysis. Please fill in this form *LEGIBLY*.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the reverse page of the white report copy.

RELINQUISHED BY:	DATE & TIME:	RECEIVED BY:	DATE & TIME:	SAMPLE CONDITION (lab use only)	
Matt Nowak	Feb 26/08		26-Feb-08	TEMPERATURE 8°C	SAMPLES RECEIVED IN GOOD CONDITION ? [✓ YES] NO (if no provide details)
RELINQUISHED BY:	DATE & TIME:	RECEIVED BY:	DATE & TIME:		

REFER TO BACK PAGE FOR REGIONAL LOCATIONS AND SAMPLING INFORMATION

WHITE - REPORT COPY, PINK - FILE COPY, YELLOW - CLIENT COPY

GENF14.00

Appendix I

Conceptual Storm Water Management and Drainage Plan

Clifton Associates Ltd.
engineering science technology

28 June 2012
File S1607.1

Grasswood Estates
4780 Prairie Lane
Grasswood, Saskatchewan
S7T 1A7

Attention: Mr. Neil Ketilson

Dear Sir:

Subject: Hydrology Methodology
Grasswood, Saskatchewan

This letter is written in response to your request to provide additional information to supplement our draft hydrology report dated 28 May 2012.

We provided additional analysis of the 1:100 year storm event plus 25% as recommended in an email dated 7 June 2012 from Rebecca Row with the R.M. of Corman Park. An excerpt from the email is included below:

The main concern we have is the stormwater plan utilizing the backs of private properties to pond water. We will be asking Council to discuss this option, but Planning will likely not be supporting it…..By utilizing private property we are in the opinion that the stormwater management plan has not been designed to effectively manage a 1:100 (plus 25% b/c of no outlet) storm event. We had made a comment regarding utilizing public lands in our first round of comments (#5 under Storm).

The additional analysis was conducted in response to this statement to compare our methodology to the 1:100 year storm event and 25% methodology it was conducted in accordance with the City of Saskatoon New Neighbourhood Design and Development Standards Manual, Section Six dated January 2012. This analysis was completed using the rational method utilizing a 1:100 year event based on the recommended developed conditions runoff coefficient, and 24 hour storm duration. The water surface elevation (WSE) that was generated based on this approach is indicated in green on the north pond on the attached Drawing S1607.4-002.

Results of this analysis indicated that the flood elevation of this event was significantly lower than the flood elevation that was recommended in our report which is indicated on the outer black line labeled Maximum WSE 507.3 (see attached drawing). The difference in flood elevations on the north pond is more than 6.5 m when compared.

Please note that the 1:100 year cumulative event plus 25% WSE shown in red is based on net volumes calculated throughout a 51 year period, and is provided to further demonstrate the conservative approach of our design methodology. The difference in flood elevations are approximately 3.5 m on both ponds using this comparison.

4 – 1925 1st Avenue North
Saskatoon, Saskatchewan
Canada S7K 6W1

Tel: 306 975.0401
Fax: 306 975.1076

Based on these comparisons, we believe that our recommendations for establishing municipal reserve boundaries and recommended building elevations meet and exceed the R.M.’s requirements.

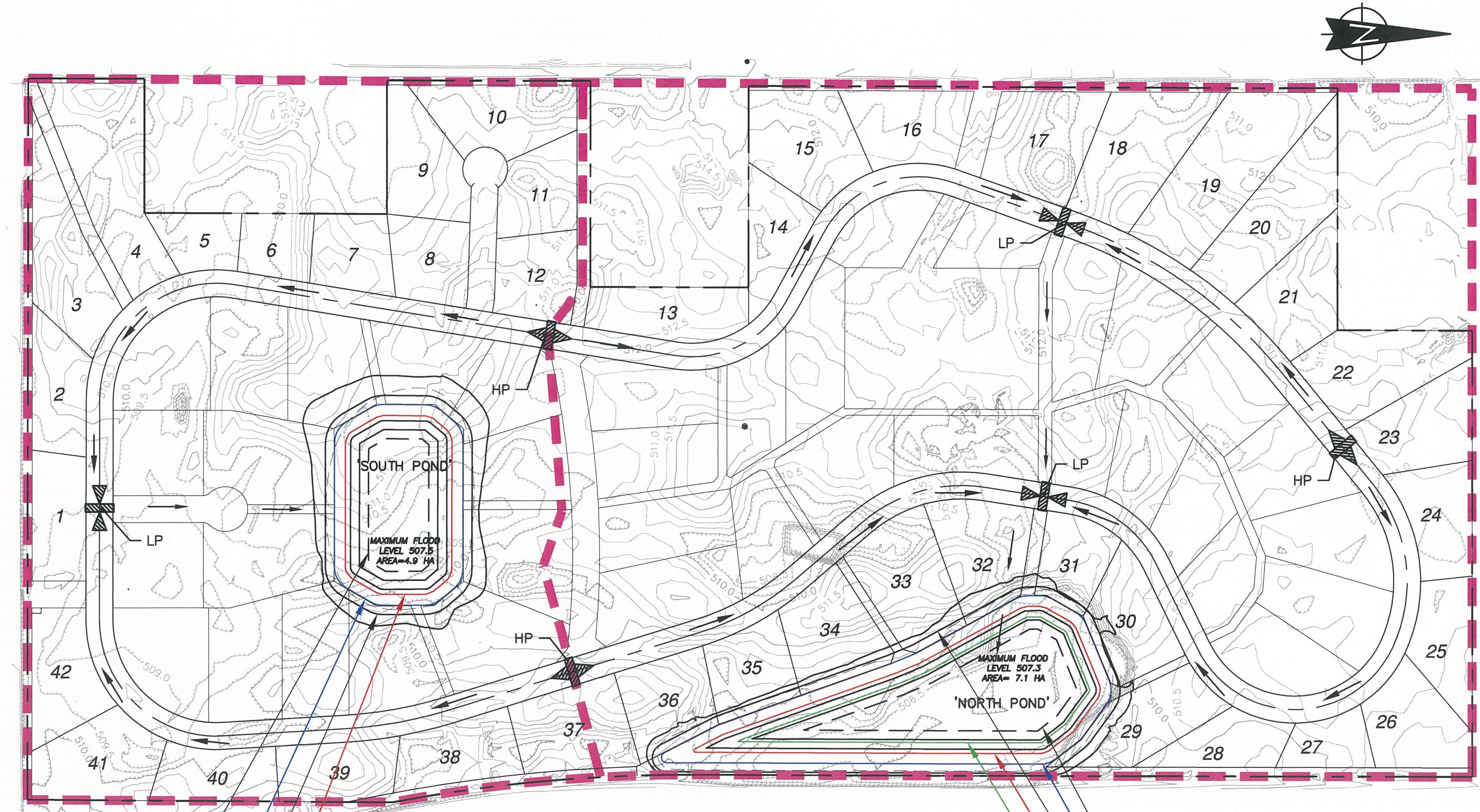
If you have any questions regarding this letter, please contact me.

Yours truly,

Clifton Associates Ltd.

Cindy Friesen, Geoscientist-in-Training
CF/alg

Attachments: Drawing S1607.4-002 Conceptual Drainage System



BASIN BOTTOM

MUNICIPAL RESERVE WSE 505.5

MAXIMUM ELEV. 507.5

CUMULATIVE 1:100 YR +25%
WSE 503.05

BASIN BOTTOM

MUNICIPAL RESERVE WSE 505.3

MAXIMUM WSE 507.3

CUMULATIVE 1:100 YR + 25% WSE 502.95

1:100 YR EVENT + 25% WSE 500.55

LEGEND

- DRAINAGE BOUNDARY
- EXIST. MAJOR CONTOUR
- EXIST. MINOR CONTOUR
- PROJECT BOUNDARY
- LOT LINE
- HIGH POINT
- LOW POINT

NOTE:
SURVEY DATA PROVIDED BY
CLIFTON ASSOCIATES LTD.
MAY 16, 2012.

DRAWING REVISIONS

REV	DESCRIPTION	BY	DATE
--	--	--	--

Clifton Associates Ltd.
engineering science technology

CLIENT
URBAN ELEMENTS DEVELOPMENT CORP.

PROJECT
CONCEPTUAL STORMWATER
MANAGEMENT PLAN
GRASSWOOD ESTATES

TITLE
CONCEPTUAL DRAINAGE SYSTEM

DESIGN J.O.	SCALE 1:5000	DATE 2012-05-22
DWN. BY Z.Y.	PROJECT NO. S1607.4	DWG. NO. S1607.4-02
CHECKED J.G.	FILE NO. S1607.4-002	

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Draft- Conceptual Stormwater Management Plan
Grasswood Estates W1/2 26-35-5W3
R.M. of Corman Park, Saskatchewan

File S1607.4 May 28, 2012

Clifton Associates Ltd.
engineering science technology

28 May 2012
File S1607.4

Crosby Hanna and Associates
407 1st Avenue North
Saskatoon, Saskatchewan
S7K 1X5

Attention: Ms. Maggie Schwab Via Email: mschwab@crosbyhanna.ca

Dear Madam:

Subject: Draft – Conceptual Stormwater Management Plan
Grasswood Estates W1/2 26-35-5W3
22 May 2012
R.M. of Corman Park, Saskatchewan

We are pleased to present you the Draft Report for Grasswood Estates Conceptual Stormwater Management Plan.

If you have any questions regarding this report, please contact me.

Yours truly,

Clifton Associates Ltd.

Cindy Friesen, G.I.T.
/alg

Distribution Neil Ketilson
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4 – 1925 1st Avenue North
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Canada S7K 6W1

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Clifton Associates Ltd. (Clifton) was commissioned on April 3, 2012 to provide an updated report in response to Mr. Bill Delaney, Planner, R.M. of Corman Park to the Draft report dated January 19, 2009 by Water Resource Consultants WRC for the proposed development at the Site.

This SWMP responds to that request. It includes a pre-development contour map and conceptual drainage plan including channels and sizing of ponds for the proposed development. Guidelines used throughout the design process were based on Transportation Association of Canada, Railroad Association of Canada and Federation of Canadian Municipalities, R.M. of Corman Park Multi Parcel Country Residential Development Guidelines and consideration of Saskatchewan Environment Stormwater Guidelines April 2006.

2.0 Description of the Site

2.1 Local Topography & Drainage

Drawing S1607.1-002 shows the contour map and topography of the Site. The Site has undulating topography characterized with high and low elevation points varying between 506.5 m to 513.0 m above sea level (a.s.l.). The highest elevation area is located in the southern region of the Site. However the Site has no natural drainage and water tends to collect in local low lying areas. There is an existing natural pond on the north section of the Site in which local drainage naturally occurs to this area. Initially it was proposed that this pond provide attenuation for the entire subdivision, but this plan incorporates a second pond in the south section.

Further description of the Site characteristics can be found in the previous reports dated January 19, 2009 and May 3, 2012 (appended) by WRC.

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Stormwater storage, drainage ditches and culverts (where needed) have been included in the concept to facilitate proper drainage of the Site. The conceptual plan of the proposed drainage system for the Site is presented in Section 4.

Consideration has been made in regards to the internal network of walking routes and associated drainage networks proposed for Phase II of the development but is not detailed in this report. However it is worth noting that all drainage calculations have been made with consideration of the entire subdivision being developed

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Development tends to alter the drainage characteristics of the Site such that infiltration (i.e. entry of rainwater into the ground) of rainfall into the ground is reduced. This loss of the capacity for the ground to absorb water is generally translated into increased surface runoff or drainage and this can lead to flooding if there is no proper and adequate drainage system in place to drain excess water. In this case, a natural outflow from the Site does not exist.

The design criteria typically utilized is for a stormwater management system to be capable of handling the rainfall and subsequent runoff from a large storm event that only occurs on average 1 in 100 years. In this case, a natural outflow from the Site does not exist, therefore an evaluation of the net evaporation, based on accumulated inflow and average evaporation rates, was required to determine the impacts of development on Site.

As such, the scope of the work undertaken by Clifton included:

- Assessment of predevelopment and post-development stormwater conditions based on Site characteristics and historical climatological data;
- Provide stormwater management options to mitigate the effects of development on Site;
- Conceptual design of stormwater management system including pond sizing and layout, and structures such as roads, channels, and culverts which are pertinent to drainage; and,
- Minimum building elevation recommendations.

4.0 Conceptual Stormwater Management Plan

The aim of the stormwater management system is to design facilities that can negate the impact, or at least reduce the impact, to that which would have occurred naturally regardless of whether the Site had been developed. The target criteria for engineering design that is generally applied, is that runoff should not exceed that which would have occurred naturally during a storm event, the magnitude of which occurs only once in 100 years.

The conceptual stormwater plan proposed in this report utilizes an evaporative stormwater pond system to collect and evaporate stormwater. Consideration has been made for effective drainage to the ponds based on the layout proposed and appropriate sizing to ensure evaporative functionality is adequate. The following sections discuss the parameters that were considered as well as the methodology for design and preferred option.

4.1 Existing Information

Various sources of information were available to develop a general assessment of the hydrological features of the site. The following was used:

- Local topographic data generated by Clifton Associates Ltd. May, 2012.
- Canada Centre for Mapping, Department of Energy, Mines and Resources.

  - Agriculture and AgriFood Canada.
  - Water Survey of Canada.
  - SaskWater.
  - R.M. of Corman Park.
  - Environment Canada.
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  - Meridian Surveys Ltd.

4.2 Stormwater Ponds

4.2.1 Methodology and Design Parameters

Parameters used to assess existing and developed conditions are provided in the previous draft letter report dated May 3, 2012 by WRC. This document details the rationale and calculations that were conducted to adequately size the ponds. This document can be found in Appendix A. A summary of the results is provided in this report.

Pond sizing initially considered only one pond in which the entire Site would drain, namely the north pond (see Drawing S1607.4-002). However, when conceptual drainage and grading of the Site was initiated, it was clear that the entire development would require a significant amount of grading to achieve drainage to the naturally existing storm pond on the north east border of the Site. Therefore, a second pond was considered.

Assessment of the natural topography indicated that a slightly higher relief area occurred as a ridge near the east west midline of the Site which split the area into north and south sections totaling 81 and 48 ha respectively. These areas were used to develop the total drainage into two sections, namely the north and south drainage areas. These areas were then designed with evaporative ponds which would capture the stormwater and manage it to mitigate flooding within the development.

The following describes the parameters that were used to define existing and post development conditions simulating the two storm ponds that were sized during the analysis.

Predevelopment Conditions

Assessment of the existing conditions was important to understand how the hydrologic dynamics currently affect the Site. A summary of the parameters that were used to assess pre-developed conditions is as follows:

Inflow to the system:

- Based on local drainage data from Brightwater Creek and the effective drainage area, on Site flow was calculated based on this area/flow ratio for north and south areas.
- Precipitation data from Agriculture and Agrifood Canada - Saskatoon area.
- Assumed that the entire area of the Site drained to ponds. (This is conservative - we know that small depressions attenuate and evaporate the water on Site now and all drainage does not flow to the existing north east pond.)

Outflow from the System:

- Evaporation data in the area was assessed, and net evaporation was calculated.

Developed Conditions

Assessment of the developed conditions was conducted based on the following assumptions:

Change in Inflow:

- All grading would occur to a pond in each drainage area. This is also conservative as it is unlikely that all land owners will fill their land leaving no small depressions.
- Percentage of impervious features once developed totals 6 ha of entire area.
- Percentage of precipitation that results in flow from the Site is 35% (this is the loss from soil infiltration, transpiration, evaporation, etc.).

  - The total inflow equals drainage area ratio times recorded flow of Brightwater Creek, plus during the summer months, the impervious areas.

Changes in Outflow:

  - No changes.

Verification of the infiltration parameters was conducted once the subdivision layout was clearly identified. A review of the impervious features was conducted based on information provided by Crosby Hanna and Associates and the parameters of which are summarized below:

- Anticipated length of roadway is approximately 5080 m with a Right of Way (ROW) of 30 m. Actual impervious area of the road is the top width only at 9 m.
- Driveways: 6 m x 35 m.
- Houses: Minimum of 1,600 square feet / 148.64 m^2.
- Triple attached garage: Approximately 69.7 m^2.

Based on this information, the total percentage of impervious area is estimated to be 7.2 ha or 6 % impervious - this value was rounded up as well which results in a conservative number. The ratio of total area to south and north total areas was applied to this value when calculating inflow to each area. Pathways proposed in the subdivision are not paved and as such were not included in the estimation.

Pond design was completed by assessing the maximum flood levels of each optimum sized pond resulting from input of the highest year event from the 51 years of available data. This was done on a monthly basis until the peak area was realized which determined the optimum sized pond for evaporation to occur effectively. To address the R.M.'s concern and to be conservative, this event was then followed by input of a 1: 100 year event into the ponds.

Further data such as precipitation, evaporation, flow rates on Brightwater Creek and net evaporation rates are included in Tables appended from WRC found in Appendix A of this report.

4.2.2 Results and Discussion

The main impact of the proposed development will be accumulated precipitation and associated runoff resulting from the added impervious surface area. In the case of an evaporation pond, the critical flood event is the accumulation of water over a series of wet years. As discussed in the previous report by WRC, available data went back 51 years. In order to recognize the 1:100 year design used by the R.M., which also recommended a 25 % increase in this value because of evaporation pond design proposed, the approach taken was to insert a 1:100 year runoff volume into the sequence right after the wettest sequence modelled. This was done by extracting the annual volumes from the previous results, completing a frequency analysis to extend the 51 years of data to estimate the 1:100 year volume.

Results of the evaporative pond layout and options for each pond is provided in the following section.

4.3 Options for Evaporative Pond Design

The original design option of having only one stormwater pond was re-evaluated based on existing grade and topography. This layout is shown in Drawing S1607.4-003. The pond lies directly west of a CN rail line. Current water level is at approximately 506.8 m. Based on recommendations from CN, the requirements to build near this facility include operational emissions recognition from future land owners in the form of easements. Stormwater implications at this time appear to be minimal and are therefore not discussed further in this report. The existing pond on the north east area of the Site is therefore proposed to remain as a natural feature with some modifications, namely deepening.

The south pond however required some consideration of the location to fully optimize the previous conceptual lot layout. The sections below discuss the options of the south pond that were considered.

Concept 1 – Man-made Stream Surrounding Currently Proposed Lots

This option is presented as an area of approximately 1.6 ha in the south area. This option would allow for all lots to remain as currently proposed, however would decrease in size by approximately 20-30%. This option was explored, however the surface area is not adequate and further increasing the size may result in the lots decreasing in size up to 50%.

Concept 2 - East Pond

This concept is proposed on the east side of the road and requires 4 potential lots be utilized for the pond area. The total area of this pond is approximately 2.78 ha.

Concept 3 - West Pond

This concept is proposed on the west side of the road and encompasses to equivalent of 5 potential lots. The total area is 3.6 ha.

Concept 4 - Middle Pond

This concept encompasses the middle area which is equivalent to 4 potential lots, as well as part of the proposed road through this area. To mitigate removal of the access road, cul de sacs could be considered for access to the lots on the north side of the pond. In this option, 4 lots would be removed; however 10 lots would gain a waterfront feature, which would likely realize a higher value to prospective buyers. The total pond area within the Municipal Reserve (MR) is approximately 2.6 ha.

Furthermore, consideration of providing permanent water features for all options was evaluated for aesthetic value and may be proposed in the final design stage when cut fill balances are better understood. A flat bottom pond would not be very attractive. It would flood with shallow water each spring and in most years it would dry up in mid summer. Occasionally, in wet years, it would remain wet from one year to the next. As the developer suggested, a permanent water feature would be preferred.

4.3.1 Recommended Option

The chosen design was Concept 4 - Middle Pond. The conceptual pond plan is shown on Drawing 1607.4-002 and the cross section in Drawing 1607.4-003. A summary of the design elevations, including pond features and functionality is provided in the table below.

Table 4.3
Evaporation Pond Functional Areas

Critical Design Levels	North		South	
	Elevation (m)	Area (ha)	Elevation(m)	Area (ha)
Maximum water level	507.3	6.1	507.5	3.4
Minimum Building elevation	508.3		508.5	
Municipal reserve boundary	505.3		505.5	
Minimum Water elevation	499.9	1.6	499.9	1.3
Depth of Pond	TBD		TBD	

The differences in maximum water elevation between the south and north pond is an effort to conserve excavation efforts where possible, as well as achieving adequate drainage via roadway ditches.

4.4 Road Way and Drainage Design Parameters

Road alignment, geometry and dimensions were designed in accordance with Transportation Association of Canada guidelines as well as Policy PW-12 *Road Servicing Agreements*, issued June 2011 by the R.M. of Corman Park.

Sizing for the drainage ditches and culverts was completed based on recommended dimensions from the R.M. Transportation Association of Canada (TAC) guidelines were followed for the following road design parameters:

- Super-elevation
- Site lines
- Turning radius

The road alignment is shown in Drawing S1607.4-002 - Site Plan and cross sections of typical walkway, road and ditch is provided in Drawings S1607.4-005 to S1607.4-007.

4.4.1 Drainage Design Considerations

Confirmation of the 1:100 year storm runoff for sizing drainage structures can be completed if required. At this level of design, typical sizing has been applied, namely 600 mm culverts and ditch dimensions consistent with R.M. standards as noted in Policy PW-12. Namely ditches with a dimension of 4 m wide, 0.8 m to 1.0 m in height with a 4:1 sideslope. Final Site grading has not been completed, therefore Clifton assumed negligible deviation from the original Site's contour plan.

5.0 Conclusions and Recommendations

The recommended evaporative pond option and associated conceptual drainage plan summary is provided in bullet form below.

a) The evaporation pond calculations have been conservative and it is likely that the ponds will not have a permanent water feature without deepening the proposed structures.

b) The model results indicated that the average level of water in the ponds was 5.3 and 5.6 m below the max water levels.

c) The minimum building elevations are recommended to be 1 m above the maximum water level.

d) Adding the final 1:100 year water levels to the ponds were found to increase the water level 2 m accordingly. Since this event may never occur, some of this area can be used as public land. Public land, therefore, has been designed to occur at 2 m below the max water level.

e) The slope from the MR to the top of the maximum building elevation could be inside the lots and available for the future owners use most of the time as long as there was a flood easement registered against the title and no flood prone developments were allowed.

f) The pond excavations will generate a substantial volume of fill. The subdivision plan in the final design phase will show where this will go and in particular should show all areas that require fill to achieve the proposed drainage.

g) If after the pond is in place, a series of floods occur, when the water begins to encroach on the lots, namely past the MR elevation, it would be recommended to pump the excess via overland temporary pipeline to an outlet. This would fit with the MR limit suggested above and since the water would be into the flood easements on the lots. Since this should be a rare event and may never occur, temporary overland pumping would be better than a permanent facility. The distance south or west to an outlet is within the range of portable pumps and pipelines typically available for rent. The pumping would not have to be completed in a short time so a modest flow rate would be adequate.

6.0 Closure

This report contains the results of Clifton's analyses as well as a proposed stormwater management option upon which certain initial recommendations have been made. Our recommendations do not constitute detailed engineering design and analysis, in whole or in part, of any of the elements of the proposed work. Incorporation of any or all of our preliminary recommendations in our report into the design of any such element does not constitute us as designers or co-designers of such elements, nor does it mean that such design is appropriate in geotechnical terms. The designers of such elements must consider the appropriateness of our recommendations in the light of all design criteria known to them, many of which may not be known to us. Our mandate has been to investigate and recommend which we have completed by means of this report. We have had no mandate to design, or review the design of, any elements of the proposed work and accept no responsibility for such design or design review.

Clifton Associates Ltd.

Cindy Friesen, Geoscientist in Training

Ray Pentland, P.Eng.

Association of Professional
Engineers and Geoscientists of Saskatchewan
Certificate of Authorization No. 238

Clifton Associates Ltd.
engineering science technology

28 May 2012
File S1607.4

Crosby Hanna and Associates
407 1st Avenue North
Saskatoon, Saskatchewan
S7K 1X5

Attention: Ms. Maggie Schwab Via Email: mschwab@crosbyhanna.ca

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- Percentage of impervious features once developed totals 6 ha of entire area.
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- Anticipated length of roadway is approximately 5080 m with a Right of Way (ROW) of 30 m. Actual impervious area of the road is the top width only at 9 m.
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Based on this information, the total percentage of impervious area is estimated to be 7.2 ha or 6 % impervious - this value was rounded up as well which results in a conservative number. The ratio of total area to south and north total areas was applied to this value when calculating inflow to each area. Pathways proposed in the subdivision are not paved and as such were not included in the estimation.

Pond design was completed by assessing the maximum flood levels of each optimum sized pond resulting from input of the highest year event from the 51 years of available data. This was done on a monthly basis until the peak area was realized which determined the optimum sized pond for evaporation to occur effectively. To address the R.M.'s concern and to be conservative, this event was then followed by input of a 1: 100 year event into the ponds.

Further data such as precipitation, evaporation, flow rates on Brightwater Creek and net evaporation rates are included in Tables appended from WRC found in Appendix A of this report.

4.2.2 Results and Discussion

The main impact of the proposed development will be accumulated precipitation and associated runoff resulting from the added impervious surface area. In the case of an evaporation pond, the critical flood event is the accumulation of water over a series of wet years. As discussed in the previous report by WRC, available data went back 51 years. In order to recognize the 1:100 year design used by the R.M., which also recommended a 25 % increase in this value because of evaporation pond design proposed, the approach taken was to insert a 1:100 year runoff volume into the sequence right after the wettest sequence modelled. This was done by extracting the annual volumes from the previous results, completing a frequency analysis to extend the 51 years of data to estimate the 1:100 year volume.

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The south pond however required some consideration of the location to fully optimize the previous conceptual lot layout. The sections below discuss the options of the south pond that were considered.

Concept 1 – Man-made Stream Surrounding Currently Proposed Lots

This option is presented as an area of approximately 1.6 ha in the south area. This option would allow for all lots to remain as currently proposed, however would decrease in size by approximately 20-30%. This option was explored, however the surface area is not adequate and further increasing the size may result in the lots decreasing in size up to 50%.

Concept 2 - East Pond

This concept is proposed on the east side of the road and requires 4 potential lots be utilized for the pond area. The total area of this pond is approximately 2.78 ha.

Concept 3 - West Pond

This concept is proposed on the west side of the road and encompasses to equivalent of 5 potential lots. The total area is 3.6 ha.

Concept 4 - Middle Pond

This concept encompasses the middle area which is equivalent to 4 potential lots, as well as part of the proposed road through this area. To mitigate removal of the access road, cul de sacs could be considered for access to the lots on the north side of the pond. In this option, 4 lots would be removed; however 10 lots would gain a waterfront feature, which would likely realize a higher value to prospective buyers. The total pond area within the Municipal Reserve (MR) is approximately 2.6 ha.

Furthermore, consideration of providing permanent water features for all options was evaluated for aesthetic value and may be proposed in the final design stage when cut fill balances are better understood. A flat bottom pond would not be very attractive. It would flood with shallow water each spring and in most years it would dry up in mid summer. Occasionally, in wet years, it would remain wet from one year to the next. As the developer suggested, a permanent water feature would be preferred.

4.3.1 Recommended Option

The chosen design was Concept 4 - Middle Pond. The conceptual pond plan is shown on Drawing 1607.4-002 and the cross section in Drawing 1607.4-003. A summary of the design elevations, including pond features and functionality is provided in the table below.

Table 4.3
Evaporation Pond Functional Areas

Critical Design Levels	North		South	
	Elevation (m)	Area (ha)	Elevation(m)	Area (ha)
Maximum water level	507.3	6.1	507.5	3.4
Minimum Building elevation	508.3		508.5	
Municipal reserve boundary	505.3		505.5	
Minimum Water elevation	499.9	1.6	499.9	1.3
Depth of Pond	TBD		TBD	

The differences in maximum water elevation between the south and north pond is an effort to conserve excavation efforts where possible, as well as achieving adequate drainage via roadway ditches.

4.4 Road Way and Drainage Design Parameters

Road alignment, geometry and dimensions were designed in accordance with Transportation Association of Canada guidelines as well as Policy PW-12 *Road Servicing Agreements*, issued June 2011 by the R.M. of Corman Park.

Sizing for the drainage ditches and culverts was completed based on recommended dimensions from the R.M. Transportation Association of Canada (TAC) guidelines were followed for the following road design parameters:

- Super-elevation
- Site lines
- Turning radius

The road alignment is shown in Drawing S1607.4-002 - Site Plan and cross sections of typical walkway, road and ditch is provided in Drawings S1607.4-005 to S1607.4-007.

4.4.1 Drainage Design Considerations

Confirmation of the 1:100 year storm runoff for sizing drainage structures can be completed if required. At this level of design, typical sizing has been applied, namely 600 mm culverts and ditch dimensions consistent with R.M. standards as noted in Policy PW-12. Namely ditches with a dimension of 4 m wide, 0.8 m to 1.0 m in height with a 4:1 sideslope. Final Site grading has not been completed, therefore Clifton assumed negligible deviation from the original Site's contour plan.

5.0 Conclusions and Recommendations

The recommended evaporative pond option and associated conceptual drainage plan summary is provided in bullet form below.

a) The evaporation pond calculations have been conservative and it is likely that the ponds will not have a permanent water feature without deepening the proposed structures.

b) The model results indicated that the average level of water in the ponds was 5.3 and 5.6 m below the max water levels.

c) The minimum building elevations are recommended to be 1 m above the maximum water level.

d) Adding the final 1:100 year water levels to the ponds were found to increase the water level 2 m accordingly. Since this event may never occur, some of this area can be used as public land. Public land, therefore, has been designed to occur at 2 m below the max water level.

e) The slope from the MR to the top of the maximum building elevation could be inside the lots and available for the future owners use most of the time as long as there was a flood easement registered against the title and no flood prone developments were allowed.

f) The pond excavations will generate a substantial volume of fill. The subdivision plan in the final design phase will show where this will go and in particular should show all areas that require fill to achieve the proposed drainage.

g) If after the pond is in place, a series of floods occur, when the water begins to encroach on the lots, namely past the MR elevation, it would be recommended to pump the excess via overland temporary pipeline to an outlet. This would fit with the MR limit suggested above and since the water would be into the flood easements on the lots. Since this should be a rare event and may never occur, temporary overland pumping would be better than a permanent facility. The distance south or west to an outlet is within the range of portable pumps and pipelines typically available for rent. The pumping would not have to be completed in a short time so a modest flow rate would be adequate.

6.0 Closure

This report contains the results of Clifton's analyses as well as a proposed stormwater management option upon which certain initial recommendations have been made. Our recommendations do not constitute detailed engineering design and analysis, in whole or in part, of any of the elements of the proposed work. Incorporation of any or all of our preliminary recommendations in our report into the design of any such element does not constitute us as designers or co-designers of such elements, nor does it mean that such design is appropriate in geotechnical terms. The designers of such elements must consider the appropriateness of our recommendations in the light of all design criteria known to them, many of which may not be known to us. Our mandate has been to investigate and recommend which we have completed by means of this report. We have had no mandate to design, or review the design of, any elements of the proposed work and accept no responsibility for such design or design review.

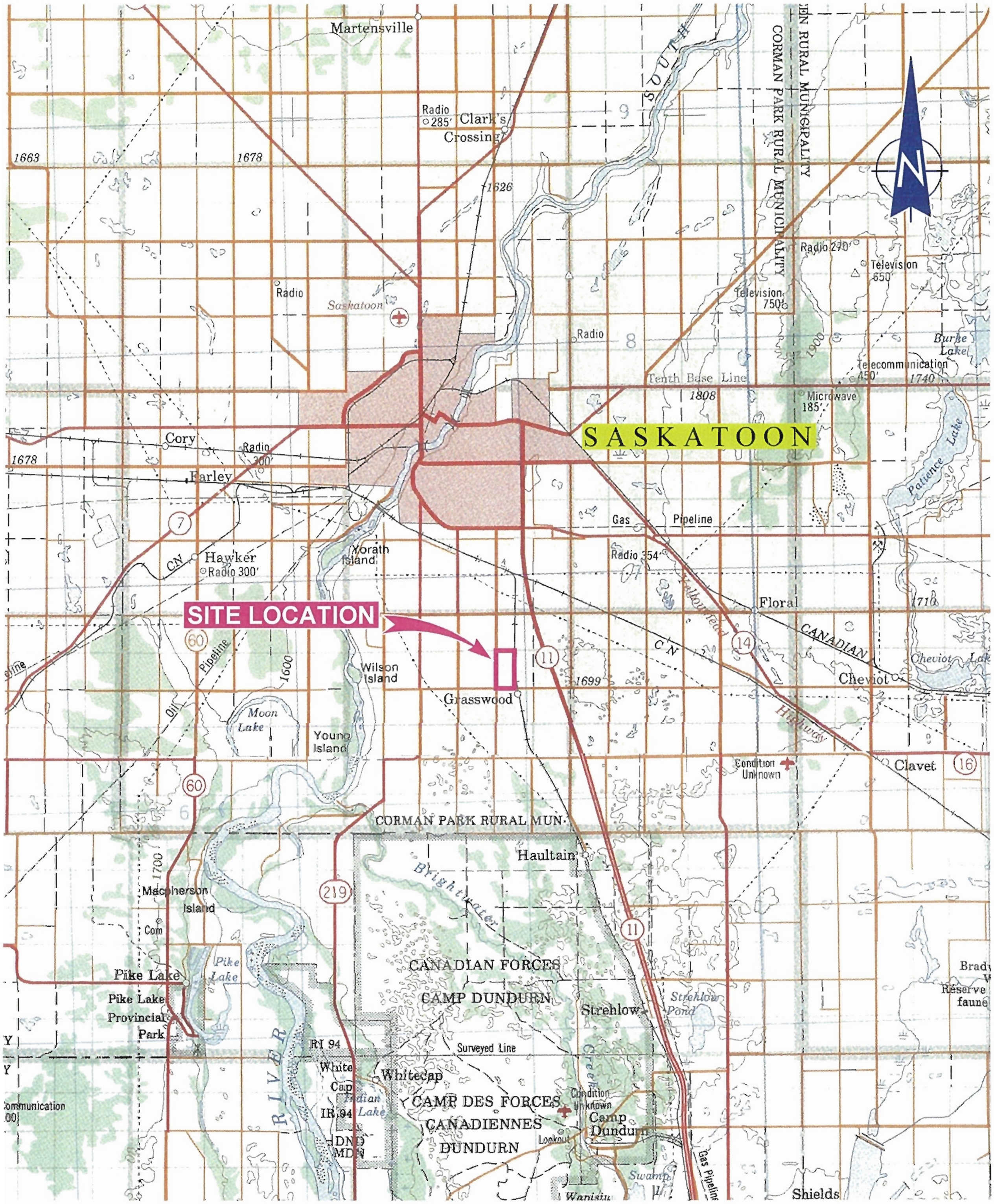
Clifton Associates Ltd.

Cindy Friesen, Geoscientist in Training

Ray Pentland, P.Eng.

Association of Professional
Engineers and Geoscientists of Saskatchewan
Certificate of Authorization No. 238

Clifton Associates Ltd. engineering science technology	**Drawings**



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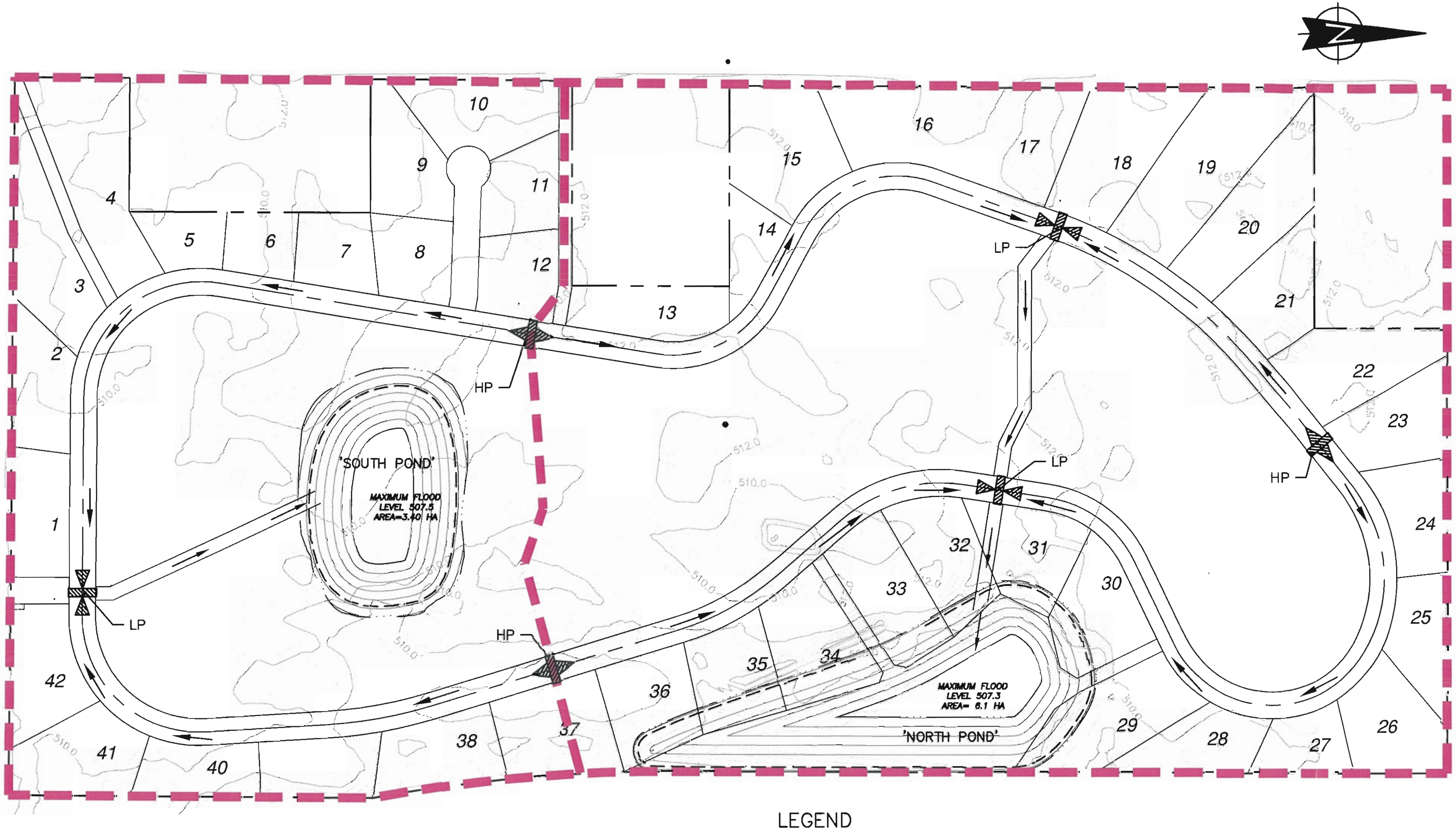
CLIENT URBAN ELEMENTS DEVELOPMENT CORP.

PROJECT CONCEPTUAL STORMWATER MANAGEMENT PLAN
GRASSWOOD ESTATES W1/2 26-35-5W3
R.M OF CORMAN PARK, SASKATCHEWAN

TITLE SITE LOCATION



NOTE:

SURVEY DATA PROVIDED BY
CLIFTON ASSOCIATES LTD.
MAY 16, 2012.

LEGEND

- DRAINAGE BOUNDARY
- EXIST. MAJOR CONTOUR
- EXIST. MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROJECT BOUNDARY
- LOT LINE
- DAYLIGHT LINE
- MAXIMUM FLOOD LINE
- HIGH POINT
- LOW POINT

DRAWING REVISIONS

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CLIENT
URBAN ELEMENTS DEVELOPMENT CORP.

PROJECT
CONCEPTUAL STORMWATER
MANAGEMENT PLAN
GRASSWOOD ESTATES

TITLE
CONCEPTUAL DRAINAGE SYSTEM

DESIGN J.O.	SCALE 1:5000	DATE 2012-05-22
DWN. BY Z.Y.	PROJECT NO. S1607.4	DWG. NO. S1607.4-02
CHECKED J.G.	FILE NO. S1607.4-002	

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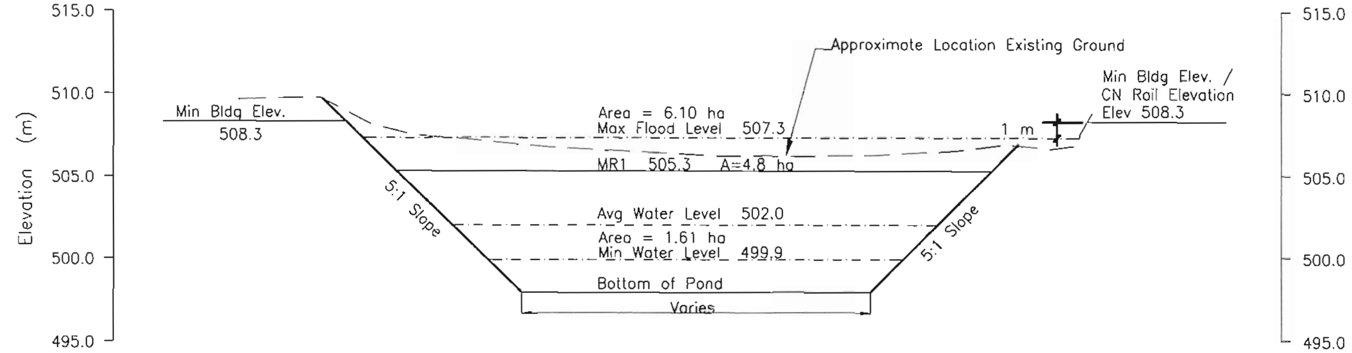

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CLIENT
URBAN ELEMENTS
DEVELOPMENT CORP.

PROJECT TITLE
CONCEPTUAL STORMWATER
MANAGEMENT PLAN
GRASSWOOD ESTATES W 1/2 26-35-5W3
R.M OF CORMAN PARK, SASKATCHEWAN

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FILE NO S1607.4-03.dwg
DATE MAY, 2012
SCALE N.T.S.
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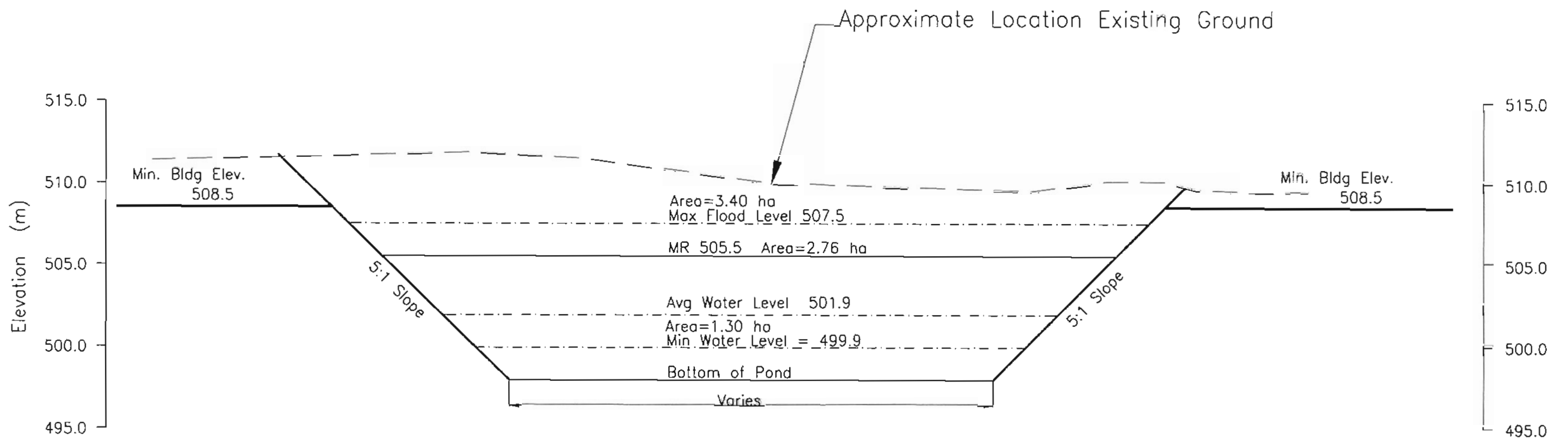

TYPICAL SOUTH POND SECTION

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PROJECT TITLE
CONCEPTUAL STORMWATER
MANAGEMENT PLAN
GRASSWOOD ESTATES W 1/2 26-35-5W3
R.M OF CORMAN PARK, SASKATCHEWAN

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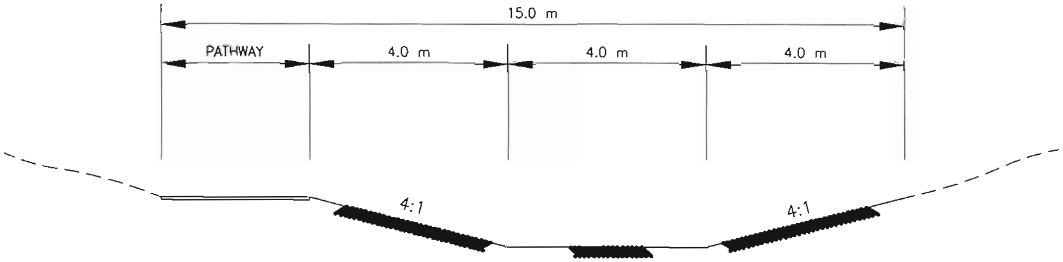

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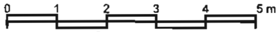

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DEVELOPMENT CORP.

PROJECT TITLE
CONCEPTUAL STORMWATER
MANAGEMENT PLAN
GRASSWOOD ESTATES W 1/2 26-35-5W3
R.M OF CORMAN PARK, SASKATCHEWAN

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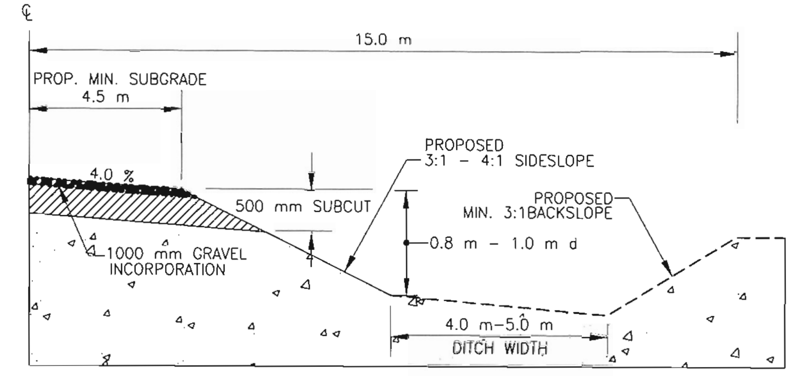

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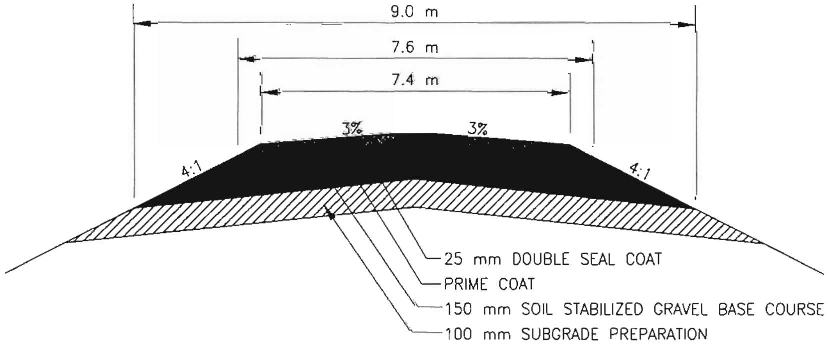

NOTE: SUBBASE MATERIAL MAY BE REQUIRED FOLLOWING SUBGRADE TEST RESULTS.

SUBDIVISION - TYPICAL CROSS SECTION
DOUBLE SEAL COAT

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PROJECT TITLE
CONCEPTUAL STORMWATER
MANAGEMENT PLAN
GRASSWOOD ESTATES W 1/2 26-35-5W3
R.M OF CORMAN PARK, SASKATCHEWAN

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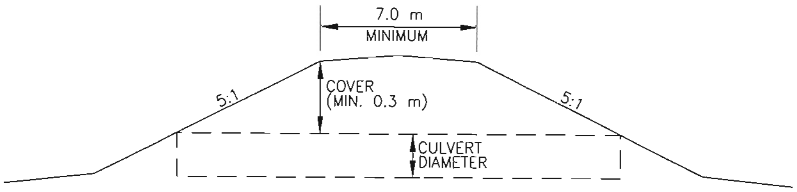

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TYPICAL CROSS SECTION
STANDARD APPROACH

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PROJECT TITLE
CONCEPTUAL STORMWATER
MANAGEMENT PLAN
GRASSWOOD ESTATES W 1/2 26-35-5W3
R.M OF CORMAN PARK, SASKATCHEWAN

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STANDARD APPROACH

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DATE: MAY, 2012
SCALE: N.T.S.
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DWG NO: S1607.4-007
REV:

Clifton Associates Ltd.
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Appendix A

January 19, 2009
File No. 493

DRAFT

Clifton Associates Ltd.
4 - 1925 1st Avenue North
Saskatoon, Saskatchewan
S7L 6W1

Attention: Lisa White

RE: COUNTRY RESIDENTIAL DEVELOPMENT - W-26-35-5-W3

I have reviewed the runoff impacts of the proposal to develop 94 country residential lots on the west half of Section 26-35-5-W3.

This land has no natural drainage. Past runoff has flowed to the many local potholes in the naturally uneven terrain. Evaporation and infiltration to the ground have provided sufficient loss to offset the runoff so that overflow has not eroded any natural runoff channel. The National Topographic Series map and digital satellite terrain maps indicate that there is a natural drainage divide just west of the road west of this land and just north of the north boundary. The road south of the property is also close to the natural drainage divide. The land has a gentle slope to the east toward the railway. The only significant hydrologic feature is the slough area adjacent to the railway just north of the quarter section line which would capture any runoff from this area in the event of very wet weather.

If overflow occurred in a flood year, this slough would drain southeast through an existing country residential area, then south about 9 km to Brightwater Creek.

The R. M. Of Corman Park has encountered flood problems as a result of past development and has implemented a policy to ensure that future developments do not add to these problems. The policy has 3 main components that could impact on this proposal.

1. Subdivisions must provide for the conveyance of water that would naturally flow across the subdivision from upstream areas.

For this subdivision the upstream areas are very small strips of land west and north of the property which are very flat and poorly drained. There is no indication that water even crosses into Section 26 from upstream so provision for upstream flows should not be a problem.

2. Subdivisions must be designed with internal drainage systems to ensure that property is protected from flooding.

For this subdivision, ditches associated with the road network can be designed to convey runoff from the developed properties. There is a general slope toward the natural slough at the railway that should permit appropriate grading. Some areas, particularly the south quarter, are very flat and will require some effort to ensure proper drainage.

3. Adverse impacts to downstream areas are not permitted.

For this subdivision, the potential for downstream impacts is significant. The development will impact flows in two ways:

First, the drainage system that must be developed to protect the future homes from flooding will move this half section of land from the ineffective drainage area into the effective drainage area for ordinary runoff. Instead of water ponding in the many small low areas, it will be concentrated and could flow downstream.

Second, the impervious surfaces of roads, roofs, driveways, etc will produce more runoff, particularly due to summer rains, than would have been the case with the original prairie. The proposed development can be expected to have about 8 ha of impervious surface (6% of the area).

This subdivision is too far from a natural stream to manage the anticipated increases in runoff by drainage. The only potential for disposing of the water would be to take advantage of the semi arid climate to mitigate the impacts by evaporation. The following sections discuss my estimate of the required mitigation.

Existing Conditions

The nearest streamflow measurements are on Brightwater Creek near Kenaston (Water Survey of Canada Station 05HG002) where flow records are available from 1960 to 2007. The attached Table A1 lists the recorded flows at this station. The published gross drainage area for this stream is 900 km^2 and its effective drainage area is 281.8 km^2. If it is assumed that the hydrologic factors that generated the measured flows apply equally to the 0.66 km^2 project area, the runoff volume can be estimated as 0.0023 times the recorded flow (0.66 km^2/281.8 km^2). Table A2 lists the estimated flows from the project lands.

Since there is no outflow channel, the runoff is being disposed mainly through evaporation. Agriculture and Agrifood Canada calculates potential evaporation for open water surfaces for various locations based on weather data. Saskatoon is one such location. Table A3 lists the calculated gross evaporation.

Part of the water lost to evaporation from a water surface will be offset by precipitation. Table A4 lists the recorded Saskatoon precipitation. Table A5 lists the net evaporation which is the gross evaporation minus the precipitation.

The project area has several low areas that capture the runoff and allow evaporation. Rather than modeling each low area separately, it was assumed that their prerformance would be approximated by one large pond with equal area.

A monthly model was set up to calculate the hydrologic balance that might have occurred for the past 48 years with the land in agricultural use.

It was found that, in most years the runoff would occur in the spring with the flooding area varying in proportion to the magnitude of the runoff. In most years the flooding would be relatively minor and would be mostly dried by the end of May. In wet years there would be longer duration flooding but usually the flooding would be gone by late summer. The recent flood years in 2005 and 2006 produced the worst flooding. In 2005 there was a heavy spring runoff that would have filled many of the sloughs. The unusual rainfall runoff events in June, July and September combined to keep the water levels high throughout 2005. Then high runoff in spring of 2006 boosted the flooding. At its peak, I calculated that about 18 ha would have been flooded in April 2006.

Developed Conditions

If the development proceeded with no runoff management, the many small low areas would be drained so that most of the natural evaporation potential would be lost. All of the developed area would drain to the lowest terrain beside the railway. In addition, there would be summer rainfall runoff from the impervious surfaces.

In order to calculate the impact of development and the potential mitigation, the same 48 year period was modeled. It was assumed that the spring runoff potential would not be significantly changed by development except that all of the flow would drian to the single downstream low area beside the railway. Summer runoff was estimated to average 35 percent of the precipitation times the 8 ha impervious area. The 35 percent factor was based on calculated runoff from rainfall to Wascana Lake in Regina derived from the rise in lake level recorded on the lake during summer rain fall over a long study period. Actual runoff will vary from zero for small rainfalls to high percentages in heavy storms. The 35 percent average is considered conservative for this type of rural residential subdivision.

When this developed model was run using the existing size of the downstream slough, the slough area was not large enough to store and evaporate the runoff. By testing various sizes of expanded storage/evaporation ponds, it was found that an area of 6 ha would be needed to mitigate the impacts of development. A potential water retention area has been sketched on the contour plan and is attached. It would utilize the existing natural low area with its bottom elevation close to elevation 483.0 and would be excavated so that it has a bottom area of 6 ha, then 5:1 slopes up to the natural terrain.

The model calculations suggest that this pond could hold water for long periods of time. Water should not pond against the railway so a dyke would be needed to protect the railway grade. The maximum depth modeled was about 1.5 m or elevation 484.5 m. To provide a safety factor, the full level should be considered to be 485.0 m and the safe building level should be set of 486.0 m.

The excavated material could be used for road construction and to fill the low areas and shape the project area so it all drains to the proposed pond.

The final shape should be coordinated with the subdivision design to maximize the developable lots.

Yours Truly

WATER RESOURCE CONSULTANTS LTD.

R. S. Pentland, P. Eng.

RSP/dp

493-09-01-15

May 3, 2012
File No. 493

Clifton Associates Ltd.
4 - 1925 1st Avenue North
Saskatoon, Saskatchewan
S7L 6W1

Attention: Cindy Freisen

RE: GRASSWOOD ESTATES - COUNTRY RESIDENTIAL

In January 2009, I completed a feasibility study for a subdivision on W26-35-4-W3. At that time, the planning was at a preliminary stage and my results were at a feasibility level. The important finding of that investigation was that there is no surface runoff outlet from this project and developing an outlet would require a major channel, crossing many other lands that are not under this developer's control. Therefore an evaporation pond concept was proposed and a pond in a natural low area in the northeast quadrant was evaluated.

The subdivision plan has been further developed. It has been found that the distance from the south part of the subdivision to the northeast pond would be too great to allow reasonable grades to drain the whole subdivision. Therefore a second pond will be needed in the south area.

The previous results are no longer applicable and this report deals with the subdivision as it is currently planned.

The R.M. of Cormon Park has encountered flood problems as a result of past development and has implemented a policy to ensure that future developments do not add to these problems. The policy has 3 main components that could impact on this subdivision.

1. Subdivisions must provide for the conveyance of water that would naturally flow across the subdivision from upstream areas.

This subdivision is at the upstream end of the local drainage area. There is no indication that drainage enters this land.

2. Subdivisions must be designed with internal drainage systems to ensure that property is protected from flooding.

The ditches associated with the road network is being designed so that all areas can be drained. Details are being developed in a drainage plan being prepared by Clifton Associates.

3. Adverse impacts to downstream areas are not permitted.

For this subdivision, the potential for downstream impacts is significant. The development will impact flows in two ways.

First, the drainage system that must be developed to protect future homes from flooding will move this half section of land from the ineffective drainage area into the effective drainage area. This land was naturally very flat with many local low areas that ponded runoff from the local tributary areas. Evaporation emptied these ponds each year so no runoff left this land. These local ponds will be mostly eliminated after development of the subdivision so the dispersed evaporation will no longer be available.

Second, the impervious surfaces of roads, roofs, driveways, etc will produce more runoff, particularly due to summer rains, than would have been the case with the original prairie. Based on the length and width of roads and an allowance for typical rural yards, the future impervious surface area is expected to be about 5.5 percent of the total area. This is about the same ratio that has been found for other similar acreage subdivisions. For this study, 6 percent was used. For the 129 ha area, this would be 8 ha.

Since no outlet drain is available, downstream areas will have to be protected from the increased flows by evaporation ponds.

Hydrologic Data

The nearest streamflow measurements are on Brightwater Creek near Kenaston (Water Survey of Canada Station 05HG002) where flow records for the 51 year period from 1960 to 2010 are available. The published gross drainage area for this stream is 900 km^2 and its effective drainage area is 281.8 km^2. This stream is very near to the project and should provide a good indication of the runoff potential in this area. Table A1 lists the recorded flows.

A key feature of this region is the high evaporation from surface water bodies. Agriculture and Agrifood Canada calculates potential evaporation for various weather stations based on weather data. Saskatoon is one such location. Table A2 lists the calculated gross evaporation.

Part of the water lost to evaporation will be offset by precipitation. Table A3 lists the recorded Saskatoon precipitation. Table A4 lists the net evaporation which is the gross evaporation minus the precipitation.

Developed Conditions

When development occurs, the small local sloughs will not be available and all runoff will be directed to two evaporation ponds. Actually, some of these natural lows will remain but, for this study, the conservative assumption was made that all will be drained.

In order to calculate the size of ponds needed to mitigate the more concentrated runoff and added flow due to summer precipitation on the impervious area, a monthly model of the 51 year period of record was set up in a spread sheet.

The drainage plan provides for 48 ha to be drained to the south pond and 81 ha to be drained to the northeast pond. The 48 ha area is 0.0017 times the 281.8 km effective drainage area at the hydrometric station and 81 ha is 0.0029 times. The natural component of the runoff can be expected to be the recorded flow at the hydrometric station times these factors.

The added runoff due to the impervious surfaces is more complicated. For ordinary subdivisions with an outlet, the performance in individual rainstorms such as a 1:100 year one day event is the critical design event. However, for an evaporation pond, the calculations must take into account the accumulative impact of many runoff events extending over years rather than days. The total volumes involved greatly exceed individual storms. Therefore the long term volume of runoff is critical rather than the individual storm runoff that would normally be calculated using a dynamic simulation model.

In 1991, Sask Water completed a study of rainfall runoff from the urban area of Regina that drains to Wascana Lake which provided a measure of how urban conditions influence runoff. The measured rise in the level of the lake combined with the known area of the lake provided a direct measure of the runoff volume from rainfall events recorded at the weather station. The urban area that is drained to the lake is known from the storm sewer plans and the area of impervious surface is known from the City's stormwater planning studies. It was found that on average 35 percent of the precipitation on impervious surfaces in the summer reaches the lake. This runoff factor was for a city type of development with a high percentage of impervious surfaces and with almost all impervious surfaces draining directly to storm sewers. For an acreage development with a small percentage of impervious area; many areas not directly connected; and the flow in ditches rather than pipes, runoff ratios will be lower. The 35 percent runoff from the impervious area was used as a conservative estimate of the increase in runoff volumc.

The increase in summer runoff due to impervious surfaces was calculated as 35 percent of the rainfall amount times 6 percent of the drainage area for each month.

The two ponds were modeled on a monthly basis. The inflow for each month was equal to the drainage area ratio times the recorded flow of Brightwater Creek plus, for the summer months, rainfall runoff from the impervious areas. The only outflow is the net evaporation. In wet periods, the ponds will accumulate runoff which will be dissipated in subsequent dry months when evaporation exceeds precipitation and runoff. The ponds act as a storage reservoir in wet periods which are lowered in subsequent dry periods.

For a subdivision with an outlet, the works are normally sized for the 1:100 year flood. In order to create a similar standard for the evaporation pond, an extra calculation was needed to identify the potential 1:100 year annual volume based on the 51 years of recorded flows. A frequency analysis was calculated using standard statistical methods as shown on the attached graph to determine the 1:100 year annual volume. To ensure that the added 1:100 year inflow has the worst possible consequence, this theoretical flood year was inserted after the wettest sequence of years in the 51 year record. This is a conservative assumption since a future flood event is just as likely to occur after an ordinary sequence or even after a drought.

The geometry of the ponds will be finalized at the final design stage. For this study, the northeast pond was assumed to be roughly triangle shaped in the natural low area. The south pond was assumed to be roughly circular. The ponds were assumed to have a flat bottom and 5:1 slopes.

The water balance calculations were set up to determine the optimum depth, area and volume to provide for removal of the runoff through evaporation while minimizing the area so that the developed area will be maximized. In addition to maximizing the developable area, this will reduce the area of public lands that will have to be managed in the future.

My calculation identified the geometry that is needed. This geometry needs to be fit into the existing topograhpy. A key elevation is the safe building level. For each pond, the local topography will have to be evaluated to identify an elevation of the local terrain that will be the lowest building site. To provide a safety factor, the 1:100 year flood level of the pond should be set 1 m below the safe building level. The terrain around these ponds suggests a safe building level of 509.5 m can be achieved with minor fill of low area. The 1:100 year flood level would then be 508.5 m.

The calculations indicate that the area of the Northeast and South Pond needs to be 6.1 ha and 3.4 ha respectively at the 1:100 year flood level. Calculations assumed pond side slopes of 5:1 below the 1:100 year level.

The average water level in the ponds was 5.3 m and 5.6 m below the 1:100 year flood level or elevations 503.2 m and 502.9 m. Since the calculations were mainly for flood design, they are conservatively high and the average level will not be this high.

The minimum levels were found to be 7.4 m and 7.6 m below the 1:100 year flood level or elevation 501.1 m and 500.9 m respectively. In theory if the pond was excavated to these elevations, in a future drought they would dry out. Again, since the calculations were designed to maximize runoff estimates, it is very likely that levels below these values will occur. If permanent water features are desired, excavation should extend further down. The pond areas at 501 m should be about 1.6 ha and 1.3 ha and they will become even smaller as they are deepened so the excavation volume to create permanent water bodies is less than the excavation to create flood storage.

Since flooding may never approach the 1:100 year level, all of the area required for flood storage does not have to be on public land. Extreme flood storage for storm water ponds is often included in the back end of the adjacent lots. In my simulations, the final 1:100 year flood in the sequence of flood years raised the ponds roughly 2 m. In the other 51 years simulated, the ponds stayed below 506.5 m. It would be reasonable to limit the public reserve lands to this elevation and register a flood easement against the portion of the adjacent lots from 506.6 m to 508.5 m.

If, in a future sequence of wet years the ponds do reach levels exceeding 506.5 m, it would be prudent to take action to remove the excess water by use of temporary pumps in order to prevent any risk of the next year being a major flood event. If the portion of the ponds between 506.5 and 508.5 was in a flood easement, in the private yards, the residents could be expected to notify the officials, even if the risk had been forgotten by the officials.

The area of public land could be reduced to about 4.8 ha and 2.8 ha respectively. This reduces the public cost of maintaining the land without adding any risk of flood damages.

It is my view that this proposal is quite conservative. All the calculations were biased toward flood maximization. It is my expectation that there will be more problems with water supply for the permanent water features than with flooding. If, at some future time, a series of very wet years occurs, these ponds will take years to reach flood stage and there would be plenty of time to take action to mitigate the risk. In the flood of 2011, we found that overland pumping with rented pumps and overland pipes was an effective management practice. As long as the ponds are not allowed to remain above 506.5 m after one flood, a second flood can be managed safely. In addition the metre of freeboard between the design flood level of 508.5 m and 509.5 m safe building level will include a very large area and storage volume for even worse events than the 1:100 year design.

Yours truly

WATER RESOURCE CONSULTANTS LTD.

RS Pentland

R. S. Pentland, P. Eng.

RSP/dp

439-12-05-03

Return Period (Yrs)	Q (m3) – North East	Q (m3) - South
2	12409.72	7358.19
5	25371.99	14659.81
10	38087.25	22385.48
25	60122.58	35210.21
50	81885.14	47839.12
100	109110.02	63601.08
200	143047.84	83206.67

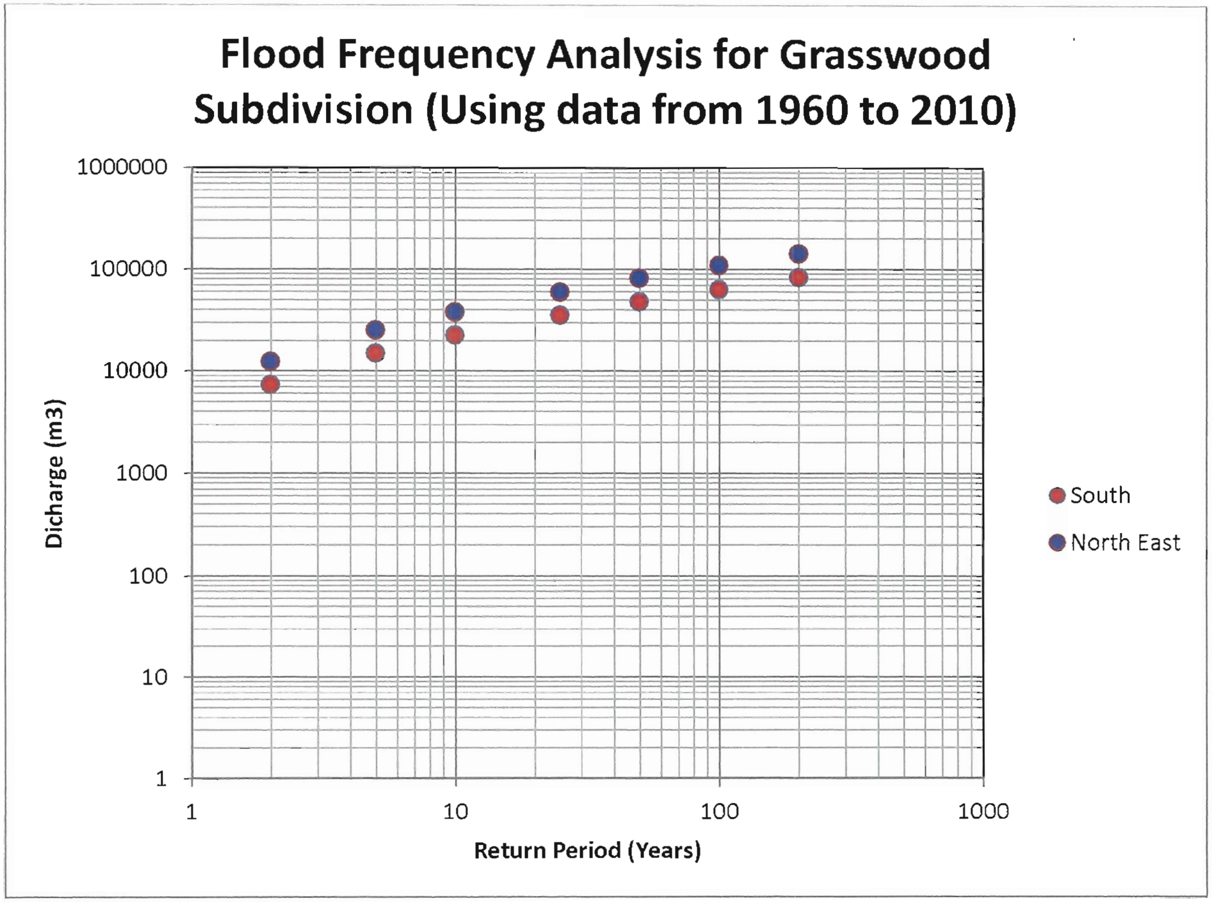


Table A1
Monthly Mean Discharge (m3/s)
Brightwater Creek Near Kenaston - Station 05HG002

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1960	-	-	0.005	2.61	0	0	0	0	0	0	-	-	-
1961	-	-	0	0	0	0	0	0	0	0	-	-	-
1962	-	-	0	0.086	0	0	0	0	0	0	-	-	-
1963	-	-	0.359	0.019	0	0	0	0	0	0	-	-	-
1964	-	-	0	0.068	0.002	0	0.026	0	0	0	-	-	-
1965	-	-	0	1.46	0.058	0.244	0.03	0	0	0	-	-	-
1966	-	-	0.751	0.323	0.001	0	0	0	0	0	-	-	-
1967	-	-	0	0.357	0.228	0	0	0	0	0	-	-	-
1968	-	-	0.894	0.034	0.001	0	0	0	0	0	-	-	-
1969	-	-	0	3.37	0.011	0	0	0	0	0	-	-	-
1970	-	-	0.461	1.64	0.026	0	0.014	0	0	0	-	-	-
1971	-	-	0	0.943	0.042	0.008	0.001	0	0	0	-	-	-
1972	-	-	0.238	0.226	0.015	0	0	0	0	0	-	-	-
1973	-	-	0.008	0.029	0.003	0	0.039	0	0	0	-	-	-
1974	-	-	0	7.82	0.314	0.028	0	0	0	0	-	-	-
1975	-	-	0	0.291	0.05	0	0	0	0	0	-	-	-
1976	-	-	0	3.39	0.019	4.15	0.125	0.001	0	0	-	-	-
1977	-	-	0	0	0	0	0	0	0	0	-	-	-
1978	-	-	0.093	0.16	0.003	0	0	0	0	0	-	-	-
1979	-	-	0	3.98	0.11	0.006	0	0	0	0	-	-	-
1980	-	-	0.451	0.171	0	0	0	0	0	0	-	-	-
1981	-	-	0	0.017	0	0.034	0	0	0	0	-	-	-
1982	-	-	0	0.71	0.058	0.081	0	0	0	0	-	-	-
1983	-	-	0.003	0.003	0.001	0	1.25	0.339	0	0	-	-	-
1984	-	-	0.208	0.027	0	0	0	0	0	0	-	-	-
1985	-	-	0	1.68	0.03	0	0	0	0	0	-	-	-
1986	-	-	0.682	0.075	0.002	0	0	0	0	0	-	-	-
1987	-	-	0.602	0.472	0.001	0	0	0	0	0	-	-	-
1988	-	-	0.07	0.021	0	0	0	0	0	0	-	-	-
1989	-	-	0	0.093	0.016	0.001	0	0	0	0	-	-	-
1990	-	-	1.15	0.145	0.059	0	0	0	0	0	-	-	-
1991	-	0	0	0	0.219	0.238	1.55	0	0	0	-	-	-
1992	-	0	2.32	0.147	0.102	0	0	0	0	0	-	-	-
1993	-	-	0.367	0.09	0.035	0	0.051	0.07	0.002	0.004	-	-	-
1994	-	-	1.76	0.476	0.007	0.001	0	0	0	0	-	-	-
1995	-	-	0	0	0	0	0	0	0	0	-	-	-
1996	-	-	0.451	1.17	0.16	0.032	0.005	0	0	0	-	-	-
1997	-	-	0.088	4.36	0.076	0	0	0	0	0	-	-	-
1998	-	-	0.071	0.13	0.003	0	0	0	0	0	-	-	-
1999	-	-	3.49	0.49	0.007	0.069	0.465	0.011	0	0	-	-	-
2000	-	-	0.001	0.001	0	0	0	0	0	0	-	-	-
2001	-	-	0.358	0.254	0.002	0	0	0	0	0	-	-	-
2002	-	-	0	0	0	0	0	0	0	0	-	-	-
2003	-	-	1.36	0.358	0.014	0	0	0	0	0	-	-	-
2004	-	-	0.002	0.445	0.016	0	0	0	0	0	-	-	-
2005	-	-	0.498	3.05	0.06	0.293	0.219	0.001	0.452	0.026	-	-	-
2006	-	-	0	8.97	0.036	0.025	0.004	0	0	0	-	-	-
2007	-	-	3.57	0.731	0.006	0	0	0	0	0	-	-	-
2008	-	-	0	0.43	0.008	0	0	0	0	0	-	-	-
2009	-	-	0	2.94	0.059	0.001	0.878	0.005	0.001	0	-	-	-
2010	-	-	0.831	0.254	0.213	1.12	0.001	0	0	0	-	-	-
Mean	-	0	0.415	1.07	0.041	0.124	0.091	0.008	0.009	0.001	-	-	-
Max	-	0.000*	3.57	8.97	0.314	4.15	1.55	0.339	0.452	0.026	-	-	-
Min	-	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	-	-	-

Table A2

Gross Evaporation - Saskatoon in mm

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1960	0	0	0	53.4	138	166.2	190.9	181.3	142.9	64.4	0	0	937
1961	0	0	0	53.6	148	202.8	211	222.9	121.1	57	0	0	1016
1962	0	0	0	50.2	129.3	176.3	179	167.2	111.8	56.6	0	0	870
1963	0	0	0	44.6	112.5	131.8	147.3	137.1	99.7	59.5	0	0	732
1964	0	0	0	53	141	162	188.4	181.8	88.7	46.5	0	0	862
1965	0	0	0	43.2	173.3	174.8	177.9	194	101.4	76.1	0	0	941
1966	0	0	0	51.1	178.9	149.6	168.8	169.2	134.7	65.1	0	0	917
1967	0	0	0	43.2	161.9	182.1	268.6	235.5	198.4	47.3	0	0	1137
1968	0	0	0	65.4	158	187.2	180.6	143	95.1	46.9	0	0	876
1969	0	0	0	51.7	143.4	169.4	168.8	204.8	119.5	42.9	0	0	901
1970	0	0	0	44.3	135	165.8	165.9	201.9	126.5	62.5	0	0	902
1971	0	0	0	56.4	178	151.5	183.8	200.2	132.4	74.5	0	0	977
1972	0	0	0	77.9	137.9	210.4	164.3	189.4	130.3	74.4	0	0	985
1973	0	0	0	60.4	147.4	170.8	210.2	213.4	132.2	71.6	0	0	1006
1974	0	0	0	47.9	129.8	189.2	215.6	171.2	121.5	72.4	0	0	947
1975	0	0	0	45.4	129.5	152	194.6	172.3	132.6	59.6	0	0	886
1976	0	0	0	62.6	186.9	147.3	184.5	201.8	137.6	66.8	0	0	987
1977	0	0	0	85.4	143.8	194.5	204.5	156.3	90.5	73	0	0	948
1978	0	0	0	65.4	145	176.7	183.1	171.1	106	64.6	0	0	912
1979	0	0	0	43.4	134.8	167.1	203.4	204.9	160.6	61.6	0	0	976
1980	0	0	0	80.5	172.3	193.4	210.2	163.8	118.1	67.1	0	0	1005
1981	0	0	0	61.4	164.5	161.9	179.3	185.3	140.1	55.9	0	0	948
1982	0	0	0	59.2	134.9	151.2	180.7	159.3	127.9	58.5	0	0	872
1983	0	0	0	51.8	125.4	176.8	173.4	193.3	126.4	60.3	0	0	907
1984	0	0	0	74.9	160.9	177.1	246.7	223.5	107.4	57.1	0	0	1048
1985	0	0	0	57.4	134.3	167	197.6	174.7	111	68.6	0	0	911
1986	0	0	0	65.7	149.8	168.5	170.7	178.3	99.3	51.2	0	0	884
1987	0	0	0	68	161.3	206.4	168.8	156	133.2	70.6	0	0	964
1988	0	0	0	78.1	187.5	264.4	239.1	164.6	132.9	62	0	0	1128
1989	0	0	0	61	136	182.4	227.1	197.8	128.7	67.2	0	0	1000
1990	0	0	0	58.3	131.1	165.9	167.5	184.5	136.3	64.8	0	0	908
1991	0	0	0	56.7	123.9	146.2	192.6	202.8	132.7	57	0	0	912
1992	0	0	0	60.5	139.3	175.9	160.3	172	112.4	56	0	0	876
1993	0	0	0	48.7	142.1	156.7	134.6	121	96.5	57.2	0	0	757
1994	0	0	0	63	141.1	132.4	139.9	133.5	126.5	54.7	0	0	791
1995	0	0	0	43.7	133.3	166.7	136.8	132.2	117.5	43.8	0	0	774
1996	0	0	0	43.2	110	156.7	132.6	167.9	95.2	46.5	0	0	752
1997	0	0	0	48.9	135.4	137.3	158.3	169.4	126.8	55.7	0	0	832
1998	0	0	0	69.3	158.1	147.3	154.5	189.8	124.7	41.2	0	0	885
1999	0	0	0	54.2	125.6	135	129.4	129.4	115	64.5	0	0	753
2000	0	0	0	48	148.8	163.6	151.6	152.4	120.9	63.6	0	0	849
2001	0	0	0	59.4	179.9	142	176.8	193.3	122.4	52.4	0	0	926
2002	0	0	0	52.7	187.3	173.3	209.7	135.8	107.8	40.2	0	0	907
2003	0	0	0	50.3	155.2	179.2	180	211.3	112.4	59.5	0	0	948
2004	0	0	0	70.5	140.5	139.8	144.5	138	94.7	52.4	0	0	780
2005	0	0	0	66.8	153.8	124.9	146.8	148.3	102.3	53.1	0	0	796
2006	0	0	0	60.7	122.7	126.9	158.2	170.9	104.7	47.6	0	0	792
2007	0	0	0	61.8	131.4	141.9	156.9	153.9	91.9	46.2	0	0	784
2008	0	0	0	54.7	152.4	141	147.1	169.4	105.5	64.2	0	0	834
2009	0	0	0	57.7	146.8	165.9	178.8	175.3	119.5	58.8	0	0	903
2010	0	0	0	57.7	146.8	165.9	178.8	175.3	119.5	58.8	0	0	903
MIN	0	0	0	43.2	110.0	124.9	129.4	121.0	88.7	40.2	0	0	732
MAX	0	0	0	85.4	187.5	264.4	268.6	235.5	198.4	76.1	0	0	1137
MEAN	0	0	0	57.7	146.8	165.9	178.8	175.3	119.5	58.8	0	0	903

Table A3

Precipitation - Saskatoon in mm

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1960	11.2	16.8	17.5	15.0	58.2	66.0	11.9	20.8	3.8	6.1	10.9	13.7	252
1961	12.7	28.7	9.9	27.7	61.0	43.9	65.5	1.0	21.1	41.4	17.3	23.6	354
1962	16.5	36.8	19.3	5.3	20.3	26.7	106.7	45.0	23.9	7.1	13.0	22.4	343
1963	13.7	26.7	15.7	31.0	41.7	93.2	73.9	43.7	32.8	5.6	31.5	9.9	419
1964	15.5	12.7	6.9	7.9	43.4	16.8	24.6	58.7	49.3	10.7	4.1	16.3	267
1965	9.1	16.3	3.0	8.9	35.1	101.9	31.0	28.7	30.5	0.5	15.5	14.2	295
1966	17.3	11.2	14.0	16.8	17.0	136.7	47.8	48.0	13.5	10.7	23.9	12.2	369
1967	20.8	9.4	42.2	4.3	19.6	51.3	19.8	57.7	34.0	32.5	16.5	22.9	331
1968	18.0	2.8	23.4	27.7	57.2	37.8	109.7	81.5	46.0	27.2	3.3	14.7	449
1969	41.7	15.7	6.9	10.4	44.7	35.6	58.9	11.7	67.1	67.6	8.6	19.8	389
1970	8.9	9.7	31.2	15.2	13.2	156.7	45.5	26.9	3.0	20.6	22.1	21.6	375
1971	25.9	5.6	21.1	20.8	5.6	87.9	142.2	16.0	5.8	11.4	14.2	33.5	390
1972	25.9	18.3	21.3	5.1	41.7	54.6	64.0	26.9	10.7	10.4	7.6	19.1	306
1973	4.8	19.8	3.6	54.9	26.2	104.6	44.7	29.2	38.1	7.9	38.4	32.5	405
1974	37.1	10.4	35.1	13.2	104.4	61.2	58.7	64.3	27.7	9.7	1.3	11.7	435
1975	22.6	21.1	8.1	31.2	74.4	77.7	27.9	38.4	21.1	16.5	5.8	13.2	358
1976	12.4	17.5	17.3	24.1	23.1	70.9	77.2	4.6	20.1	3.6	2.5	15.2	288
1977	7.3	4.7	8.5	6.6	147.4	16.5	33.8	27.8	47.1	5.0	11.7	28.1	344
1978	10.5	4.9	4.7	32.2	34.3	39.9	56.0	41.4	52.5	19.8	32.0	8.8	337
1979	7.3	28.7	17.4	42.0	23.5	90.8	36.0	14.0	19.7	28.0	4.6	25.1	337
1980	23.4	14.3	14.4	5.5	20.2	42.3	24.2	63.1	38.8	16.5	5.4	21.1	289
1981	14.5	1.6	13.3	27.1	12.8	81.0	55.2	26.6	19.5	36.7	2.0	13.3	304
1982	9.5	4.0	12.7	13.0	83.0	52.9	80.4	81.2	41.6	6.2	21.4	7.6	413
1983	6.3	6.0	23.0	30.5	45.4	115.2	64.0	27.5	65.2	9.0	26.4	5.2	424
1984	9.0	1.2	11.3	18.2	29.0	70.0	13.4	7.9	58.2	58.6	18.8	14.6	310
1985	9.8	13.6	9.0	59.8	76.2	11.4	59.0	26.7	42.0	5.8	8.2	13.6	335
1986	25.4	9.4	19.0	6.2	58.6	49.8	119.8	14.6	58.8	6.8	13.0	7.2	389
1987	10.4	13.4	16.6	13.8	32.4	28.9	37.2	41.6	13.0	9.2	1.2	11.2	229
1988	12.6	9.8	34.4	1.8	11.0	23.4	58.4	89.5	26.7	7.6	7.4	16.2	299
1989	14.4	5.8	6.0	5.2	94.0	61.3	27.8	51.6	27.8	19.2	22.9	26.5	362
1990	13.2	4.8	7.8	23.8	27.6	59.8	75.9	6.3	6.6	5.8	21.2	12.8	266
1991	5.4	14.8	10.6	69.2	72.4	136.0	49.2	14.0	16.8	56.8	18.0	13.4	477
1992	17.6	10.4	3.6	12.1	46.6	14.6	66.2	47.4	47.3	21.9	18.8	18.2	325
1993	3.4	3.0	16.4	27.5	36.8	58.4	75.3	64.3	43.5	0.5	19.5	8.9	358
1994	24.9	10.8	2.8	8.4	115.7	54.3	41.7	64.1	0.8	18.8	12.6	10.0	365
1995	11.8	12.9	30.0	34.0	14.9	32.6	81.4	84.6	0.6	34.7	16.0	22.0	375
1996	14.0	12.4	12.8	30.1	58.7	100.8	114.1	18.4	40.3	5.5	22.7	16.6	446
1997	15.6	5.1	19.3	35.8	25.6	53.1	24.6	49.6	55.4	21.1	2.6	5.1	313
1998	12.5	4.2	9.2	7.3	8.6	75.4	31.1	37.2	27.1	49.9	6.5	11.0	280
1999	27.5	5.9	8.5	14.7	114.8	58.9	80.4	43.4	19.7	8.5	5.0	14.1	401
2000	19.6	12.6	21.9	41.2	16.4	49.8	82.8	42.0	27.0	0.4	10.1	20.8	345
2001	2.1	2.9	2.0	5.5	21.6	38.3	52.2	6.0	7.6	6.5	6.5	8.5	160
2002	2.3	6.7	8.0	14.8	1.5	52.2	69.5	75.2	48.9	11.1	2.4	6.7	299
2003	9.0	9.9	8.7	46.2	16.0	19.0	48.5	30.0	25.5	13.0	4.5	3.5	234
2004	23.1	12.2	27.0	11.8	27.0	79.7	75.0	73.5	21.0	28.9	0.0	23.4	403
2005	18.0	23.0	29.5	16.0	27.5	160.5	53.5	53.5	74.0	18.0	29.0	20.5	523
2006	19.5	11.5	38.0	38.0	39.8	108.0	32.0	30.0	118.0	32.5	18.0	3.5	489
2007	47.5	10.5	21.0	2.0	46.0	131.0	22.0	102.1	24.0	14.0	17.0	14.2	451
2008	11.5	8.0	4.0	20.5	5.0	65.5	93.0	19.5	13.0	48.0	13.5	30.0	332
2009	6.5	1.1	1.3	2.8	6.9	75.5	50.3	82.4	21.4	17.4	0.0	3.9	269
2010	0.0	0.3	0.6	72.6	128.5	169.0	46.0	43.7	87.9	12.2	22.4	3.5	587
MIN	0.0	0.3	0.6	1.8	1.5	11.4	11.9	1.0	0.6	0.4	0.0	3.5	160
MAX	47.5	36.8	42.2	72.6	147.4	169.0	142.2	102.1	118.0	67.6	38.4	33.5	587
MEAN	15.3	11.4	15.1	21.9	43.4	68.6	57.6	41.3	33.1	18.5	13.3	15.4	355

Table A4

Net Evaporation - Saskatoon in mm

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1960	-11.2	-16.8	-17.5	38.4	79.8	100.2	179.0	160.5	139.1	58.3	-10.9	-13.7	685
1961	-12.7	-28.7	-9.9	25.9	87.0	158.9	145.5	221.9	100.0	15.6	-17.3	-23.6	663
1962	-16.5	-36.8	-19.3	44.9	109.0	149.6	72.3	122.2	87.9	49.5	-13.0	-22.4	527
1963	-13.7	-26.7	-15.7	13.6	70.8	38.6	73.4	93.4	66.9	53.9	-31.5	-9.9	313
1964	-15.5	-12.7	-6.9	45.1	97.6	145.2	163.8	123.1	39.4	35.8	-4.1	-16.3	595
1965	-9.1	-16.3	-3.0	34.3	138.2	72.9	146.9	165.3	70.9	75.6	-15.5	-14.2	646
1966	-17.3	-11.2	-14.0	34.3	161.9	12.9	121.0	121.2	121.2	54.4	-23.9	-12.2	548
1967	-20.8	-9.4	-42.2	38.9	142.3	130.8	248.8	177.8	164.4	14.8	-16.5	-22.9	806
1968	-18.0	-2.8	-23.4	37.7	100.8	149.4	70.9	61.5	49.1	19.7	-3.3	-14.7	427
1969	-41.7	-15.7	-6.9	41.3	98.7	133.8	109.9	193.1	52.4	-24.7	-8.6	-19.8	512
1970	-8.9	-9.7	-31.2	29.1	121.8	9.1	120.4	175.0	123.5	41.9	-22.1	-21.6	527
1971	-25.9	-5.6	-21.1	35.6	172.4	63.6	41.6	184.2	126.6	63.1	-14.2	-33.5	587
1972	-25.9	-18.3	-21.3	72.8	96.2	155.8	100.3	162.5	119.6	64.0	-7.6	-19.1	679
1973	-4.8	-19.8	-3.6	5.5	121.2	66.2	165.5	184.2	94.1	63.7	-38.4	-32.5	601
1974	-37.1	-10.4	-35.1	34.7	25.4	128.0	156.9	106.9	93.8	62.7	-1.3	-11.7	513
1975	-22.6	-21.1	-8.1	14.2	55.1	74.3	166.7	133.9	111.5	43.1	-5.8	-13.2	528
1976	-12.4	-17.5	-17.3	38.5	163.8	76.4	107.3	197.2	117.5	63.2	-2.5	-15.2	699
1977	-7.3	-4.7	-8.5	78.8	-3.6	178.0	170.7	128.5	43.4	68.0	-11.7	-28.1	603
1978	-10.5	-4.9	-4.7	33.2	110.7	136.8	127.1	129.7	53.5	44.8	-32.0	-8.8	575
1979	-7.3	-28.7	-17.4	1.4	111.3	76.3	167.4	190.9	140.9	33.6	-4.6	-25.1	639
1980	-23.4	-14.3	-14.4	75.0	152.1	151.1	186.0	100.7	79.3	50.6	-5.4	-21.1	716
1981	-14.5	-1.6	-13.3	34.3	151.7	80.9	124.1	158.7	120.6	19.2	-2.0	-13.3	645
1982	-9.5	-4.0	-12.7	46.2	51.9	98.3	100.3	78.1	86.3	52.3	-21.4	-7.6	458
1983	-6.3	-6.0	-23.0	21.3	80.0	61.6	109.4	165.8	61.2	51.3	-26.4	-5.2	484
1984	-9.0	-1.2	-11.3	56.7	131.9	107.1	233.3	215.6	49.2	-1.5	-18.8	-14.6	737
1985	-9.8	-13.6	-9.0	-2.4	58.1	155.6	138.6	148.0	69.0	62.8	-8.2	-13.6	575
1986	-25.4	-9.4	-19.0	59.5	91.2	118.7	50.9	163.7	40.5	44.4	-13.0	-7.2	495
1987	-10.4	-13.4	-16.6	54.2	128.9	177.5	131.6	114.4	120.2	61.4	-1.2	-11.2	735
1988	-12.6	-9.8	-34.4	76.3	176.5	241.0	180.7	75.1	106.2	54.4	-7.4	-16.2	830
1989	-14.4	-5.8	-6.0	55.8	42.0	121.1	199.3	146.2	100.9	48.0	-22.9	-26.5	638
1990	-13.2	-4.8	-7.8	34.5	103.5	106.1	91.6	178.2	129.7	59.0	-21.2	-12.8	643
1991	-5.4	-14.8	-10.6	-12.5	51.5	10.2	143.4	188.8	115.9	0.2	-18.0	-13.4	435
1992	-17.6	-10.4	-3.6	48.4	92.7	161.3	94.1	124.6	65.1	34.1	-18.8	-18.2	552
1993	-3.4	-3.0	-16.4	21.2	105.3	98.3	59.3	56.7	53.0	56.7	-19.5	-8.9	399
1994	-24.9	-10.8	-2.8	54.6	25.4	78.1	98.2	69.4	125.7	35.9	-12.6	-10.0	426
1995	-11.8	-12.9	-30.0	9.7	118.4	134.1	55.4	47.6	116.9	9.1	-16.0	-22.0	398
1996	-14.0	-12.4	-12.8	13.1	51.3	55.9	18.5	149.5	54.9	41.0	-22.7	-16.6	306
1997	-15.6	-5.1	-19.3	13.1	109.8	84.2	133.7	119.8	71.4	34.6	-2.6	-5.1	519
1998	-12.5	-4.2	-9.2	62.0	149.5	71.9	123.4	152.6	97.6	-8.7	-6.5	-11.0	605
1999	-27.5	-5.9	-8.5	39.5	10.8	76.1	49.0	86.0	95.3	56.0	-5.0	-14.1	352
2000	-19.6	-12.6	-21.9	6.8	132.4	113.8	68.8	110.4	93.9	63.2	-10.1	-20.8	504
2001	-2.1	-2.9	-2.0	53.9	158.3	103.7	124.6	187.3	114.8	45.9	-6.5	-8.5	766
2002	-2.3	-6.7	-8.0	37.9	185.8	121.1	140.2	60.6	58.9	29.1	-2.4	-6.7	608
2003	-9.0	-9.9	-8.7	4.1	139.2	160.2	131.5	181.3	86.9	46.5	-4.5	-3.5	714
2004	-23.1	-12.2	-27.0	58.7	113.5	60.1	69.5	64.5	73.7	23.5	0.0	-23.4	378
2005	-18.0	-23.0	-29.5	50.8	126.3	-35.6	93.3	94.8	28.3	35.1	-29.0	-20.5	273
2006	-19.5	-11.5	-38.0	22.7	82.9	18.9	126.2	140.9	-13.3	15.1	-18.0	-3.5	303
2007	-47.5	-10.5	-21.0	59.8	85.4	10.9	134.9	51.8	67.9	32.2	-17.0	-14.2	333
2008	-11.5	-8.0	-4.0	34.2	147.4	75.5	54.1	149.9	92.5	16.2	-13.5	-30.0	503
2009	-6.5	-1.1	-1.3	54.9	139.9	90.4	128.5	92.9	98.1	41.4	0.0	-3.9	633
2010	0.0	-0.3	-0.6	-14.9	18.3	-3.1	132.8	131.6	31.6	46.6	-22.4	-3.5	316
MIN	-47.5	-36.8	-42.2	-14.9	-3.6	-35.6	18.5	47.6	-13.3	-24.7	-38.4	-33.5	273
MAX	0.0	-0.3	-0.6	78.8	185.8	241.0	248.8	221.9	164.4	75.6	0.0	-3.5	830
MEAN	-15.3	-11.4	-15.1	35.8	103.4	97.3	121.2	134.1	86.4	40.3	-13.3	-15.4	548

Appendix J
Heritage Resource Review Correspondence

Saskatchewan

Ministry of
Tourism, Parks,
Culture and Sport

Heritage Resources Branch
9th Floor, 1919 Saskatchewan Drive
Regina, Saskatchewan
S4P 4H2

(306) 787-5774
Nathan.friesen@gov.sk.ca

January 26, 2009

Our File: 09-0086

Kim Bonneau
Clifton Associates Ltd.
4 - 1925 1st Avenue North
Saskatoon SK S7K 6W1

Dear Kim Bonneau:

RE: Residential Subdivision;
R.M. of Corman Park;
W ½ 26-35-5-W3M;
HERITAGE RESOURCE REVIEW

Thank you for referring this development proposal for heritage resource review.

In determining the need for, and scope of, heritage resource impact assessment (HRIA) or other action pursuant to S. 63 of *The Heritage Property Act*, the following factors were considered: the presence of previously recorded heritage sites within or near the project area, the area's overall heritage resource potential, the extent of previous land disturbance, and the scope of proposed new land alteration.

There are no recorded sites in conflict with the proposed development. The area proposed for development has already been disturbed in the past, and exhibits low potential for intact heritage resources. Accordingly, our office has no concerns with the development proceeding as planned.

Thank you again for notifying this office.

Sincerely,

Nathan Friesen

Nathan Friesen
Archaeologist/GIS Specialist
Archaeological Resource Management

Appendix K

Traffic Impact Assessment and Correspondence

Clifton Associates Ltd.
engineering science technology

22 June 2012
File S1607.6

Grasswood Estates
4780 Prairie Lane
Grasswood, Saskatchewan
S7T 1A7

Attention: Mr. Neil Ketilson

Dear Sir:

Subject: Traffic Impact Assessment Update
Proposed Casa Grande Development
Grasswood, Saskatchewan

This letter is an update to the Traffic Impact Assessment report dated 19 January 2009 and addresses the need for a right turn lane on Highway 11 for traffic turning west on to Baker Road.

In 2009 the writer was advised that it would be likely that the Ministry of Highways would be constructing a right turn lane in the next few years since the warrant for doing was met at that time.

It now appears that the timing of the construction of this right turn lane will be further in the future. The Ministry of Highways indicates that their timing will be dependent on overall priorities and funding available for this type of project.

If you have any questions regarding this letter, please contact me.

Yours truly,

Clifton Associates Ltd.

S Armstrong.

R. Stu Armstrong, P.Eng.
SA/alg

4 – 1925 1st Avenue North
Saskatoon, Saskatchewan
Canada S7K 6W1

Tel: 306 975.0401
Fax: 306 975.1076

Clifton Associates Ltd.
engineering science technology

26 April 2012
File S1607.4

Grasswood Estates
4780 Prairie Lane
Grasswood, Saskatchewan
S7T 1A7

Attention: Mr. Neil Ketilson

Dear Sir:

Subject: Traffic Impact Assessment Update
Proposed Casa Grande Development
Grasswood, Saskatchewan

This letter is in response to a question raised at a public meeting, regarding the south access to Baker Road.

The current plan proposes an access point which is directly opposite to the access south of Baker Road to the Casa Rio development.

In our opinion, this is the safest location for access point for the following reasons:

a) Through traffic on Baker Road only has one location to deal with. Staggered access points would result in two points of possible conflict.

b) Having staggered access points would result in more conflicts between vehicles making turns into the developments on either side of the road.

If you have any questions regarding this letter please contact Clifton Associates Ltd. at 306-975-0401.

Yours truly,

Clifton Associates Ltd

S Armstrong

Stu Armstrong, P.Eng.

RSA/alg

4 – 1925 1st Avenue North
Saskatoon, Saskatchewan
Canada S7K 6W1

Tel: 306 975.0401
Fax: 306 975.1076

Clifton Associates Ltd.
engineering science technology

17 January 2012
File S1607.3

Grasswood Estates
4780 Prairie Lane
Grasswood, Saskatchewan
S7T 1A7

Attention: Mr. Neil Ketilson

Dear Sir:

Subject: Traffic Impact Assessment Update
Proposed Casa Grande Development
Grasswood, Saskatchewan

This letter is a follow up to my previous letter dated 10 January 2012. On 16 January 2012, a traffic count and further assessment was made on the traffic turning left from Baker Road and travelling north to Saskatoon. The findings of the traffic count were similar to the traffic projections used in my 10 January 2012 report.

In my opinion, the current level of service for vehicles making a left turn onto Highway No. 11 is a level of service "C". With this level of service it is unlikely that an acceleration lane would be necessary.

If you have any questions regarding this letter please contact Clifton Associates Ltd. at 306-975-0401.

Yours truly,

Clifton Associates Ltd

S Armstrong

Stu Armstrong, P.Eng.

RSA/alg

Attachments: Level of Service Analysis

4 – 1925 1st Avenue North
Saskatoon, Saskatchewan
Canada S7K 6W1

Tel: 306 975.0401
Fax: 306 975.1076

Clifton Associates Ltd.
engineering science technology

Level of Service Analysis

January 16, 2012

Traffic Assessment - Baker Road West of Highway No. 11

- Total east bound trips in 3 hour period = 99

8 south bound
5 cross trips

- Total west bound trips in 3 hour period = 53
- Only one tandem truck was observed in the 3 hour period. All other traffic was light vehicles including six school bus trips.
- Of the total east bound trips, 87 % were making a left turn at Highway No. 11.
- Peak Hourly Traffic occurred between the hours of 8:00 am and 9:00 am. A total of 43 vehicles turned left.
- During the peak traffic period the maximum vehicle queue was four.
- The maximum time to make a left turn was 60 seconds.
- The vast majority of turning movements were less than 30 seconds.
- During the peak hour period, the average time to make a left turn was approximately 20 seconds.

Level of Service for At-Grade Intersections

The Highway Capacity Manual defines level-of-service (LOS) for unsignalized intersections as a function of the average vehicle control delay:

LOS	Unsignalized Intersection	
A	$\leq$ 10 sec	Free flow
B	10-15 sec	Reasonable free flow
C	15-25 sec	Stable flow
D	25-35 sec	Approaching unstable flow
E	35-50 sec	Unstable flow
F	$\geq$ 50 sec	Forced or breakdown flow

Clifton Associates Ltd.
engineering science technology

10 January 2012
File: S1607.3

Grasswood Estates
4780 Prairie Lane
Grasswood, Saskatchewan
S7T 1A7

Attention: Mr. Neil Ketilson

Dear Sir:

Subject: Traffic Impact Assessment Update
Proposed Casa Grande Development
Grasswood, Saskatchewan

This letter is a follow up to the Traffic Impact Assessment dated 19 January 2009 for the Proposed Casa Grande Development in the R.M. of Corman Park.

The traffic count information available at the time the report was written was done in 2005. This information was updated by new traffic counts done in 2010 (see attached).

The most significant change is that the traffic count on Baker Road, just west of Highway No. 11, increased from 270 vehicles per day to 590 vehicles per day. The previous report had assumed a background traffic of 450 vehicles per day on Baker Road. With the updated traffic count, it is apparent that the warrants for a right turn lane on Highway 11 southbound are currently met.

In 10 years, the traffic on Baker Road could be approximately 730 vehicles per day. The proposed subdivision could increase the future level of traffic to 930 vehicles per day, or by 27%.

With this level of traffic the warrant for a right turn lane on Highway 11 would be somewhat higher than it currently is, as shown on the following pages.

Due to the low percentage of trucks it is felt that there is no need for an acceleration lane for vehicles making a left turn from Baker Road to the northbound lanes on Highway 11.

If you have any questions regarding this letter please contact Clifton Associates Ltd. at 975-0401.

Yours truly,

Clifton Associates Ltd

S Armstrong

Stu Armstrong, P.Eng.

RSA/ alg

Attachments: 2010 Traffic Count Program
Traffic Assessment Data
Standard Plan No. 20614: Warrants for Right Turn Lanes

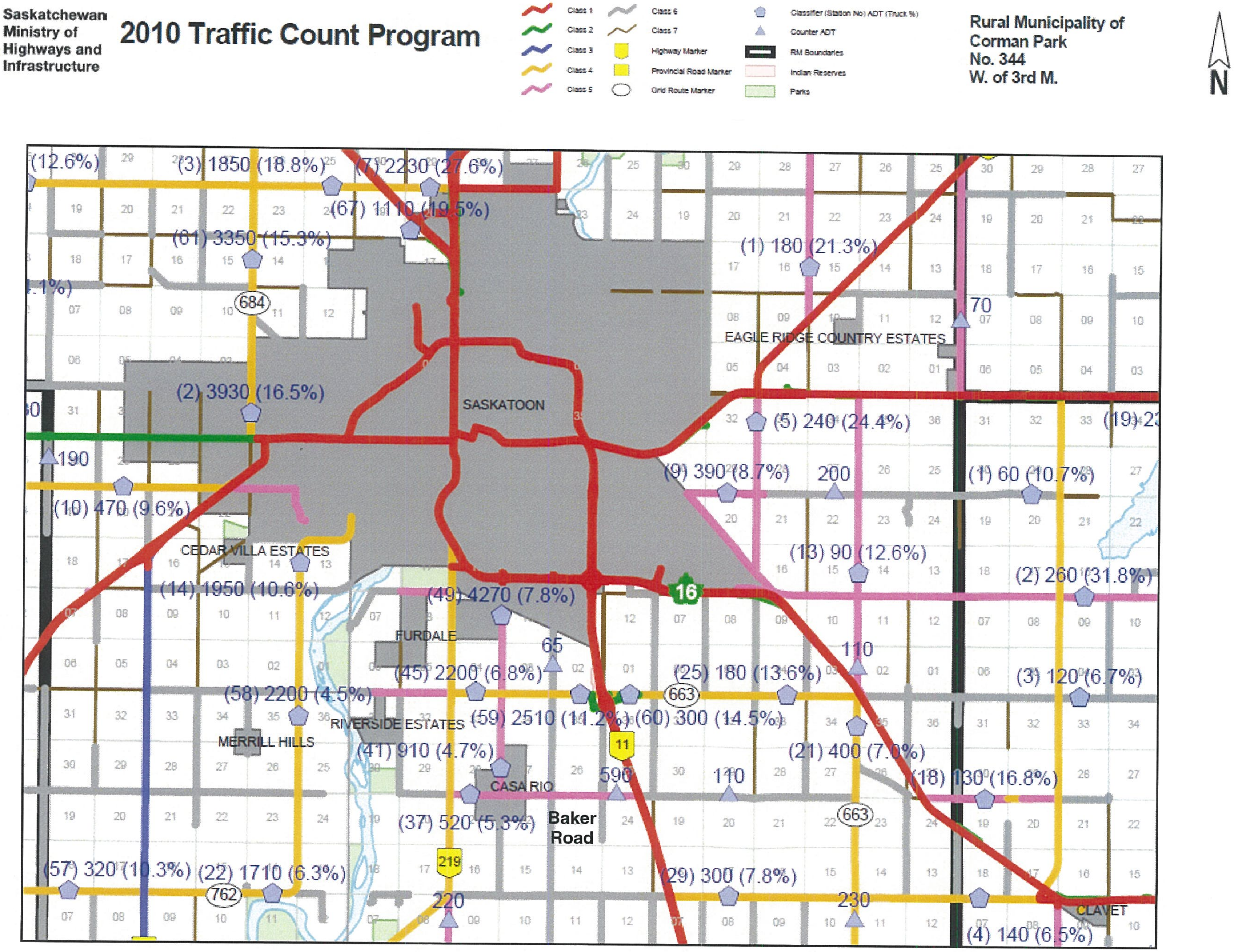
4 – 1925 1st Avenue North
Saskatoon, Saskatchewan
Canada S7K 6W1

Tel: 306 975.0401
Fax: 306 975.1076

Saskatchewan
Ministry of
Highways and
Infrastructure

2010 Traffic Count Program

Rural Municipality of
Corman Park
No. 344
W. of 3rd M.



Clifton Associates Ltd.
engineering science technology

Traffic Assessment Data

Intersection of Highway 11 and Baker Road West of Highway 11

- 2010 AADT Hwy 11 = 4940 in SB lanes
- Peak Hourly Traffic Hwy 11 = 12 % (provided by Tom Anderson of MHI) which is 593 vehicles per hour
- 2010 AADT on Baker Road = 590
- Approximate Truck Percentage = 5.0%
- Assumed peak vph on Baker road is 12% = 71 vph

Warrant for Right Turn Lane on Highway 11 Southbound

- Assume 80% to 90% of traffic on Baker Road has an origin/destination from Highway 11 to the North (use 85 %)

$$\textit{vph making right turns} = 0.85 \text{ x } 0.5 \text{ x } 71 = \mathbf{30.18}$$

$$v_A \textit{ on Highway 11 is 50\% of vph} = 0.50 \text{ x } 593 = \mathbf{296}$$

$$R = \mathrm{vr} / \mathrm{v}_A = 30.18/296 = \mathbf{0.102}$$

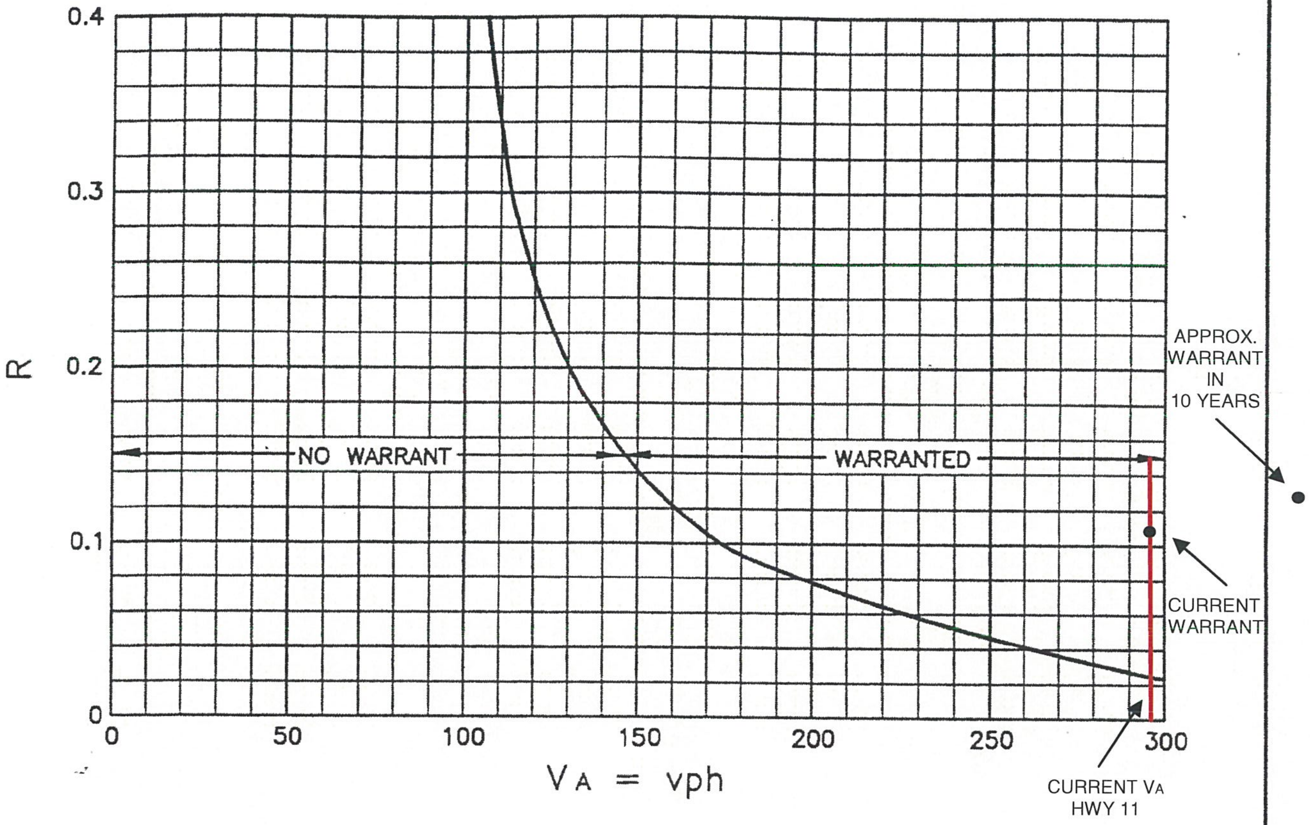
Summary

Due to existing traffic counts , **the warrant for a right turn lane is currently met** (see attached Standard Plan 20614).

In 10 years traffic on Highway 11 and traffic on Baker Road will increase by approximately 20 to 25% even without the new subdivision. The impact of the new subdivision is that the traffic count on Baker Road would increase by 200 vehicles per day over and above other traffic using Baker Road.

Traffic Projections in 2020 are summarized as follows :
Hwy 11 SB lanes = 6000
Baker road west of Hwy 11 without new subdivision = 730
Baker road west of Hwy 11 if subdivision is fully developed = 930
Vehicles per hour making right turn = 47. Vehicles advancing on Hwy 11 per lane = 359 vph.

As seen in attached Standard Plan 20614 the warrant for a right turn lane increases. However, the warrant is already met under existing traffic conditions .



Warrants are based on Design Hourly Volumes

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

V_R = Right Turn Volume, vph.

$R = V^R/V^A$

Warrants: NON FLARED INTERSECTION – Provide 3.7 m turning lane.
FLARED INTERSECTION – Lengthen deceleration lane to meet the right turn lane standard.

LAST REV DATE: FEB.14,1995

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	1 of 2

ACAD DWG: 20614-1

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

From: Darren Hagen [durban@sasktel.net]
Sent: Wednesday, May 02, 2012 9:36 AM
To: Maggie Schwab; Jim Walters
Cc: 'Neil Ketilson'; martyfletcher@ued.ca; 'Richard King'; urbele
Subject: FW: South Access to Baker Road

Hi Maggie/Jim,
Below please find an update from Stu Armstrong concerning the traffic on Preston Ave. I think we need to include this as it will address an inquiry or concern from the RM (Rebecca).
Thank you.
dth

From: Stu Armstrong [mailto:stu_armstrong@clifton.ca]
Sent: May 2, 2012 9:27 AM
To: Neil Ketilson
Cc: Cindy Friesen; Jorge Ortiz; durban@sasktel.net
Subject: Re: South Access to Baker Road

Hi Neil

No traffic count was taken on Preston Avenue (Or on Baker Road)
We used prior RM counts from 2005 for Baker Road which was 260 ADT and assumed 450 ADT due to knowing that growth had occurred (Note that our report was done in 2009)

The RM 2010 traffic count map was released in 2011 -- It shows a count of 590 ADT just west of Hwy 11 . This includes some traffic whuch is generated from the subdivisions just to the West so I would estimate that the 2010 traffic count on Baker near the proposed development would be approximately 500 ADT as opposed to the 450 which we had used in our report

The assumption of existing traffic on Preston Ave was 200 ADT based on comparisons with other roads since there was no count available

(In 2009 I asked you about doing traffic counts and you advised us to apply our best judgement .)

I feel that even though no count was done on Preston Avenue that the assumption of 200 ADT (Average daily traffic) is a reasonable estimate and may even be on the high side .

The other assumption made in the report was that traffic on roads in the area would probably increase by 50% in the next 10 years .

This assumption was not based on any development plans of the area since no plans were available. The 50% estimate was an assumption that general traffic growth would probably be 4 to 5% per year which is a higher than normal growth rate .

Since the RM has done additional studies on these roads recently they may now have better information available

In terms of the split of traffic from the proposed subdivision I had assumed a 50-50 split using each exit

Based on the current layout and roads I would now assume that 60% woulkd use the south exit .. This is not that significant in terms of its total impact on Baker road traffic ,

The bottom line here is that in the last 3 years there have been some changes and some new data available . If the RM sees the whole assessment could be updated but that costs money

We can discuss this further -- I understand that you may be available for a meeting later today
On Fri, Apr 27, 2012 at 11:18 AM, Neil Ketilson <nketilson@saskpork.com> wrote:

Thanks Stu, the letter looks fine.

With respect to the E W internal road, would the removal of the internal road at the north end make a significant difference in traffic flow and or its implications?

If not maybe we leave the report as is.

Also we had a question about the whether a traffic count had been done or considered for Preston Ave and either results /Implications or a response as to why it was not done. Could you provide a response to that question.

Thank s

Neil

From: Stu Armstrong [mailto:stu_armstrong@clifton.ca]
Sent: April-27-12 9:13 AM
To: Neil Ketilson
Cc: Cindy Friesen; Jorge Ortiz
Subject: South Access to Baker Road

A. Attached is a letter regarding the safety of the south acess point which is currently proposed . This location should not be unsafe.

Please advise if you feel that additional comments are required

B. Another thing we noticed is that the current layout does not include an E-W internal road which connects to the west exit to Preston Avenue . This may have some bearing on the choices made for travel routes.

In my previous report I had assumed that approx 50% of the traffic would use each access/exit . With the current layout I would think that 60% may use the south exit and 40% may use the west exit . However this is a guess since a lot of the traffic may be destined to the Stonegate shopping areas and for many of the residents it would be a shorter distance to use the west access and travel north on Preston to Grasswood. Road conditions may also be a factor which affects the choices made by residents on their travel routes.

Please adivise if you would want us to amend the previous report

--
Work Smart, Work Safe.
Stu Armstrong, P.Eng.,
Senior Project Engineer

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Work Smart, Work Safe.
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Traffic Impact Assessment
Proposed Casa Grande Development
RM of Corman Park W1/2 26-35-5-W3rd

RM of Corman Park, Saskatchewan

File S1607.2 19 January 2009

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1.0 Introduction

This report presents an overview of the future road and traffic impact which would arise if the proposed 85 lot development proceeds in the S1/2-26-35-5-3 in the R.M. of Corman Park.

It is anticipated that eventually 85 new permanent residences would be constructed in the proposed development.

Traffic from/to the development would have direct access to Baker Road on the south and to Preston Avenue on the west side of the development.

2.0 Overview of Study Area

The study area is bounded by Highway 219 on the west and Highway 11 to the east. Since almost all the traffic generated will be from/to Saskatoon the study area is bound by Baker Road on the south and the city boundary to the north.

Currently Grasswood Road and Baker Road which are under the jurisdiction of the R.M. of Corman Park are paved. Other north-south roads are gravel roads with the exception of the Clarence Avenue extension which is also paved.

Traffic on roads in this area has increased significantly in recent years due to rural residential developments and due to traffic to the Whitecap golf course and casino. The Stonegate commercial development on the south side of Saskatoon has also changed traffic patterns in the area.

3.0 Traffic Counts in Study Area

Unfortunately there are no recent traffic counts on municipal roads in this area. Appendix B shows traffic count information from 2005. At that time the average daily traffic (ADT) on Baker road west of Highway 11 was 270 vehicles per day. For purpose of this report it is assumed that the current ADT on Baker Road would be approximately 450 vehicles per day. It is likely that the ADT on the Preston Avenue extension adjacent to the proposed development is approximately 200 vehicles per day.

There is a 4-way stop on Baker Road at the intersection with Preston Avenue.

Due to developments in this area it is expected that traffic on roads in this area will increase by approximately 50% in the next 10 years.

4.0 Traffic Generation from Proposed Development

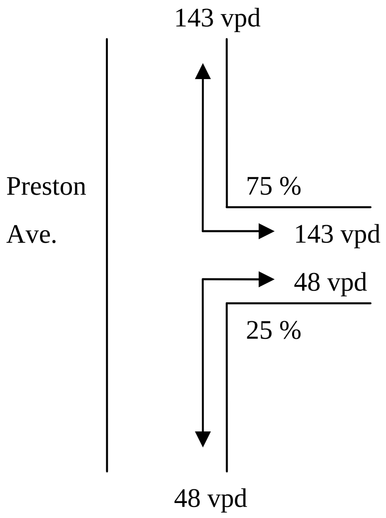
According to the Institute of Traffic Engineers (ITE) Trip Generation, 7th Edition, a residential subdivision will typically generate between 9 and 10 vehicle trips per day per dwelling. For purposes of this report 9 trips per day which is 4.5 return trips per day per lot in each direction are being used.

An 85 lot residential area will generate an ADT of 85 x 9 = 765 vehicles per day if all traffic uses only one road.

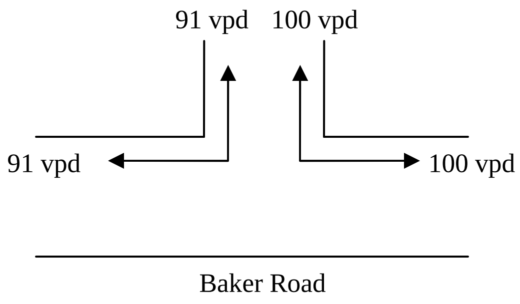
With the proposed development it is estimated that one half of the traffic would use the south access and one half would use the west access.

Estimated directional flows are shown below.

West Access



South Access



When the full development is completed the impact would be approximately as follows:

- The ADT on Baker Road east of the south access would increase from 450 x 1.5 = 675 vpd to 875 vpd.

- The ADT on Preston Avenue north of the west access would increase from 200 x 1.5 = 300 vpd to 586 vpd.

5.0 Impact on Transportation Infrastructure

If the proposed development and other developments in the area proceed the RM of Corman Park will incur some additional road maintenance costs. At some point it may be necessary to resurface Baker Road. However this will be necessary at some point in the future even if the proposed development does not take place.

The Ministry of Highways and Infrastructure currently have a tentative plan to construct a right turn lane on Highway 11 to Baker Road in 2010 or 2011.

If the development proceeds there may be some demand to surface Preston Avenue from the west access point north to connect to the Grasswood Road which is a distance of 1.3 miles.

6.0 Summary

The proposed development will obviously have some impact on traffic levels on adjacent roads. For the most part the existing infrastructure is adequate to accommodate additional traffic. However in the long term the RM of Corman Park will incur increased costs for road maintenance and resurfacing. These costs will probably be offset by tax revenues to the municipality since the proposed development is only one contributing factor to the need for road maintenance and future upgrading.

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Appendix A

5.00
EXISTING YARD
LOT 17
3.04 ACRES
LOT 18
2.9 ACRES
LOT 19
2.17 ACRES
LOT 20
2.37 ACRES
LOT 16
3.87 ACRES
30m WIDE ROAD
LOT 21
2.04 ACRES
LOT 72
4.65 ACRES
LOT 71
4.24 ACRES
LOT 70
4.18 ACRES
LOT 69
3.99 ACRES
LOT 73
3.15 ACRES
LOT 15
2.59 ACRES
LOT 22
1.58
ACRES
20m WIDE PATH
LOT 68
2.24 ACRES
LOT 74
2.68 ACRES
LOT 75
2.96 ACRES
20m WIDE PATH
LOT 67
3.52 ACRES
LOT 23
3.15 ACRES
LOT 14
3.59 ACRES
LOT 66
2.6 ACRES
LOT 24
2.01 ACRES
30m WIDE ROAD
LOT 25
2.61 ACRES
LOT 13
3.11 ACRES
LOT 76
2.62 ACRES
LOT 65
1.83 ACRES
LOT 26
2.94 ACRES
LOT 27
2.94 ACRES
30m WIDE ROAD
30m WIDE ROAD
EXISTING
YARD
30m WIDE ROAD
20m WIDE PATH
LOT 12
2.74 ACRES
LOT 28
2.83 ACRES
LOT 77
1.5
ACRES
LOT 64
3.72 ACRES
LOT 29
3.94 ACRES
LOT 11
3.74 ACRES
LOT 78
3.96 ACRES
LOT 10
2.56 ACRES
LOT 63
2.88 ACRES
LOT 30
3.35 ACRES
5.00
EXISTING YARD
LOT 9
2.66 ACRES
LOT 62
1.55 ACRES
LOT 79
1.62
ACRES
LOT 61
1.42 ACRES
LOT 31
3.86 ACRES
LOT 60
1.46 ACRES
LOT 7
2.37 ACRES
LOT 8
2.68 ACRES
LOT 80
1.8 ACRES
LOT 45
4.92 ACRES
LOT 32
3.32 ACRES
20m WIDE PATH
LOT 59
1.77 ACRES
LOT 81
0.84 ACRES
LOT 82
1.28 ACRES
LOT 83
1.46 ACRES
LOT 6
1.95
ACRES
LOT 44
3.63 ACRES
LOT 58
ACRES
LOT 85
1.87 ACRES
LOT 84
1.64 ACRES
LOT 46
2.42 ACRES
LOT 57
.93 ACRES
LOT 33
2.59 ACRES
LOT 43
3.31 ACRES
30m WIDE ROAD
30m WIDE ROAD
LOT 5
2.37
ACRES
30m WIDE ROAD
20m WIDE PATH
LOT 42
3.42 ACRES
LOT 47
3.35 ACRES
LOT 52
1.73
ACRES
LOT 53
1.48
ACRES
LOT 56
1.93 ACRES
30m WIDE ROAD
LOT 34
2.54 ACRES
LOT 48
3.94 ACRES
LOT 41
3.84 ACRES
LOT 54
1.2 ACRES
LOT 55
1.42 ACRES
LOT 51
1.6 ACRES
LOT 4
2.17 ACRES
20m WIDE PATH
LOT 35
2 ACRES
LOT 40
3.57 ACRES
LOT 3
2.57 ACRES
LOT 50
1.55 ACRES
LOT 49
1.24 ACRES
LOT 39
2.55 ACRES
30m WIDE ROAD
LOT 36
3.5 ACRES
20m WIDE PATH
LOT 2
2.55 ACRES
LOT 1
2.21 ACRES
EXISTING
YARD
5.00
LOT 38
2.71 ACRES
LOT 37
2.61 ACRES
5.00
2

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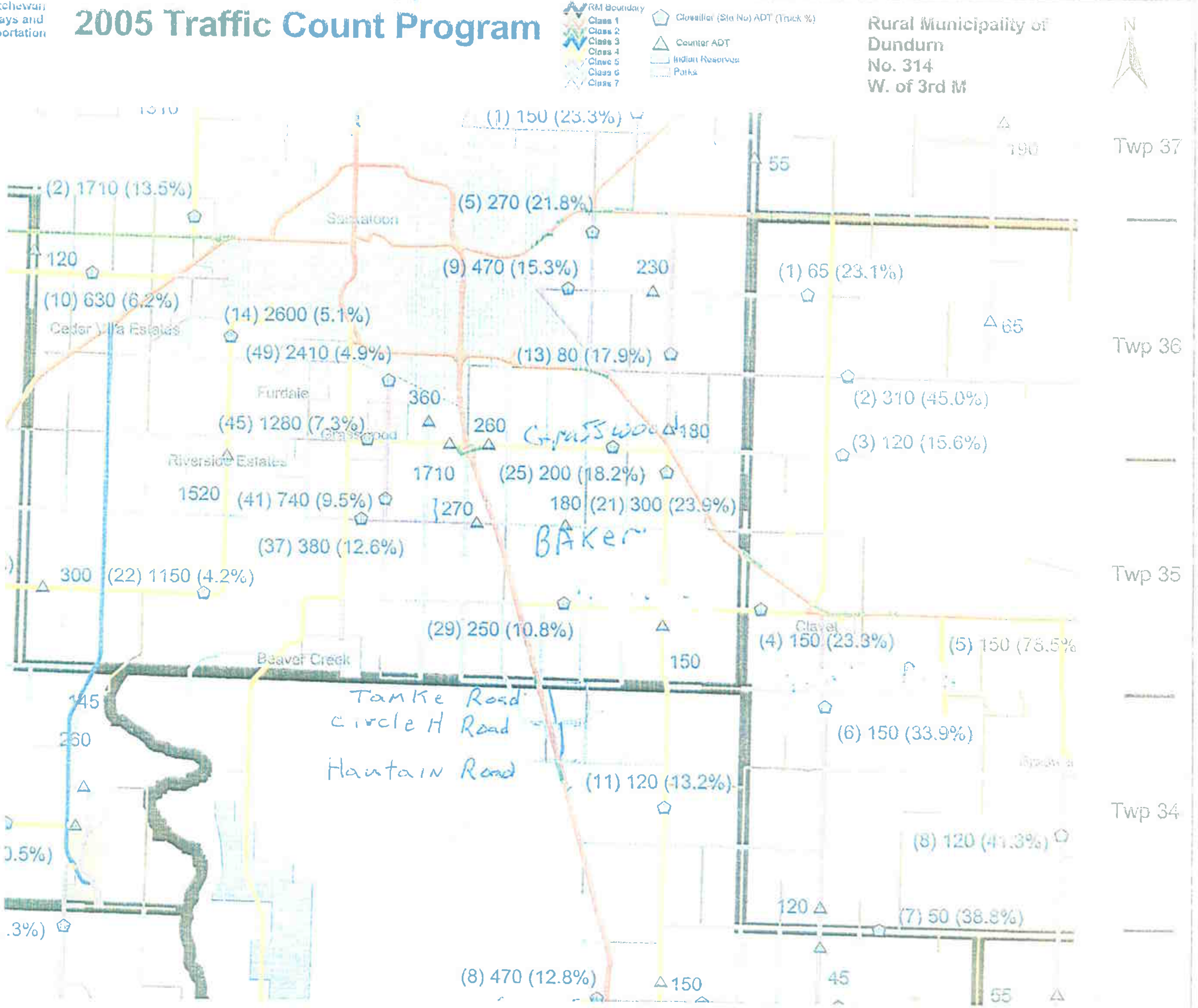
Appendix "B"

Saskatchewan
Highways and
Transportation

2005 Traffic Count Program

Rural Municipality of
Dundurn
No. 314
W. of 3rd M



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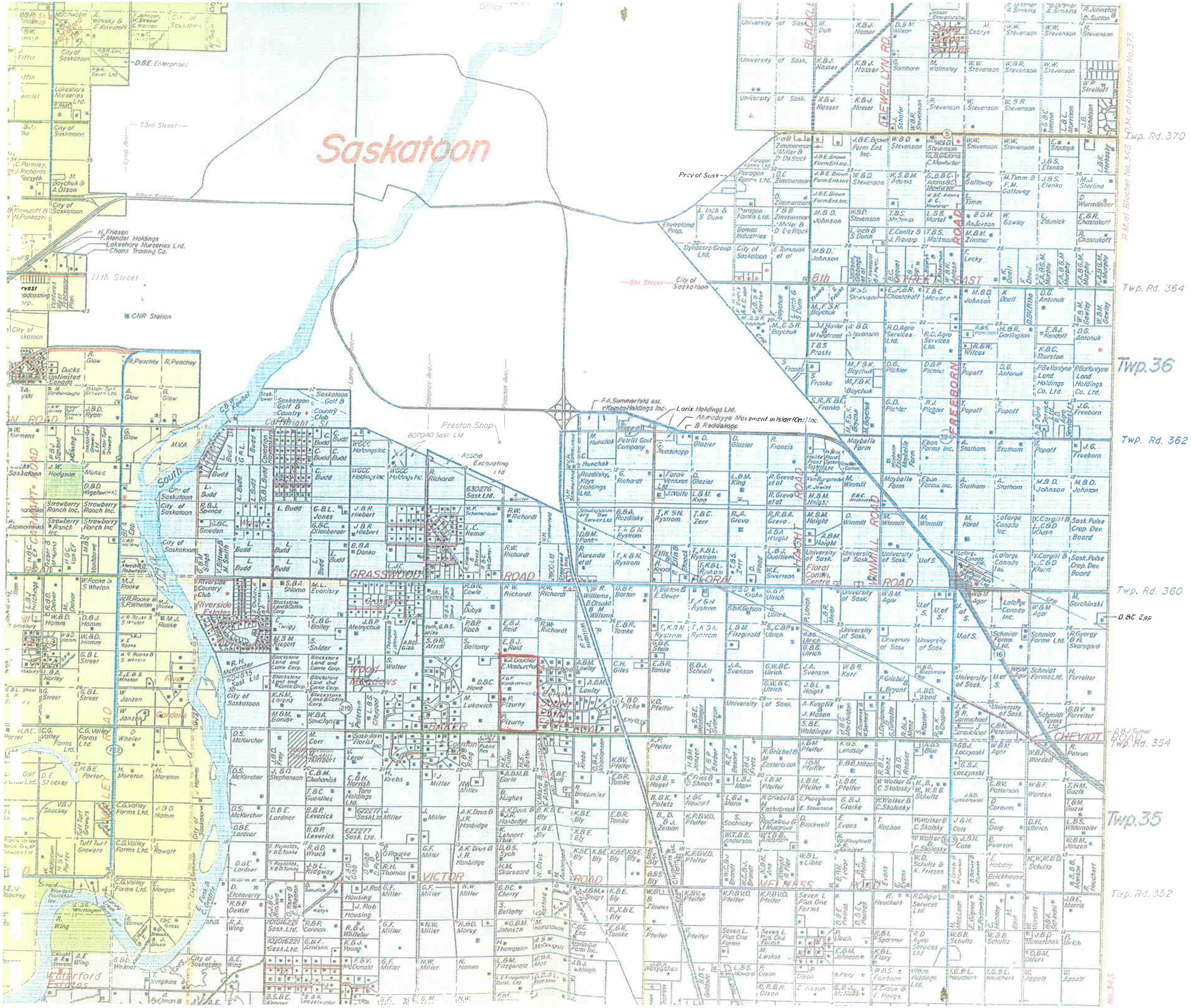
Appendix C



Saskatoon
Office
33rd Street
22nd Street
11th Street
CNR Station
D.B.E. Enterprises
H. Friesen
F. Mendel Holdings
Lakeshore Nurseries Ltd.
Chans Trading Co.
Lorne Ave.
Clarence Ave.
Preston Ave.
Preston Shop
607040 Sask. Ltd
Assiniboia Excavating Ltd
F.A. Sommerfeld est.
Kemco Holdings Inc.
Larix Holdings Ltd.
Ahmadiyya Movement in Islam (Ont) Inc.
B. Reddekopp
Prov of Sask
8th Street
City of Saskatoon
8th STREET EAST
Twp. Rd. 370
Twp. Rd. 364
Twp. 36
Twp. Rd. 362
Twp. Rd. 360
Twp. Rd. 354
Twp. 35
Twp. Rd. 352
R.M. of Aberdeen No. 373
R.M. of Blucher No. 343
LLEWELLYN RD.
BLACKLEY
FREEBORN
HAIGHT ROAD
GRASSWOOD ROAD
FLORAL ROAD
BAKER ROAD
CHEVIOT ROAD
VICTOR ROAD
CARTWRIGHT ROAD
VALLEY ROAD
Saskatoon Golf & Country Club
Riverside Country Club
Riverside Estates
Wood Meadows
Waterford Estates
South
D.B.J. Epp
B&J Turner

Appendix L
Road Standards

PW – 12

Policy Name: Road Servicing Agreements

Date Adopted: June 13, 2011

Policy Objective: To provide a uniform approach for specifications and requirements for roads constructed as a condition of subdivision or issuance of a development permit.

Policy:

1. The road design guidelines herein generally follow the most recent Transportation Association of Canada (TAC) and Saskatchewan Ministry of Highways and Infrastructure design standards. The Municipality may consider alternate design variations from these standards to accommodate unique site circumstances, provided that public safety and the Municipality are not at risk. It is the Developer’s responsibility to ensure that the design, construction, and performance of all infrastructure constructed under the Development or Servicing Agreement meets or exceeds these standards/guidelines.

2. Good engineering practice and design is required for all road construction situations.

3. All road design and construction must be certified by and performed under the supervision of a qualified professional engineer registered to practice in the Province of Saskatchewan. The design guidelines in this section are minimum requirements and the Developer’s Engineer must certify that an adequate roadway structure is provided to the Municipality, both in design and as constructed. Where required, a complete traffic analysis may dictate the need for additional engineering.

4. Design and construction practices shall take into consideration site specific conditions which might cause deviation from standard practice. Such deviations must be approved by the Municipality prior to entering into a Development or Servicing Agreement.

5. All roadways constructed within the Municipality shall be constructed according to the design requirements appended to this policy based upon the rural road classifications provided below:

    - Main Farm Access Road
    - Grid Road
    - Primary Grid Road
    - Heavy Haul – High Volume Road
    - Internal Commercial Industrial Road
    - Internal Residential Road

6. Prior to initiating road construction the Developer shall be required to submit a formal written request to Council indicating the location and length of roadway construction being requested; and subject to receiving written approval from Council the Developer shall be required to enter into a Development or Servicing Agreement defining the financial security required by the Municipality as well as the staged release of this security. Generally security shall be calculated based upon 125% of the construction cost estimate prepared by a certified engineer prepared in support of the development.

7. Where security is required, it shall be provided in the form of Cash or Unconditional Letter of Credit from a local branch of a chartered bank or Credit Union.

8. Upon completion of construction and submission of as-built drawings, an inspection shall be undertaken by the Municipal Engineer and if no deficiencies have been identified, a Construction Completion Certificate (CCC) shall be issued and the maintenance period shall commence.

9. Upon issuance of a CCC, the maintenance period for a paved road development is two years.

10. Upon issuance of a CCC, the maintenance period for a gravel road development is one year.

11. The Municipality will retain financial security of sufficient amount to ensure repair to any deficiencies which might arise during the maintenance period. At the end of the maintenance period and repair of deficiencies, the Municipality shall release securities and issue a Final Acceptance Certificate (FAC).

12. Financial security shall not be required for condominium road developments but building permits shall not be issued until a FAC has been issued confirming that the roadway has been properly constructed.

13. CCC's and FAC's applied for after October 1st may not be considered for an inspection and issuance until the following spring after snow thaw.

Main Farm Access Road Program	Required Construction Standards
	Subject: Main Farm Access Road - Gravel

SUMMARY OF BASIC STANDARDS

Right-of-way width = 30 meters (purchased).

Full width of right-of-way to be cleared.

The standard basic finished top width for main farm access roads is 7.0 meters.
Top width for curves = 7.6 meters.

Sideslopes = 3:1
- fills 2 – 3 meters = 7.6 m top width
- fills over 3 meters = 8.0 m top width

Backslopes
- 5:1, with maximum of 3:1
- 5:1 backslope is to be maintained until top of backslope reaches the edge of right-of-way. The backslope will remain at the edge of the right-of-way to a maximum of 3:1.

Snowclearance – When shoulder grade elevation is 0.3 meters or less above natural surface at 15.0 meters to 20.0 meters from center line then the backslope must be flattened using a variable slope of 5:1 to a maximum of 3:1.

Maximum gradient – 9%. In unusual circumstances – 11%.

Stopping sight distance – 85 meters minimum.

Clear vision at road intersection – minimum of 85 meters from the point of intersection on municipal roads and grid intersections and to a maximum of 140 meters on main farm access roads using 60 km/h design speed.

Main Farm Access Road Program	
Required Construction Standards	Subject: Main Farm Access Road - Gravel

1. Shall include the installation of all necessary drainage structures and construction of drainage ditches. Culverts should be designed for at least a Q^{15} flow, with a minimum culvert size of 500 mm diameter. Riprap only where

necessary to avoid undue erosion. All culverts will be constructed of metal unless approved by the Municipality prior to construction.

2. Construction shall include all road connections and approaches. See attached plan – Standard Approach.

3. The average shoulder elevation of the road surface to be approximately 0.5 meters above the adjacent ground surface, except in cuts.

4. Objectionable organic material shall be subcut where the fill is less than 0.3 meters in depth.

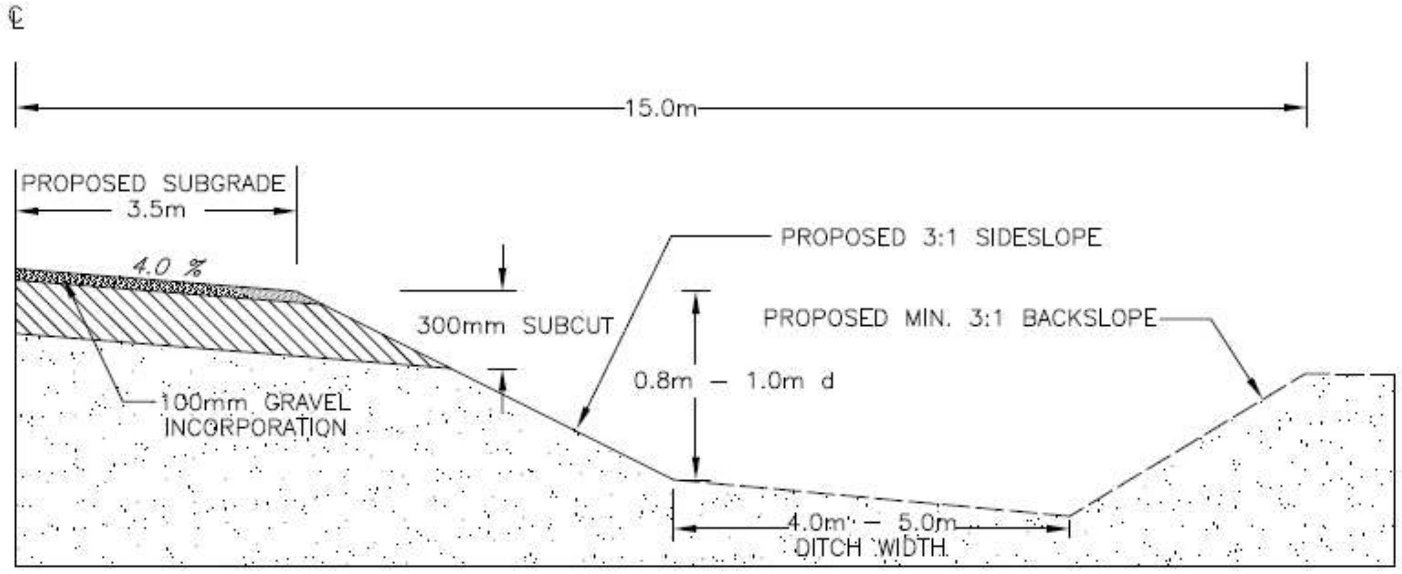
5. The subgrade surface shall not be less than 1.0 meters above high water level on the ground water table. (ie: level to which free water would rise in a hole sunk in the ground).

6. Road surface, sideslopes, ditches and backslopes shall be bladed smooth to conform to the typical cross-section.

7. Where necessary to provide a smooth, stable driving surface, the road shall be capped with a layer of clay material. The depth of clay cap shall be a minimum of 0.3 meters. Gravel shall be incorporated in the top 100 mm of the subgrade prior to traffic gravel being applied. Gravel incorporation shall be done according to the Municipal Specification attached. The gravel specification for incorporation is Type 103 or 104.

8. Gravel surfacing for the subgrade required at the rate of 180 m^3/km for the first application, 150 m^3/km for the year following construction and additional applications as required. The required gravel specification for traffic gravel is Type 106 or 108.

9. Alignment – curves must be constructed with the proper super-elevation using 80 km/hr design speed and emax = 0.08.
   – minimum radius of curvature = 250 m, preferred radius = 300 m.



RM OF
CORMAN PARK
#344

PUBLIC WORKS
MAIN FARM ACCESS - TYPICAL CROSS SECTION SUBGRADE

DATE: 2011

SCALE: NTS

DRAWN BY: AMEC E & E

Grid Road Program	Required Construction Standards
	Subject: Grid Road - Gravel

SUMMARY OF BASIC STANDARDS

Right-of-way width = 42 meters (purchased). With municipal approval = 30 meters (purchased).

Full width of right-of-way to be cleared.

The standard basic finished top width for grid roads is 8.0 meters.

Sideslopes = 4:1
- fills 0 – 3 meters = 4:1
- fills 3 meters to 4 meters - toe of slope to be 12.0 meters from shoulder
- fills over 4 meters = 3:1

Backslopes
- 5:1, with maximum of 3:1
- 5:1 backslope is to be maintained until top of backslope reaches the edge of right-of-way. The backslope will remain at the edge of the right-of-way to a maximum of 3:1.

Snowclearance – When shoulder grade elevation is 0.3 meters or less above natural surface at 15.0 meters to 21.0 meters from center line then the backslope must be flattened using a variable slope of 5:1 to a maximum of 3:1.

Maximum gradient – 9%. In unusual circumstances – 11%.

Stopping sight distance – 140 meters minimum (for 80 km/h design).

Clear vision at road intersection – minimum of 85 meters from the point of intersection on municipal roads and grid intersections and to a maximum of 140 meters on main farm access roads using 80 km/h design speed.

Grid Road Program	
Required Construction Standards	Subject: Grid Road - Gravel

1. Shall include the installation of all necessary drainage structures and construction of drainage ditches. Culverts should be designed for at least a Q^{15} flow, with a minimum culvert size of 500 mm diameter. Riprap only where

necessary to avoid undue erosion. All culverts will be constructed of metal unless approved by the Municipality prior to construction.

2. Construction shall include all road connections and approaches. See attached plan – Standard Approach.

3. The average shoulder elevation of the road surface to be approximately 0.5 meters above the adjacent ground surface, except in cuts.

4. Objectionable organic material shall be subcut where the fill is less than 0.5 meters in depth.

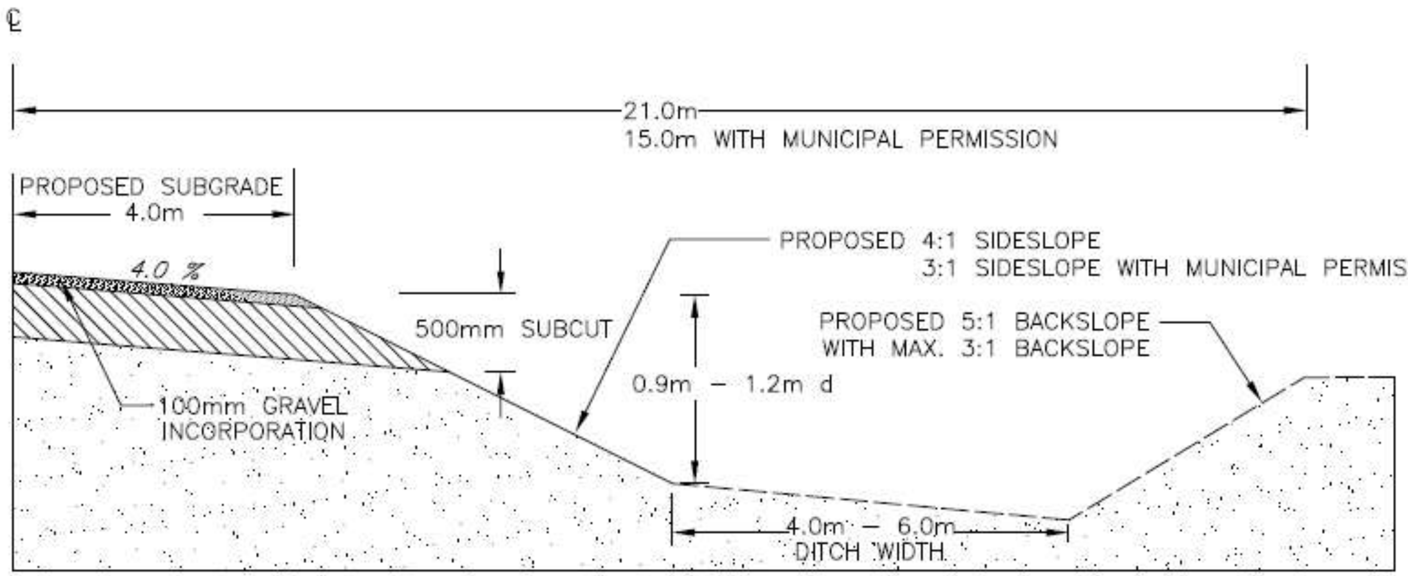
5. The subgrade surface shall not be less than 1.0 meters above high water level on the ground water table. (ie: level to which free water would rise in a hole sunk in the ground).

6. Road surface, sideslopes, ditches and backslopes shall be bladed smooth to conform to the typical cross-section.

7. Where necessary to provide a smooth, stable driving surface, the road shall be capped with a layer of clay material. The depth of clay cap shall be a minimum of 0.3 meters. Gravel shall be incorporated in the top 100 mm of the subgrade prior to traffic gravel being applied. Gravel incorporation shall be done according to the Municipal Specification attached. The gravel specification for incorporation is Type 103 or 104.

8. Gravel surfacing for the subgrade required at the rate of 180 m^3/km for the first application, 180 m^3/km for the year following construction and additional applications as required. The required gravel specification for traffic gravel is Type 106 or 108.

9. Alignment – curves must be constructed with the proper super-elevation using 80 km/hr design speed and emax = 0.08.
   – minimum radius of curvature = 300 m.



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PUBLIC WORKS
GRID ROAD - TYPICAL CROSS SECTION SUBGRADE

DATE: 2011	SCALE: NTS	DRAWN BY: AMEC E & E

Primary Grid Road Program	Required Construction Standards
	Subject: Primary Grid Road

SUMMARY OF BASIC STANDARDS

Right-of-way width = 46 meters (purchased).

Full width of right-of-way to be cleared.

The standard basic finished top width for primary grid roads is 8.6 meters for gravel surface and 8.0 meters for asphalt surfaces.

Sideslopes = 4:1
- fills 0 – 3 meters = 4:1
- fills 3 meters to 4 meters - toe of slope to be 12.0 meters from shoulder
- fills over 4 meters = 3:1

Backslopes
- 5:1, with maximum of 3:1
- 5:1 backslope is to be maintained until top of backslope reaches the edge of right-of-way. The backslope will remain at the edge of the right-of-way to a maximum of 3:1.

Snowclearance – When shoulder grade elevation is 0.3 meters or less above natural surface at 21.0 meters from center line then the backslope must be flattened using a variable slope of 5:1 to a maximum of 3:1.

Maximum gradient – 6%. In unusual circumstances – 7%.

Stopping sight distance – 140 meters minimum (for 80 km/h design).

Clear vision at road intersection – minimum of 85 meters from the point of intersection on municipal roads and grid intersections and to a maximum of 140 meters on main farm access roads using 80 km/h design speed.

Primary Grid Road Program	
Required Construction Standards	Subject: Primary Grid Road

1. Shall include the installation of all necessary drainage structures and construction of drainage ditches. Culverts should be designed for at least a Q^{15} flow, with a minimum culvert size of 500 mm diameter. Riprap only where

necessary to avoid undue erosion. All culverts will be constructed of metal unless approved by the Municipality prior to construction.

2. Construction shall include all road connections and approaches. See attached plan – Standard Approach.

3. The average shoulder elevation of the road surface to be approximately 0.5 meters above the adjacent ground surface, except in cuts.

4. Objectionable organic material shall be subcut where the fill of subgrade is less than 0.5 meters in depth for gravel surfaces and 0.6 meters in depth for asphalt surfaces.

5. The subgrade surface shall not be less than 1.5 meters above high water level on the ground water table. (ie: level to which free water would rise in a hole sunk in the ground).

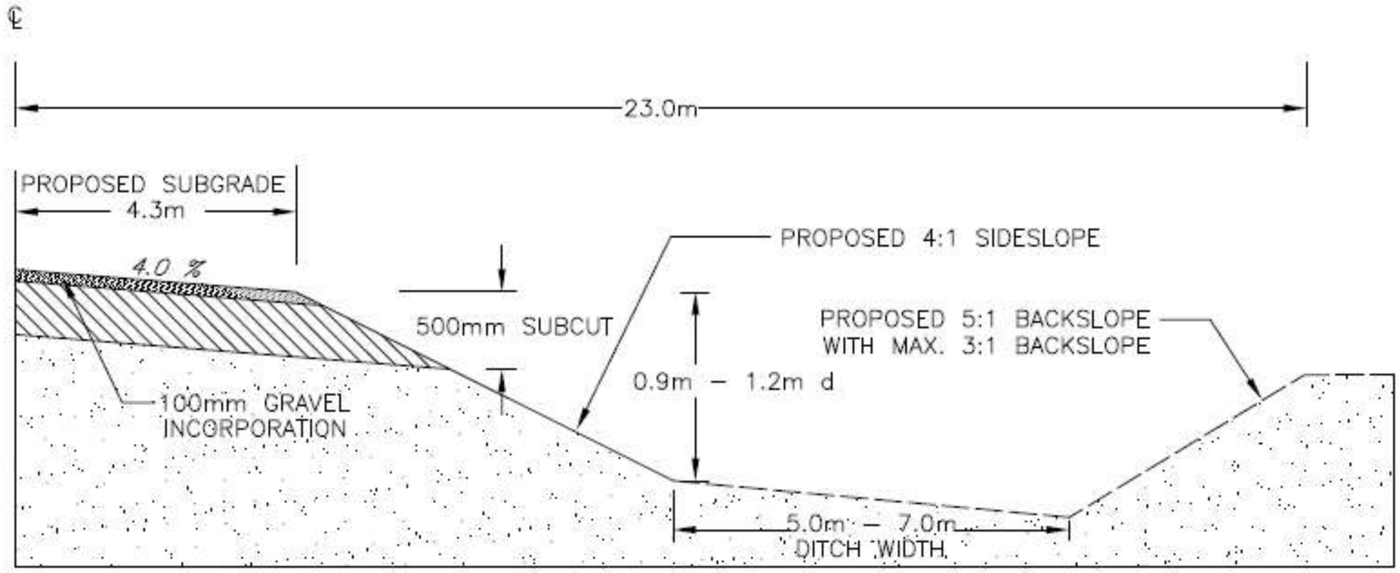
6. Road surface, sideslopes, ditches, and backslopes shall be bladed smooth to conform to the typical cross-section.

7. Where necessary to provide a smooth, stable driving surface, the road shall be capped with a layer of clay material. The depth of clay cap shall be a minimum of 0.3 meters. If the subgrade is to be surfaced clay material should be avoided if possible and a granular subgrade constructed. Gravel shall be incorporated in the top 100 mm of the subgrade prior to traffic gravel being applied. Gravel incorporation shall be done according to the Municipal Specification attached. The gravel specification for incorporation is Type 103 or 104.

8. Gravel surfacing for the subgrade required at the rate of 200 m^3/km for the first application, 200 m^3/km for the year following construction and additional applications as required. The required gravel specification for traffic gravel is Type 106 or 108.

9. Alignment – curves must be constructed with the proper super-elevation as per the Ministry of Highways & Transportation Standards.

10. Asphalt surface for Primary Grid – Soil testing is required to determine surface design. Along with the soil testing, traffic volume and vehicle configurations must be considered when selecting the surface structure.



NOTE: SUBGRADE WIDTH FOR PRIMARY GRID–SURFACED ROADS TO BE DETERMINED AFTER COMPLETION OF SURFACING DESIGN.

RM OF
CORMAN PARK
#344

PUBLIC WORKS
PRIMARY GRID - TYPICAL CROSS SECTION SUBGRADE

DATE: 2011

SCALE: NTS

DRAWN BY: AMEC E & E

SUMMARY OF BASIC STANDARDS

Right-of-way width = 46 meters (purchased).

Full width of right-of-way to be cleared.

The standard basic finished top width for heavy haul roads is 10.0 meters for gravel surface and 9.0 meters for surfaced.

Sideslopes = 4:1

- fills 0 – 3 meters = 4:1
- fills 3 meters to 4 meters - toe of slope to be 12.0 meters from shoulder.
- fills over 4 meters = 3:1

Backslopes

- 5:1, with maximum of 3:1
- 5:1 backslope is to be maintained until top of backslope reaches the edge of right-of-way. The backslope will remain at the edge of the right-of-way to a maximum of 3:1.

Snowclearance – When shoulder grade elevation is 0.3 meters or less above natural surface at 23.0 meters from center line then the backslope must be flattened using a variable slope of 5:1 to a maximum of 3:1.

Maximum gradient – 5%. In unusual circumstances – 6%.

Stopping sight distance – 200 meters minimum (for 100 km/h design).

Clear vision at road intersection – minimum of 85 meters from the point of intersection on municipal roads and grid intersections and to a maximum of 140 meters on primary grid roads using 80 km/h design speed and 200 meters for a highway on another heavy haul road using 100 km/hr design spread.

Heavy Haul Access Road Program	
Required Construction Standards	Subject: Heavy Haul Road - Gravel

1. Shall include the installation of all necessary drainage structures and construction of drainage ditches. Culverts should be designed for at least a Q^{15} flow, with a minimum culvert size of 500 mm diameter. Riprap only where necessary to avoid undue erosion. All culverts will be constructed of metal unless approved by the Municipality prior to construction.

2. Construction shall include all road connections and approaches. See attached plan – Standard Approach.

3. The average shoulder elevation of the road surface to be approximately 0.6 meters above the adjacent ground surface, except in cuts.

4. Objectionable organic material shall be subcut where the fill is less than 0.6 meters in depth.

5. The subgrade surface shall not be less than 1.5 meters above high water level on the ground water table. (ie: level to which free water would rise in a hole sunk in the ground).

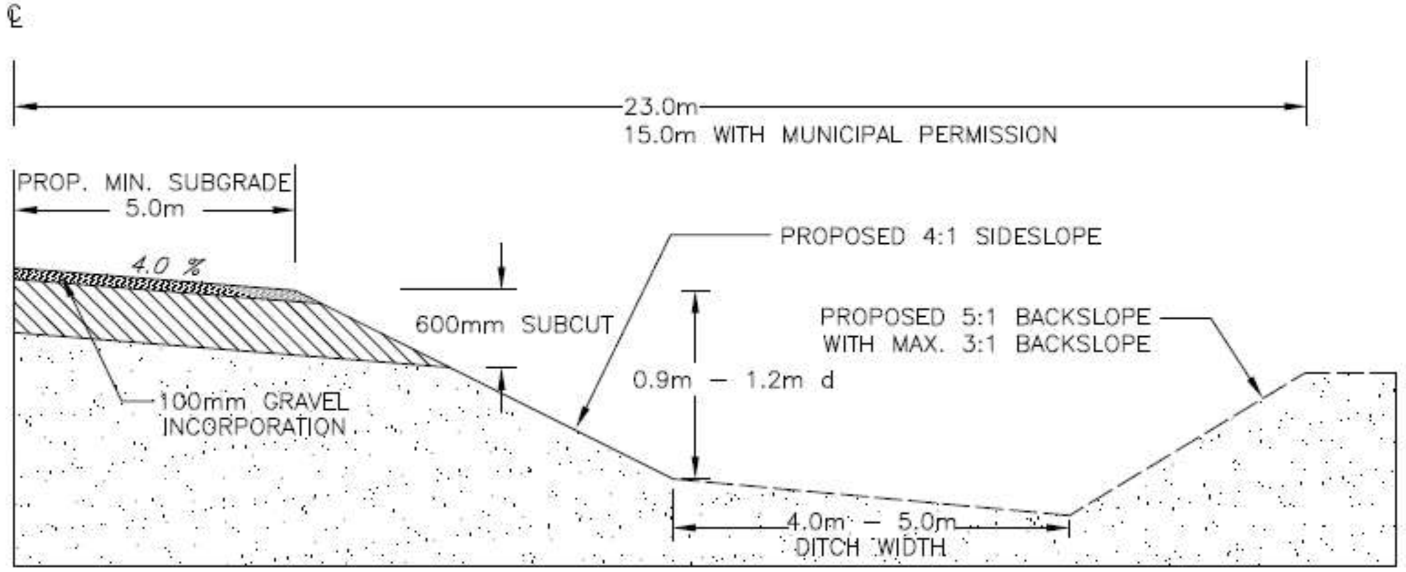
6. Road surface, sideslopes, ditches and backslopes shall be bladed smooth to conform to the typical cross-section.

7. Where necessary provide a smooth, stable driving surface, the road top shall be capped with a minimum of 0.3 meters of clay material. If the subgrade is to be surfaced clay material should be avoided if possible and a granular subgrade constructed. Gravel shall be incorporated in the top 100 mm of the subgrade prior to traffic gravel being applied. Gravel incorporation shall be done according to the Municipal Specification attached. The gravel specification for incorporation is Type 103 or Type 104.

8. Gravel surfacing for the subgrade required at the rate of 250 m^3/km for the first application, 250 m^3/km for the year following construction and additional applications as required. The required gravel specification for traffic gravel is Type 106 or Type 108.

9. Alignment – curves must be constructed with the proper super-elevation as per the Ministry of Highways & Transportation Standards.

10. Asphalt surface for heavy haul roads – Soil testing is required to determine surface design. Along with the soil testing, traffic volume and vehicle configurations must be considered when selecting the surface structure.



NOTE: SUBGRADE WIDTH FOR HEAVY HAUL—SURFACED ROADS TO BE DETERMINED AFTER COMPLETION OF SURFACING DESIGN.

RM OF
CORMAN PARK
#344

PUBLIC WORKS
HEAVY HAUL - TYPICAL CROSS SECTION
SUBGRADE

DATE: 2011	SCALE: NTS	DRAWN BY: AMEC E & E

Internal Commercial Industrial Road Program	Required Construction Standards
	Subject: Internal Commercial Industrial Road

SUMMARY OF BASIC STANDARDS

Right-of-way width = 46 meters (purchased). With municipal approval = 30 meters (purchased).

Full width of right-of-way to be cleared.

The standard basic finished top width for heavy haul roads is 10.0 meters for gravel surface and 9.0 meters for asphalt.

Sideslopes = 4:1
- fills 0 – 3 meters = 4:1
- fills 3 meters to 4 meters - toe of slope to be 12.0 meters from shoulder.
- fills over 4 meters = 3:1

Backslopes
- 5:1, with maximum of 3:1
- 5:1 backslope is to be maintained until top of backslope reaches the edge of right-of-way. The backslope will remain at the edge of the right-of-way to a maximum of 3:1.

Snowclearance – When shoulder grade elevation is 0.3 meters or less above natural surface at 15.0 meters from center line then the backslope must be flattened using a variable slope of 5:1 to a maximum of 3:1.

Maximum gradient – 5%. In unusual circumstances – 6%.

Stopping sight distance – 140 meters minimum (for 80 km/h design).

Clear vision at road intersection – minimum of 85 meters from the point of intersection on municipal roads and grid intersections and to a maximum of 140 meters on primary grid roads using 80 km/h design speed and 200 meters for a highway on another heavy haul road using 100 km/hr design spread.

Internal Commercial Industrial Road Program	
Required Construction Standards	Subject: Internal Commercial Industrial Road

1. Shall include the installation of all necessary drainage structures and construction of drainage ditches. Culverts should be designed for at least a Q^{15} flow, with a minimum culvert size of 500 mm diameter. Riprap only where necessary to avoid undue erosion. All culverts will be constructed of metal unless approved by the Municipality prior to construction.

2. Construction shall include all road connections and approaches. See attached plan – Standard Approach.

3. The average shoulder elevation of the road surface to be approximately 0.6 meters above the adjacent ground surface, except in cuts.

4. Objectionable organic material shall be subcut where the fill is less than 0.6 meters in depth.

5. The subgrade surface shall not be less than 1.5 meters above high water level on the ground water table. (ie: level to which free water would rise in a hole sunk in the ground).

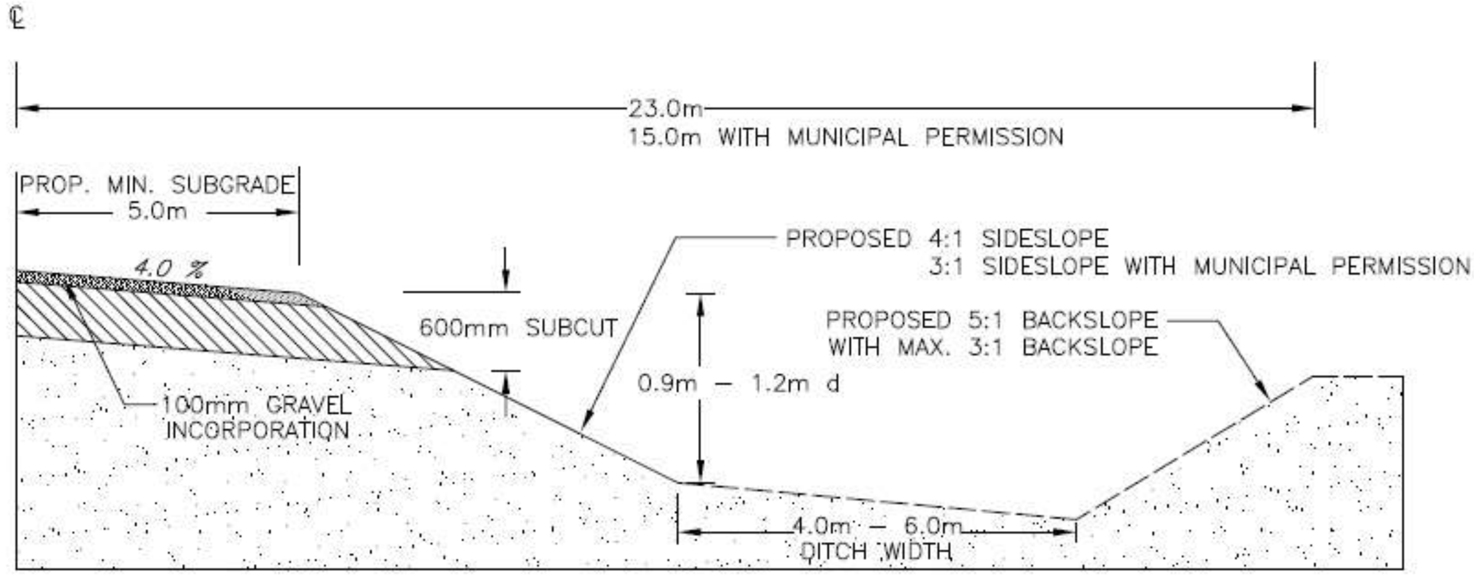
6. Road surface, sideslopes, ditches and backslopes shall be bladed smooth to conform to the typical cross-section.

7. Where necessary to provide a smooth, stable driving surface, the road shall be capped with a layer of clay material. The depth of clay cap shall be a minimum of 0.3 meters. If the subgrade is to be surfaced clay material should be avoided if possible and a granular subgrade constructed. Gravel shall be incorporated in the top 100 mm of the subgrade prior to traffic gravel being applied. Gravel incorporation shall be done according to the Municipal Specification attached. The gravel specification for incorporation is Type 103 or 104.

8. Gravel surfacing for the subgrade required at the rate of 250 m^3/km for the first application, 250 m^3/km for the year following construction and additional applications as required. The required gravel specification for traffic gravel is Type 106 or Type 108.

9. Alignment – curves must be constructed with the proper super-elevation as per the Ministry of Highways & Transportation Standards.

10. Asphalt surface for Internal Commercial Industrial Roads – Soil testing is required to determine surface design. Along with the soil testing, traffic volume and vehicle configurations must be considered when selecting the surface structure.



NOTE: SUBGRADE WIDTH FOR INTERNAL COMMERCIAL–SURFACED ROADS
TO BE DETERMINED AFTER COMPLETION OF SURFACING DESIGN.

RM OF
CORMAN PARK
#344

PUBLIC WORKS
INTERNAL COMMERCIAL INDUSTRIAL ROADS
TYPICAL CROSS SECTION
SUBGRADE

DATE: 2011	SCALE: NTS	DRAWN BY: AMEC E & E

SUMMARY OF BASIC STANDARDS

Right-of-way width = 30 meters (purchased).

Right-of-way width for cul-de-sac and turnabouts = 60 meters (purchased) with 15 meters radius on driving surface.

Full width of right-of-way to be cleared.

The standard basic finished top width for subdivision roads is 7.4 meters. On fills over 3 meters in height, the top width is to be a Minimum of 0.6 meters wider than the basic top width.

Top widths should be widened as follows:
- Fills 0 meters to 3 meters – 7.4 meter finished top width
- Fills over 3 meters – 8.0 meter finished top width

Sideslopes
- 3:1 only with permission from the municipality.
- 4:1 Preferred:
  - fills 0 – 3 meters = 4:1
  - fills 3 meters to 4 meters - toe of slope to be 12.0 meters from shoulder.
  - fills over 4 meters = 3:1

Backslopes
- 5:1, with maximum of 3:1
- 5:1 backslope is to be maintained until top of backslope reaches the edge of right-of-way. The backslope will remain at the edge of the right-of-way to a maximum of 3:1.

Snowclearance – When shoulder grade elevation is 0.3 meters or less above natural surface at 15.0 meters to 20.0 meters from center line then the backslope must be flattened using a variable slope of 5:1 to a maximum of 3:1.

Maximum gradient – 5%. In unusual circumstances – 6%.

Stopping sight distance – 140 meters minimum (for 80 km/h design).

Clear vision at road intersection – minimum of 85 meters from the point of intersection on municipal roads and grid intersections and to a maximum of 140 meters on primary grid roads using 80 km/h design speed.

Subdivision Road Program	
Required Construction Standards	Subject: Subdivision And Special Roads Gravel

1. Shall include the installation of all necessary drainage structures and construction of drainage ditches. Culverts should be designed for at least a Q^{15} flow, with a minimum culvert size of 400 mm diameter. Riprap only where necessary to avoid undue erosion. All culverts will be constructed of metal unless approved by the Municipality prior to construction.

2. Construction shall include all road connections and approaches. See attached plan – Standard Approach.

3. The average shoulder elevation of the road surface to be approximately 0.5 meters above the adjacent ground surface, except in cuts.

4. Objectionable organic material shall be subcut where the fill is less than 0.5 meters in depth.

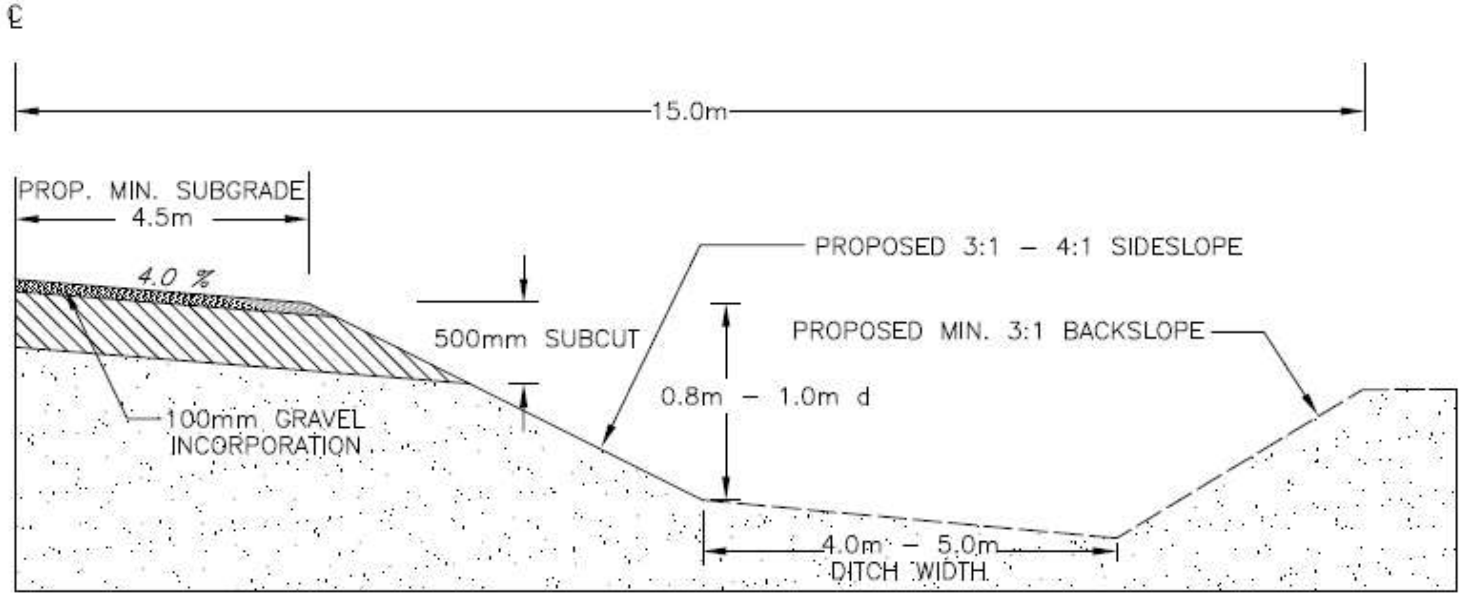
5. The subgrade surface shall not be less than 1 meter above high water level on the ground water table. (ie: level to which free water would rise in a hole sunk in the ground).

6. Road surface, sideslopes, ditches and backslopes shall be bladed smooth to conform to the typical cross-section.

7. Gravel shall be incorporated in the top 100 mm of the subgrade prior to traffic gravel being applied. Gravel incorporation shall be done according to the Municipal Specification attached. The gravel specification for incorporation is Type 103 or Type 104.

8. Gravel surfacing for the subgrade required at the rate of 100 m^3/km for the first application, 100 m^3/km for the year following construction and additional applications as required. The required gravel specification for traffic gravel is Type 106 or Type 108.

9. Alignment – curves must be constructed with the proper super-elevation.



NOTE: SUBGRADE WIDTH MAY BE WIDER IF SOIL TESTING DETERMINES ADDITIONAL SUBBASE MATERIAL IS REQUIRED.

RM OF
CORMAN PARK
#344

PUBLIC WORKS
SUBDIVISION - TYPICAL CROSS SECTION
SUBGRADE

DATE: 2011	SCALE: NTS	DRAWN BY: AMEC E & E

Road Program	
Municipal Specification	Subject: Gravel Incorporation Specification

SPECIFICATION FOR GRAVEL INCORPORATION

DESCRIPTION

The work will consist of traffic gravel uniformly mixed with the insitu material in the top of the subgrade.

MATERIALS

1. The gravel will be supplied, hauled and placed on the road by the developer.

2. The gravel will meet Type 103 or Type 104 specifications.

3. The gravel will be mixed with insitu material from the top of the subgrade.

4. A water source will be supplied by the developer.

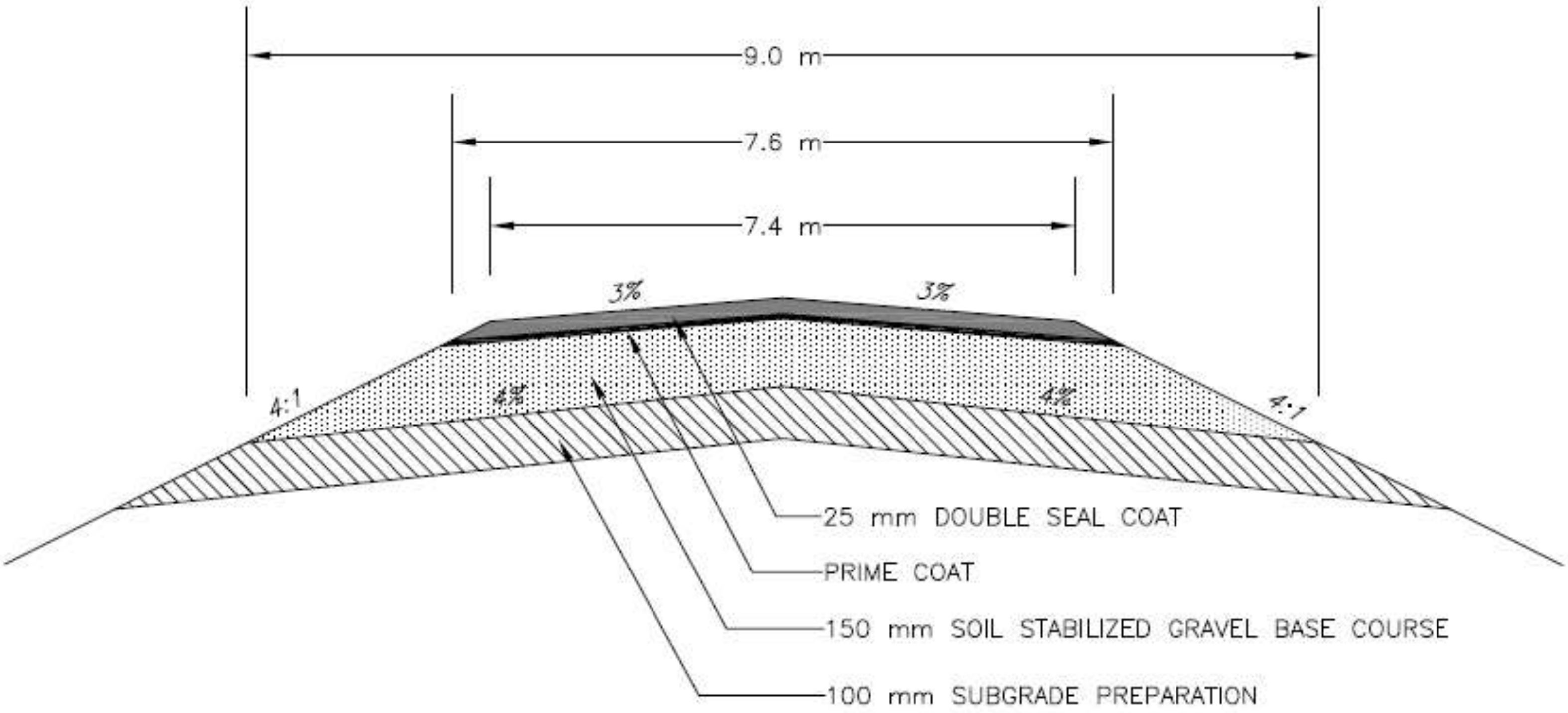
CONSTRUCTION

1. The contractor may use any machine, combination of machines or equipment that will result in the gravel being uniformly mixed with the subgrade material in the top **100 millimetres** of the finished road top. The mixture of gravel and subgrade material shall be packed enough to produce a smooth firm surface that will support normal road traffic without rutting or becoming unstable.

2. The amount of gravel to be blended into the subgrade may vary as directed by the Engineer but will normally be 190 cubic metres per kilometre (400 cubic yards per mile). The width and depth of subgrade material scarified or loosened up may also vary as designated by the Engineer, however, the width will normally be two metres less than the subgrade road top width and the depth will be between 75 to 100 millimetres.

3. Adding water to the mixture will be directed by the Engineer if there is insufficient moisture to produce a stable driving surface.

4. All surplus rock (80 millimetres and larger) shall be removed from the surface and disposed of as directed by the municipality. All small rocks from thirty millimetres (30 mm) to eighty millimetres (80 mm) shall be bladed off the road top into the ditch or onto the sideslope.

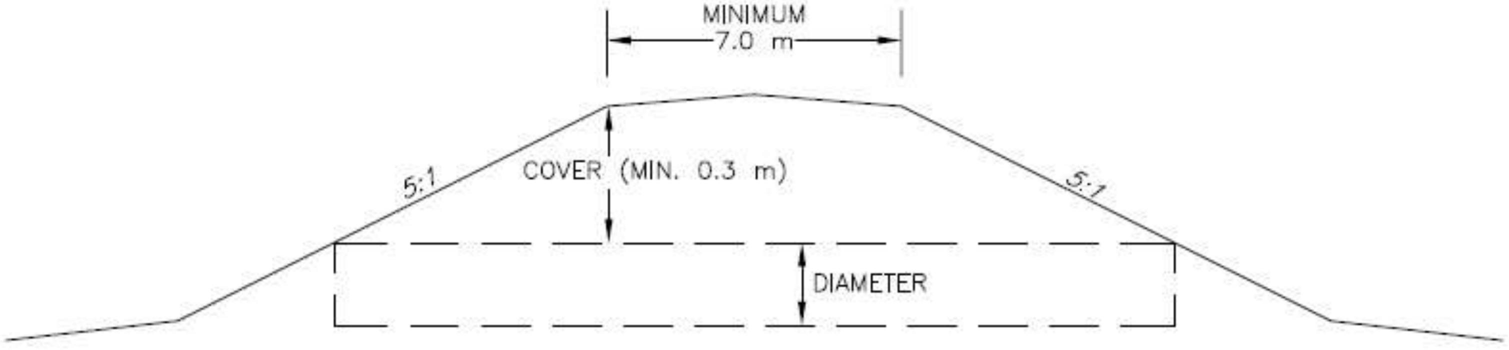


NOTE: SUBBASE MATERIAL MAY BE REQUIRED FOLLOWING SUBGRADE TEST RESULTS

RM OF
CORMAN PARK
#344

PUBLIC WORKS
SUBDIVISION - TYPICAL CROSS SECTION
DOUBLE SEAL COAT

DATE: 2011	SCALE: NTS	DRAWN BY: AMEC E & E



CULVERT DIAMETER	COVER	CULVERT LENGTH
400 mm	0.3 m	12 m
500 mm	0.4 m	12 m
500 mm	0.6 m	13 m
600 mm	0.3 m	12 m
600 mm	0.4 m	12 m
600 mm	0.6 m	13 m

RM OF
CORMAN PARK
#344

PUBLIC WORKS
TYPICAL CROSS SECTION
STANDARD APPROACH

DATE: 2011

SCALE: NTS

DRAWN BY: AMEC E & E

Appendix M
Utilities and Waste Disposal Correspondence

Maggie Schwab

From: Darren Hagen [durban@sasktel.net]
Sent: November 30, 2011 11:23 AM
To: jwalters@crosbyhanna.ca; 'Maggie Schwab'
Cc: 'Neil Ketilson'; 'Richard King'; 'Marty Fletcher'; urbele
Subject: FW: Grasswood Sun division Ketilson

Hi Jim/Maggie,
Please find below the letter from Sk Energy. Please note the positive comment in the letter.
Thank you.
Darren Hagen

-----Original Message-----
From: Neil Ketilson [mailto:nketilson@saskpork.com]
Sent: November 30, 2011 10:28 AM
To: Darren Hagen
Cc: Richard King
Subject: FW: Grasswood Sun divsion Ketilson

Darren, here is Sask Energy.

-----Original Message-----
From: DFarthing@saskenergy.com [mailto:DFarthing@saskenergy.com]
Sent: November-25-11 4:19 PM
To: Neil Ketilson
Subject: Re: Grasswood Sun divsion Ketilson

Neil,

When you have all your approvals in place, and can send us a drawing of the proposed subdivision, Sask Energy would be happy to provide you with a quote to service your subdivision with natural gas service. You can tell the R.M. council that we have worked with you in the past on subdivisions and look forward to doing so again.

D. J. (Dale) Farthing
Business Supervisor
408 36th Street East
P.O. Box 8670
Saskatoon, SK S7K 6K8
Ph: (306) 975-8573
Fax: (306) 975-8672

"Neil Ketilson"
<nketilson@saskpork.com>
To
<dfarthing@saskenergy.com>
14/11/2011 10:33 AM
cc

Subject
Grasswood Sun divsion Ketilson

Hi Dale, I am working for a company, Urban Elements LTD, on a new proposed 85 lot, country residential sub division on the W ½ 26-35-5 W3 in the RM of Corman Park. The land is located just north of Casa Rio East, and is bounded by Baker and Preston roads.

I have done most of the background studies for permitting the subdivision however have not formally applied to Municipal Planning as we want to have the RM's approval first, and are busy trying to get this on front of Council soon.

I understand Council always asks if the major Utilities have been consulted with and would supply the services to the new subdivision.

Would you please let me know if Sask Energy would supply service to the new sub division if it were approved.

Thanks
Neil Ketilson

Maggie Schwab

From: Darren Hagen [durban@sasktel.net]
Sent: December 1, 2011 2:01 PM
To: jwalters@crosbyhanna.ca; 'Maggie Schwab'
Cc: 'Neil Ketilson'; 'Neil Ketilson'; 'Richard King'; 'Marty Fletcher'; urbele
Subject: FW: Grasswood estates Ketilson

Hi Jim/Maggie,
Attached as part of this email stream please find the favorable response from Sask Tel.
We have requested the required information from the Water Utility Board and we will provide you with the same upon our receipt.
In the meantime I am hopeful that we can advance things as quickly as possible, particularly in light of the internal problems/issues with the RM and the restructuring of the zones and number of councilors. I am nervous that if the councilors are reduced from 11 to 8 that it may negatively impact us. Thus I think we should try to get this matter before council as soon as we can.
Thank you.
Darren Hagen

From: Don Ernst [mailto:don.ernst@sasktel.com]
Sent: December-01-11 8:38 AM
To: Neil Ketilson
Subject: RE: Grasswood estates Ketilson

Yes we will provide telephone service to this subdivision.

Don Ernst
SaskTel
Engineering Assistant
Technology Development Engineering
306.931.5443, 306.222.4564
Email: Don.Ernst@sasktel.sk.ca

From: "Neil Ketilson" <nketilson@saskpork.com>
To: "Don Ernst" <don.ernst@sasktel.com>
Cc: "Eldon Yuskiw" <eldon.yuskiw@sasktel.com>
Date: 11/12/01 08:34 AM
Subject: RE: Grasswood estates Ketilson

Thanks Don, I appreciate your response and will forward a cad file and a formal request for service when appropriate.

One of the critical questions the RM of Corman Park requires as a condition for consideration to sub divide land for country residential acreages is the availability and willingness of the major utilities to provide services to the sub division. I take from your email Sask Tel can and will provide telephone service to the sub division if it obtains approval to sub divide. Is that a correct assumption?

From: Don Ernst [mailto:don.ernst@sasktel.com]
Sent: December-01-11 8:08 AM
To: Neil Ketilson
Cc: Eldon Yuskiw
Subject: Re: Grasswood estates Ketilson

Neil, Eldon Yuskiw is the designer for that area and will likely be doing the network expansion to service the subdivision. We will work with SaskPower to share trenching where ever possible and we don't charge the developer a fee to service the lots. Individuals who apply for service would pay the standard rural connection fees. Hi Speed internet is only available in the major urban centres or over the cellular network outside of the major centres.

You are responsible to contact SaskTel to arrange for relocation of any existing facilities at your cost that may interfere with your project and we ask that you send us a digital CAD file of your subdivision to avoid delays in servicing.

Eldon is away from the office today but can normally be reached at Eldon.Yuskiw@sasktel.com or 931-6094, or call me if you have any questions.

Thanks

Don Ernst
SaskTel
Engineering Assistant
Technology Development Engineering
306.931.5443, 306.222.4564
Email: Don.Ernst@sasktel.sk.ca

From: "Neil Ketilson" <nketilson@saskpork.com>
To: <don.ernst@sasktel.com>
Date: 11/11/30 02:37 PM
Subject: Grasswood estates Ketilson

Hi Don, I am working for a company, Urban Elements LTD, on a new proposed 85 lot, country residential sub division on the W ½ 26-35-5 W3 in the RM of Corman Park. The land is located just north of Casa Rio East, and is bounded by Baker and Preston roads.

I have done most of the background studies for permitting the subdivision however have not formally applied to Municipal Planning as we want to have the RM's approval first, and are busy trying to get this in front of Council soon.

I understand Council always asks if the major Utilities have been consulted with and would supply the services to the new subdivision.

Would you please let me know if Sask Tel would supply service, telephone and internet, to the new sub division if it were approved. I have contacted Sask Power and Sask Energy and they will provide service.

Thanks
Neil Ketilson

Maggie Schwab

From: Jim Walters [jwalters@crosbyhanna.ca]
Sent: November 23, 2011 8:52 PM
To: Maggie Schwab
Subject: FW: Grasswood sub division Ketilson

Jim Walters, PPS, MCIP
Crosby Hanna & Associates
407 1st Avenue North
Saskatoon, SK S7K 1X5
T (306)-665-3441
F (306) 652-9613
E jwalters@crosbyhanna.ca
www.crosbyhanna.ca

From: Darren Hagen [mailto:durban@sasktel.net]
Sent: Tuesday, November 15, 2011 2:58 PM
To: jwalters@crosbyhanna.ca
Cc: 'Neil Ketilson'; 'Richard King'; 'Marty Fletcher'; urbele
Subject: FW: Grasswood sub division Ketilson

Hi Jim,
Below please find the Sk Power communication relative to the our within matter. We will provide you with copies of the Sk Energy, Sk Tel and Loraas communications in due course.
Thank you.
Darren Hagen

From: Neil Ketilson [mailto:nketilson@saskpork.com]
Sent: November 14, 2011 2:21 PM
To: Darren Hagen
Subject: FW: Grasswood sub division Ketilson

FYI

From: hangus@saskpower.com [mailto:hangus@saskpower.com]
Sent: November-14-11 2:01 PM
To: Neil Ketilson
Subject: Re: Grasswood sub division Ketilson

Hi Neil,

SaskPower will provide service to your subdivision.

SaskPower is adopting a new design philosophy that has been piloted in other regions of the province. These changes do have an effect on SaskTel and it is no longer a given that they will share our trench. You would be best to contact Sasktel.

Howard

From: "Neil Ketilson" [nketilson@saskpork.com]
Sent: 11/14/2011 10:34 AM CST
To: Howard Angus
Subject: Grasswood sub division Ketilson

Hi Howard, I am working for a company, Urban Elements LTD, on a new proposed 85 lot, country residential sub division on the W ½ 26-35-5 W3 in the RM of Corman Park. The land is located just north of Casa Rio East, and is bounded by Baker and Preston roads.

I have done most of the background studies for permitting the subdivision however have not formally applied to Municipal Planning as we want to have the RM's approval first, and are busy trying to get this on front of Council soon.

I understand Council always asks if the major Utilities have been consulted with and would supply the services to the new subdivision.

Would you please let me know if Sask Power would supply service to the new sub division if it were approved. I assume your response would include service for Sask tel as well.

Thanks
Neil Ketilson

Appendix N
MicroFAST Wastewater Treatment Septic Systems

TANKSMART inc.

Dear Darren,

As you know, onsite wastewater treatment systems are commonly used where communal collection and treatment systems are not available or viable. In Canada, approximately 20% of all residential wastewater systems fall into this category. As I'm sure you also know, historically, the idea has been to dispose of the wastewater in the most convenient way. For decades Bio-Micbrobics Inc. has been leading the onsite wastewater industry in a paradigm shift from disposal to treatment.

The developers of Grasswood Estates (GWE) have chosen to participate in that shift by ensuring the highest level of wastewater treatment for each parcel is a priority. Their selection of the MicroFAST® septic system employs decades of engineered wastewater treatment technology development that has proven itself in literally millions of locations worldwide and ensures that the purchase of every system includes bi-annual inspection for a minimum of two years after installation. Following the two years of included inspection, ongoing (annual) system inspection will be implemented for a fee of only $75 per year.

The MicroFAST® septic system is proven technology that actively treats sewage before safely returning it to the environment, it exceeds health and environmental regulations and also fits ideally into the proposed layout and existing topography of GWE. This approach to wastewater treatment will allow GWE developers and residents alike the peace of mind of knowing that a proven, exceptional level of wastewater treatment is being provided without the significant disturbance to the existing landscape that would be required to install the massive storage ponds or lagoons that come along with a communal collection and treatment system. The ability to maintain the property sizes desired by acreage buyers and still maximize occupancy of the development is key in the MicroFAST® approach to wastewater treatment.

The following information is intended to provide you, your prospective clients, stakeholders of Grasswood Estates, and interested parties with an introduction to the Bio-microbics MicroFAST® septic system outlining the basics of the systems functionality, dependability and capabilities.

MicroFAST ® Consumes Biodegradable Contaminates & Releases Clear, Odourless Water The bio-chemical processes activated in the MicroFAST ® Septic Systems, as outlined below, consumes 99% of the harmful contaminates and releases into the smaller drain (leach) field clear, odourless water for the soil to disperse. The off gases from the MicroFAST ® processes are captured and sent into the soil for removal and conversion to non-greenhouse gases. No unpleasant odours are associated with the MicroFAST ® System.

The MicroFAST® also reduces Total Nitrogen up to 70% in residential applications.

MicroFAST ® Septic Systems have been tested and certified by the Standards Council of Canada recognized agencies such as the National Sanitation Foundation International (a.k.a. NSF International) and verifies the bio-chemical processes resulting in the 99% reduction of contaminates.

Dependable, Reliable & Affordable MicroFAST ® septic system

There are no in-sewage filters to be cleaned or replaced, no shafts or bearings to be lubricated, no media to be replenished or replaced and no media to be removed and hauled away to a landfill or to be composted by a 3rd party at a cost.
MicroFAST ® contains no in-sewage submersible pumps, sewage filters, air diffusers or any in-sewage moving part to repair or replace. All internal parts are made from recycled durable, long lasting plastic and not subject to deterioration.
The MicroFAST ® septic system rigid plastic media is self-cleaning and is structurally sound and will not collapse or join together as the microorganisms grow, develop and treat. There is no need to clean or remove the MicroFAST ® media at any time.
The MicroFAST ® septic system is the most affordable attached growth technology with the lowest maintenance cost for the future. The MicroFAST ® septic system is a peace of mind operation and maintenance product.

Warranty
All of the MicroFAST ® septic system parts, other than the external air blower, come with a full 20 year warranty. There is a two year warranty on the external air blower and an offer for a 2 year cost free maintenance inspection agreement is available.

MicroFAST ® Installation
The one tank design provides a quick and easy install saving the property owner money and expense. There is no onsite assembly required as the MicroFAST ® septic system comes factory assembled.

MicroFAST® Proven Performance
MicroFAST ® wastewater treatment septic systems have been tested, approved and certified by various agencies such as Standards Council of Canada recognized wastewater treatment standard setting and testing agencies such as National Sanitation Foundation International (NSF International).
Also meeting standards of the Canadian Standards Association (CSA), US Electrical Systems, Underwriters Laboratories (UL), the Canadian Great Lakes (CGL), the USA Environmental Protection Agency (USEPA), the US Coast Guard, European Union (CE), European Electrical Systems (including EES Tropical Certification), the UK Department of Trade, the International Maritime Organization (IMO), the Australian Department of Transportation, the Royal Australian Navy and SASSO (Saudi Arabia).
FAST ® is registered under the LEEDS program

At Tanksmart Inc. we are pleased to be able to partner with Grasswood Estates in healthy residential growth that preserves and protects our ground water resources.

Best regards,

Greg Plett
President
Tanksmart Inc.

MicroFAST ® Consumes Biodegradable Contaminates & Releases Clear, Odourless Water

The bio-chemical processes activated in the MicroFAST ® Septic Systems, as outlined below, consumes 99% of the harmful contaminates and releases into the smaller drain (leach) field clear, odourless water for the soil to disperse. The off gases from the MicroFAST ® processes are captured and sent into the soil for removal and conversion to non-greenhouse gases. No unpleasant odours are associated with the MicroFAST ® System.

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Dependable, Reliable & Affordable MicroFAST ® septic system

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MicroFAST ® contains no in-sewage submersible pumps, sewage filters, air diffusers or any in-sewage moving part to repair or replace. All internal parts are made from recycled durable, long lasting plastic and not subject to deterioration.

The MicroFAST ® septic system rigid plastic media is self-cleaning and is structurally sound and will not collapse or join together as the microorganisms grow, develop and treat. There is no need to clean or remove the MicroFAST ® media at any time.

The MicroFAST ® septic system is the most affordable attached growth technology with the lowest maintenance cost for the future. The MicroFAST ® septic system is a peace of mind operation and maintenance product.

Warranty

All of the MicroFAST ® septic system parts, other than the external air blower, come with a full 20 year warranty. There is a two year warranty on the external air blower and an offer for a 2 year cost free maintenance inspection agreement is available.

MicroFAST ® Model Sizes and Capacities

MicroFAST ® wastewater treatment system comes in various models and capacities to provide the most cost efficient sewage treatment for each individual application. The size of the home and number of bedrooms determine the recommended model to be used. The larger MicroFAST ® septic system model sizes are recommended for clusters of residences, trailer parks, mobile home parks, modular buildings and subdivisions. The smallest MicroFAST ® models are typically recommended for the average home or vacation property.

MicroFAST® Proven Performance

MicroFAST ® wastewater treatment septic systems have been tested, approved and certified by various agencies such as Standards Council of Canada recognized wastewater treatment standard setting and testing agencies such as National Sanitation Foundation International (NSF International).

Also meeting standards of the Canadian Standards Association (CSA), US Electrical Systems, Underwriters Laboratories (UL), the Canadian Great Lakes (CGL), the USA Environmental Protection Agency (USEPA), the US Coast Guard, European Union (CE), European Electrical Systems (including EES Tropical Certification), the UK Department of Trade, the International Maritime Organization (IMO), the Australian Department of Transportation, the Royal Australian Navy and SASSO (Saudi Arabia).

FAST ® is registered under the LEEDS program

Effective: 9/1/2010 MicroFAST® Model Number		Hydraulic Loading per Day	Equivalent Number of persons	Tanks Working Volumes				Standard Blower Power Details alternates available
				Trash Collection		FAST® Treatment		
				Minimum	Maximum	Minimum	Maximum	
MicroFAST® 0.375	US Gals	375	up to 6	240	563	300	N/A	1/3 HP, 115/1/60
(not in Ont & AB)	Imp Gals	312		200	450	250	N/A	0.322 kW/hr
	Litres	1,420		909	2,045	1,136	N/A	3.6 FLA 20 LRA
MicroFAST® 0.5	US Gals	500	up to 8	350	750	450	N/A	1/3 HP, 115/1/60
	Imp Gals	416		292	625	375	N/A	0.322 kW/hr
	Litres	1,893		1,325	2,841	1,705	N/A	3.6 FLA 20 LRA
MicroFAST® 0.6	US Gals	600	up to 9	400	900	450	N/A	1/3 HP, 115/1/60
(not in Ont & AB)	Imp Gals	500		375	750	375	N/A	0.322 kW/hr
	Litres	2,273		1,705	3,409	1,705	N/A	3.6 FLA 20 LRA
MicroFAST® 0.75	US Gals	750	up to 11	500	1,125	750	N/A	1/3 HP, 115/1/60
	Imp Gals	625		416	950	625	N/A	0.322 kW/hr
	Litres	2,841		1,891	4,318	2,841	N/A	3.6 FLA 20 LRA
MicroFAST® 0.9	US Gals	900	up to 14	500	1,350	750	N/A	1/3 HP, 115/1/60
	Imp Gals	750		416	1,125	625	N/A	0.322 kW/hr
	Litres	3,407		1,891	5,114	2,841	N/A	3.6 FLA 20 LRA
MicroFAST® 1.0	US Gals	1,000	6 - 16	500	1,500	750	N/A	1/2 HP, 115/1/60
(not in Ont & AB)	Imp Gals	834		416	1,250	625	N/A	0.575 kW/hr
	Litres	3,791		1,891	5,683	2,841	N/A	5.6 FLA 23.2 LRA
MicroFAST® 1.5	US Gals	1,500	6 - 21	750	2,250	1,125	N/A	1/2 HP, 115/1/60
	Imp Gals	1,250		625	1,875	938	N/A	0.575 kW/hr
	Litres	5,678		2,841	8,523	4,259	N/A	5.6 FLA 23.2 LRA
MicroFAST® 3.0	US Gals	3,000	10 - 42	1,500	4,500	2,250	N/A	1 1/2 HP, 230/1/60
	Imp Gals	2,500		1,250	3,750	1,875	N/A	1.85 kW/hr
	Litres	11,365		5,682	17,048	8,517	N/A	9.5 FLA 21 LRA
MicroFAST® 4.5	US Gals	4,500	18 - 63	1,406	6,750	4,219	N/A	2 1/2 HP, 230/3/60
	Imp Gals	3,750		1,250	5,620	3,513	N/A	1.69 kW/hr
	Litres	17,034		5,683	25,549	15,971	N/A	7.6 FLA 54 LRA
MicroFAST® 9.0	US Gals	9,000	30 - 126	4,500	13,500	8,438	N/A	5 HP, 230/3/60
	Imp Gals	7,500		3,750	11,240	7,026	N/A	1.69 kW/hr
	Litres	34,068		17,048	51,097	31,941	N/A	12 FLA 54 LRA
MicroFAST® 12.0	US Gals	12,000	30 - 140	6,000	18,000	10,688	N/A	7 1/2 HP, 230/3/60
	Imp Gals	10,000		5,000	15,000	8,900	N/A	kW/hr
	Litres	45,424		22,730	68,190	40,460	N/A	14 FLA 58 LRA

MicroFAST® details listed above are for residential strength sewage watewater. For sewage wastewater that is considered to be high strength or mixed/complex flows contact Pinnacle Environmental Technologies Inc. for site specific design specifications and details.

Air Blowers are dual voltage - 115~230 VAC or 208,230~460. Note the phase on the standard blowers as listed above The controller for the air blower determines the Voltage and the Phase required for the system being installed.

Controllers and air blowers for the alternate or the other Voltage or Phase are available on request.

MicroFAST® - Provincial Approval

British Columbia

Flows Under 22,700 Litres / Day – Sewerage System Regulation
Approved as Type 2 Treatment Method (secondary) meeting BOD5 and TSS of 45 mg/l each respectively.

Approved as an Advanced Type 2 meeting BOD5 and TSS of 10 mg/l each respectively.

Approved as Type 3 (tertiary), with PROTECTOR™ UV System, meeting BOD5 and TSS of 10 mg/l each respectively, and, less than 400 CFU/100 ml for fecal coliform.

Flows Over 22,700 litres / Day - Municipal Sewage Regulation
Installed under Class A, Class B and Class C

Alberta

Flows Under 10,000 litres / Day - Private Sewage Disposal Systems Regulation
Approved as an Advanced Treatment Unit. The PSDS does not distinguish between secondary and tertiary treatment units.

Flows Over 10,000 Litres / Day – Ministry of Environment
Approved under the MoE Regulation on a project-by-project basis.

Saskatchewan

Approved as a Treatment Unit for flows under 10,000 litres / day. The Regulation does not distinguish between secondary and tertiary treatment units.

Manitoba

Approved as a Treatment Unit for flows under 10,000 litres / day. The Regulation does not distinguish between secondary and tertiary treatment units.

Ontario

Flows Under 10,000 Litres / Day – Ontario Building Code – Part 8
Listed in the Code's Supplementary Listing as secondary and tertiary treatment unit.

Flows Over 10,000 Litres / Day – Ministry of Environment
Approved under the MoE Regulation on a project-by-project basis.

Nova Scotia

Approved for installation as a treatment unit for any flow.

Newfoundland

Approved for installation as a treatment unit for any flow.

MicroFAST ® Septic Systems typically have a smaller drain (leach) field than as required for a septic tank based system.

Onsite Wastewater Aerobic Treatment Units Ratings for 2009

To rate each of the available onsite sewage wastewater aerobic treatment units (ATU) certain items or features will be assessed and others will not be considered.

Not Considered

Product market price will not be considered, as the price is not a suitable indicator of reliability but a reflection of market conditions. Price is also variable from market place to market place.

System pump-out frequency is also not considered as there is a reliance on the user of the systems to maintain a certain behaviour or operational habit.

Considered Items & Rating Schedule

The rating score is designed that the higher the value the better the system for those items considered.

Systems that use as part of that system's operation or function a septic tank or pre-tank, the prescribed tank and any parts placed into are considered as a component to the treatment system.

1. Type of Treatment Technology

Suspended Growth technologies are susceptible to surge loadings and over-aeration, whereas, the Attached Growth technologies were developed partially to overcome the suspended growth problems. Hybrid systems are systems that have technological advantages of suspended and attached to create a system that maximizes the benefits of both into one unit.

Rating for Suspended Growth is a value of one (1).
Rating for Attached Growth is a value of two (2).
Rating for a Hybrid Technology is a value of three (3).

2. Listed with a Recognized Independent Performance Agency

Systems that are certified under NSF International Standard 40 Class 1 or the equivalent Bureau d' Normalization du Quebec (BNQ) are given a rate value of 1. Systems that are not NSF International or BNQ listed as meeting are given a rate value of zero (0).

Systems that are listed by NSF International as meeting Standard 245 for nitrogen reduction or the equivalent BNQ standard are assigned an additional value of one (1).

3. Treatment Level - Tertiary

Systems that meet the BNQ testing standard for BOD5 and TSS of 10 mg/l each are assigned a value of one (1).

4. Diffusion & Air Contact Method

Suspended Growth systems use either a coarse or a fine diffusion method. Coarse is viewed as being the better as it is not susceptible to clogging. Fine diffusion slowly reduces efficiency over time as the diffuser slowly clogs.

Rating for Fine Diffusions is a value of one (1).
Rating for Coarse Diffusion is a value of two (2).

Attached Growth systems typically introduce air to make contact with the sewage either passively (atmosphere air makes contact) or actively (using an air blower, pump or mixer)
Rating for active air contact is one (1)
Rating for passive air contact is two (2)

5. Media – Attached Growth

Attached Growth technologies use a wide variety of materials to have the micro-organisms attached to the provide the treatment. Media on the market today consists of corrugated plastic sheets, plastic shavings, fabric, foam, sand, gravel, peat, glass, and plastic bottles.

These materials are rated for their ability to self-clean (sloughing off) and whether they need either replenishing or replacement.

Rating for media that does not need replenishing, replacement or cleaning a value of 2 is given.
Rating for media that needs replenishing only is a value of one (1) is given
Rating for media that is to be disposed of by composting or in a sanitary landfill a value of zero (0) is given.

6. Years of Service

The years of in-service-use is an indicator of the systems reliability and the technical abilities of the primary technology owner/manufacturer to support the product in the field. The years of service in North America is based on the date of start-up of the primary technology owner/manufacturer.

Years in Service	Rate Value	Years in Service	Rate Value
0 – 5	1	16 – 20	4
6 – 10	2	21 – 30	5
11 – 15	3	31 – 40	6
16 – 20	4	+ 41	7

7. Number of Serviceable Parts

System components or parts that need to be serviced or maintained are counted. Inspection points are counted. Any part that requires service and is also an inspection point is counted once only. The rating value granted is:

No. of Parts/Points	Rating Value	No. of Parts/Points	Rate Value
1	6	4	3
2	5	5	2
3	4	6	1

8. Location of Serviceable Parts

If the component part is located with the wastewater or is sometimes exposed to or in the wastewater prior to discharge from the system, this means that the service provider is directly interface and make contact with sewage wastewater during the performance of inspection of the mechanical / operational parts of the system. Sludge testing or sampling is not counted or rated.

Parts in Wastewater	Rating Value
0	7
1	6
2	5
3	4
4	3
5	2
+6	1

9. Pre-Discharge Filter

Systems that have, just prior to discharge, a filter of any type are matched against systems that do not have a filter.

Rating for Systems that have a pre-discharge filter are given a value of one (1).
Rating for Systems that do not have a pre-discharge filter are given a value of two (2).

10. Power Consumption Demands

We have 3 categories that the treatment systems are arranged into.
- Category 1 is for systems that do not have any electrical power demands.
- Category 2 is for systems that have intermittent electrical power demands.
- Category 3 is for systems that have a constant electrical power demand.

Ratings for each category are:

Category 1 =	4
Category 2 =	3
Category 3 =	2 for systems that have a wattage of 1 = 75 1 for systems that have a wattage of 76 – 150

We have selected to use treatment systems that are most commonly used in Canada for 4 bedroom homes (i.e. 450 imp gallons per day).

Suspended Growth Based Treatment Systems

	Maximum Available Rate	**White water**	**Clear Stream**	**Nay adic**	**JetBat**	**Nor weco**	**Bio Cycle**
Type	1	1	1	1	1	1	1
Listed	1	1	1	1	1	1	0
Nitrogen	1	0	0	0	0	0	0
Treatment	1	0	0	0	0	0	0
Air	2	2	1	2	2	2	1
Years	7	6	6	6	5	5	3
No. Parts	6	6	1	5	4	5	3
Location	7	7	2	6	4	5	3
Filter	2	2	1	2	1	1	1
Power	4	2	2	2	1	1	2
TOTAL	**32**	27	15	25	19	21	14
	100%	84%	47%	78%	59%	66%	44%

Attached Growth Based Treatment Systems

	Maximum Available Rate	**Water loo**	**Eco Flo**	**Ad Vantex**	**FAST**	**Bio Nest**	**Enviro Septic**	**Chrom aglas**	**Bio Green**
Type	3	2	2	2	3	2	3	3	2
Listed	1	1	1	1	1	1	1	0	0
Nitrogen	1	0	0	1	1	0	0	0	0
Treatment	1	1	1	1	1	1	1	0	0
Air	2	2	2	1	1	1	2	1	1
Media	2	0	0	1	2	2	2	1	2
Years	7	3	3	3	7	2	4	6	3
No. Parts	6	2	6	1	6	3	6	3	4
Location	7	2	5	1	7	4	7	3	4
Filter	2	2	2	2	2	2	2	1	2
Power	4	3	4	3	3	1	4	2	2
TOTAL	**36**	15	22	14	31	18	28	18	18
%	100%	42%	61%	39%	86%	50%	78%	50%	50%

Summary

For the suspended growth technologies it would appear that the coarse bubble based systems have lower costs of operation and maintenance resulting in a higher rating.

For attached growth technologies it would appear that the systems that have a lower number and location of the serviceable parts results in a higher rating.

To compare the suspended versus the attached growth technologies, it appears that the key factors for the highest ratings relate to the systems that offer a design that provide lower operation and maintenance costs.

END of REPORT

FAST®

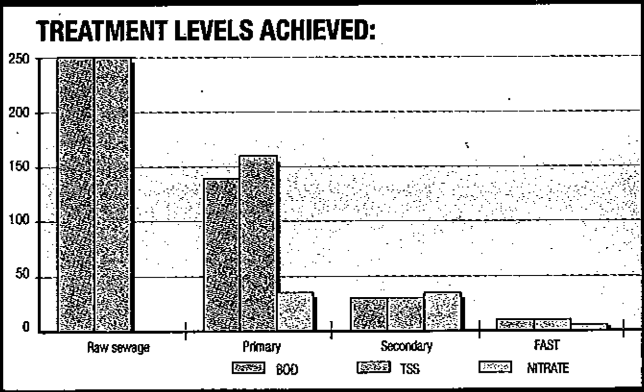
SEWAGE WASTEWATER TREATMENT SYSTEMS

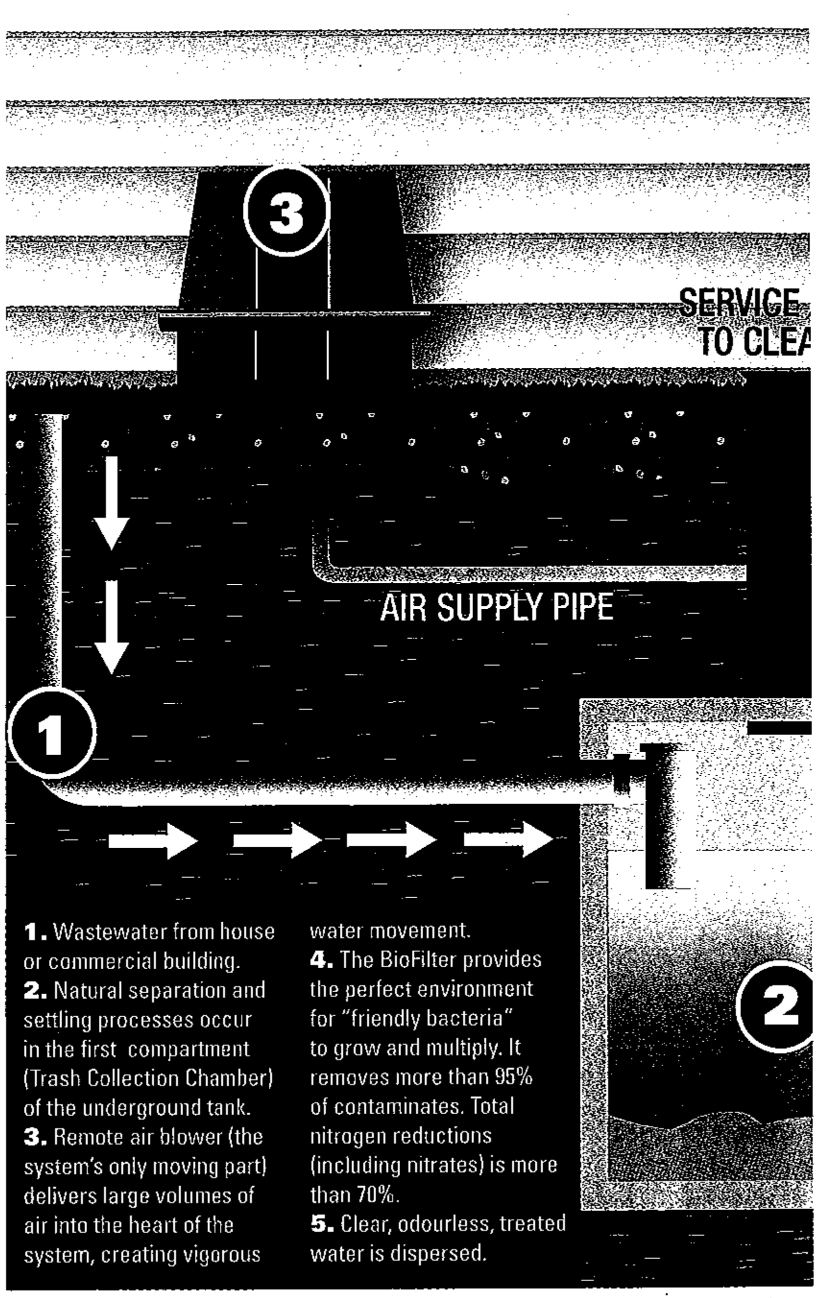
**TO PROTECT
PUBLIC HEALTH
AND THE
ENVIRONMENT
WE ALL SHARE**

PINNACLE
ENVIRONMENTAL TECHNOLOGIES INC.

EFFLUENT QUALITY

In domestic sewage wastewater, the two (2) main characteristics often mentioned are Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS), and are expressed as being 250 mg/l respectively. The graph shows the treatment levels of BOD and TSS from a septic tank, a secondary treatment device, or a **FAST®** sewage wastewater treatment plant. The **FAST®** has the capabilities of achieving a tertiary treatment level of BOD – less then 10/mg/l, TSS – less than 10 mg/l, total Nitrogen – 70% reduction with Nitrate – less than 5 mg/l.





1. Wastewater from house or commercial building.
2. Natural separation and settling processes occur in the first compartment (Trash Collection Chamber) of the underground tank.
3. Remote air blower (the system's only moving part) delivers large volumes of air into the heart of the system, creating vigorous water movement.
4. The BioFilter provides the perfect environment for "friendly bacteria" to grow and multiply. It removes more than 95% of contaminates. Total nitrogen reductions (including nitrates) is more than 70%.
5. Clear, odourless, treated water is dispersed.

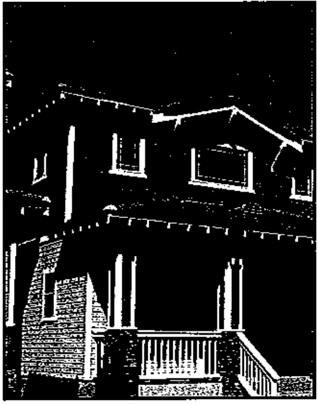
- **SECONDARY AND TERTIARY LEVELS**
- **TOTAL NITROGEN REDUCTION 70%**

APPROVALS

- STANDARDS COUNCIL OF CANADA
- NSF STANDARD 40, CLASS 1
- CANADIAN GREAT LAKES
- INTERNATIONAL MARITIME ORGANIZATION (IMO)
- INDIVIDUAL PROVINCIAL CERTIFICATIONS

NSF
Standards Council of Canada
Conseil canadien des normes

MICROFAST®



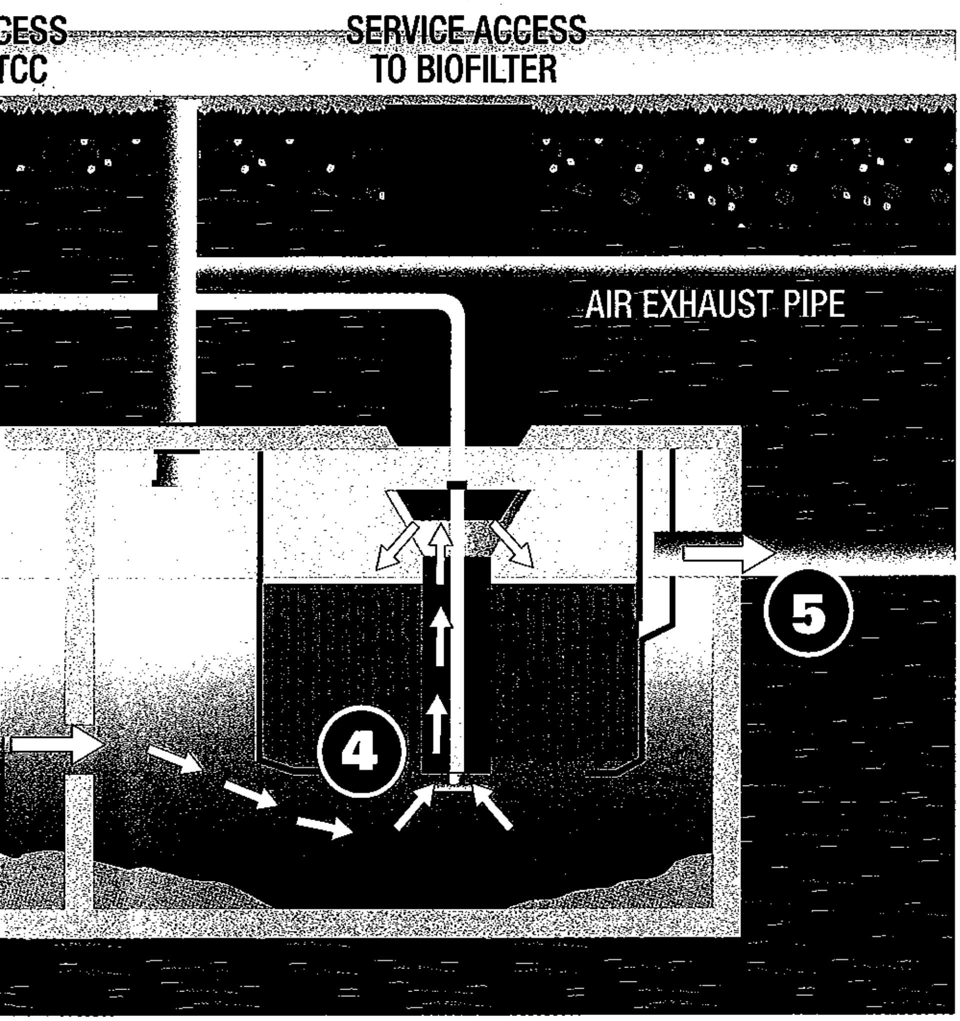
Advanced treatment systems for homes, sub-divisions, small communities, parks, mobile home parks and campgrounds.

peti@canada.com

The FAST® system is available from any o

FAST®

EWAGE WASTEWATER
REATMENT SYSTEMS



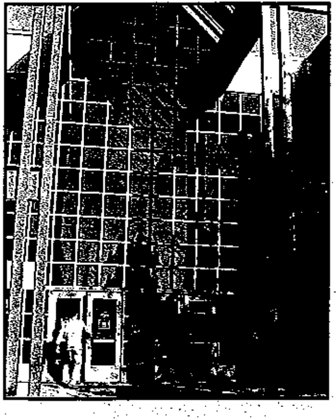
INSTALLATION

The **FAST®** system may be installed for residential and commercial facilities, including schools and public buildings. The **FAST®** is delivered to the site completely factory pre-assembled into the tank. The installer connects building drain, air blower and discharge pipe to the system.
The system is simple, quiet and efficient.

MAINTENANCE

There is no part in the **FAST®** system to be removed, replaced or cleaned. Typically, the liquids and sewage solids in suspension will need to be removed once every 3 years.

HIGH-STRENGTH FAST®



System for restaurants, pubs, lounges, golf and country clubs, service stations, commercial operations and permanent or mobile work camps.

RETROFAST®

- **Upgrade on existing septic tank systems.**
- **Places FAST® BioFilter into existing tank**
- **or places FAST® BioFilter after existing tank.**

of Pinnacle's dealers throughout Canada **www.peti.ca**

FAST®

SEWAGE WASTEWATER TREATMENT SYSTEMS

PINNACLE ENVIRONMENTAL TECHNOLOGIES INC.
22765 - A Fraser Highway, Langley, BC, Canada

Telephone: 604.514.7555
Toll Free : 866.514.7555
Fax: 604.514.7595
Mailing Address: P.O. Box 3070
Langley, BC, Canada, V3A 4R3

MODEL NO.	DAILY SEWAGE FLOW RATES	
	i. gals	Cu. Metres
HighStrenthFAST® 1.0	833	3.8
HighStrenthFAST® 1.5	1,250	5.7
HighStrenthFAST® 3.0	2,500	11.4
HighStrenthFAST® 4.5	3,750	17.1
HighStrenthFAST® 9.0	7,500	34.1
MicroFAST® 0.5	420	1.9
MicroFAST® 0.75	625	2.8
MicroFAST® 0.9	750	3.4
MicroFAST® 1.5	1,250	5.7
MicroFAST® 3.0	2,500	11.4
MicroFAST® 4.5	3,750	17.1
MicroFAST® 9.0	7,500	34.1

WARRANTY

Pinnacle's materials and workmanship warranty is 2 years on the air blower and 10 years on the tank and BioFilter. All residential units listed by NSF International have a two (2) year inspection service. Commercial, institutional and non-NSF International listed units have a one (1) year warranty on the air pump. The **FAST®** treatment module insert is manufactured from environment-friendly, recycled plastic that is corrosion-resistant and should never need replacement.

Appendix O
William Brown Consulting Report

William Brown
Consulting

William Brown
85 Ashwood D
Saskatoon, Sa
S7T 1B9

Cost of Community Services (COCS)

Grasswood Estates Development

Rm of Corman Park

(W1/2 26-35-5-W3rd)

Introduction

This study assesses the benefits and costs of providing communities services by the RM of Corman Park to the Grasswood Estates Development at (W1/2 26-35-5-W3rd).

Studies Done in the US

A number of Cost of Community Services (COCS) studies were reviewed. All of these studies were done in the US. The US studies did not show details on how the benefits and costs were calculated, just the final ratios of benefits and costs. In almost all the studies the costs outweighed the benefits for residential developments by an average of 1.19 to 1 (American Farmland Trust, 2006). However, the benefits outweighed the costs for commercial/industrial developments and working/open land.

Red Deer County COCS

The COCS document reviewed that was done for Red Deer County, Alberta used numbers from the US and did not generate any of their own data (Red Deer County and Miistakis Institute, 2005).

J.H. Dorfman on COCS

A slide presentation by Jeffrey H. Dorfman of the University of Georgia analyzes all the COCS studies done in the US up until that time (Dorfman, 2004). It indicates that the calculations include providing educational facilities and teachers for the children likely to live in the development. He uses a standard mill rate (10 mills), to calculate the total income from the property taxes that then covers both the cost of the RM and the cost of the school division. Dorfman's slides show that the benefits outweigh the costs when the property tax income is compared to the cost of supplying all the services except educational services (Dorfman, slide 12). The benefits are only marginally greater than the costs in a "standard" subdivision (not defined) but are almost 2 to one in a "conservation" subdivision (again not defined). The cost increases substantially when educational services (schools) are considered. He states that home values, and therefore their tax assessment values, have to increase substantially as the number of children per household increases (Dorfman, slides 13 and 14). There is obviously some education cost per child assumption (not explained) behind these calculations.

The Canadian Situation

The Canadian situation is different from the US. In Canada, RMs set a mill rate to collect taxes for municipal services and the school division sets a mill rate to collect taxes for their educational services. Even the US studies show that residential developments have more benefits than costs to the RM when schools are not included.

The Financial Advantages and Disadvantages of Grasswood Estates Development

The financial advantages of the Grasswood Estates Development are assumed to be 85 residential lots paying annual property taxes of $2,500 each for a total of $212,500 per year. There are other financial advantages that could occur but have not been calculated. They include; current residences having better roads, increased net revenue from supplying water, increased net revenue from supplying sewage services, and increased net revenue from supplying garbage pickup services.

The financial disadvantages of the Grasswood Estates Development deal with increased costs of road grading and snow removal ($900/yr), annualized cost of paving and repaving existing roads ($38,361/yr), a 5% annual repair cost on these roads ($22,000/yr), an increased administration fee ($5,000/yr), and a decrease in the taxes collected from the ½ section of farm land ($5,000). The annualized cost of paving and repaving and the repair costs were based on an estimated cost of $400,000 per mile of paving. According to the Traffic Impact Assessment for the Grasswood Estates Development the increase in traffic flow on the 3.3 miles of municipal roads in the immediate area will be about 50% (Clifton Associates, 2009). This means that 1/3 of the total traffic will be attributed to the Grasswood Estates Development.

The net financial advantage of the Grasswood Estates Development is $141,239 per year. The benefit cost ratio in this case appears to be 2.98:1.

Table 1: The Financial Advantages and Disadvantages of Grasswood Estates Development

	Annual Advantages			Annual Disadvantages
Increased Revenue			**Increased Costs**	
Property Tax on 85 lots @$2500/lot	$212,500		2.5 miles of grading and snow clearing @$120/hr @4mph, 12 times/yr	$900
Current Residences have better roads??			3.3 miles new or upgrade pavement @ $400,000/mile, Total =$1,320,000, 50% increase in traffic therefore 1/3 of cost allocated, 20 yr life, Interest @6%	$38,361
Increased Net Revenue from Supplying Water			5% repair rate X $1,320,000 x 33%	$22,000
Increased Net Revenue from Supplying Sewage Services			Increased Administration	$5,000
Increased Net Revenue from Supplying Garbage Pickup Services				
Decreased Costs			**Decreased Revenue**	
			Taxes on 1/2 section as farm land	$5,000
Total Annual Advantages	**$212,500**		**Total Annual Disadvantages**	**$71,261**
Net Financial Advantage/yr	**$141,239**			

Conclusions

The Canadian situation is significantly different from the US situation with regards to the benefits and costs of RMs providing community services to residential developments. US RMs are also responsible for levying the education portion of the property tax. It appears that the benefits outweigh the cost of providing community services by both US and Canadian RMs when the cost of providing educational services is not included.

References

American Farmland Trust, Farmland Information Center, 2006. Cost of Community Services Studies a Fact Sheet.

Clifton Associates. 2009. Traffic Impact Assessment Proposed Casa Grande Development Rm of Corman Park (W1/2 26-35-5-W3rd).

Dorfman, J.H., 2004. The Economics of Growth, Sprawl and Land Use Decisions. A slide show presentation, University of Georgia, August 17, 2004.

Red Deer County and Miistakis IInstitute, 2005. Report on the "Cost of Community Services" Multi-Municipality Workshop, June 9, 2005.

Appendix P

Ministry of Highways and Infrastructure Correspondence

From: Jim Walters [jwalters@crosbyhanna.ca]
Sent: Tuesday, February 07, 2012 11:56 AM
To: Maggie Schwab; Darren Hagen
Subject: FW: Grasswood Estates Proposed Subdivision

Highways response looks good.

Jim Walters, PPS, MCIP
Crosby Hanna & Associates
407 1st Avenue North
Saskatoon, SK S7K 1X5
T (306)-665-3441
F (306) 652-9613
E jwalters@crosbyhanna.ca
www.crosbyhanna.ca

From: Fertuck, Jennifer HI [mailto:jennifer.fertuck@gov.sk.ca]
Sent: Tuesday, February 07, 2012 8:39 AM
To: Jim Walters
Subject: RE: Grasswood Estates Proposed Subdivision

Jim:

The Ministry has completed its review of the assessment completed for Casa Grande Developments subdivision proposal. No action items were generated from this review and the Ministry does not require anything further.

Please contact me at 933-8003 if you require anything else from the Ministry.

Jennifer Fertuck, P.Eng | Senior Project Manager | 306.933.8003

From: Jim Walters [mailto:jwalters@crosbyhanna.ca]
Sent: Wednesday, January 11, 2012 10:22 PM
To: Fertuck, Jennifer HI
Subject: RE: Grasswood Estates Proposed Subdivision

Hi Jennifer, please find attached a supplemental TIA addressing your previous request. Please let me know if you have any further questions.

Jim Walters, PPS, MCIP
Crosby Hanna & Associates
407 1st Avenue North
Saskatoon, SK S7K 1X5
T (306)-665-3441
F (306) 652-9613
E jwalters@crosbyhanna.ca
www.crosbyhanna.ca

From: Fertuck, Jennifer HI [mailto:jennifer.fertuck@gov.sk.ca]
Sent: Thursday, December 22, 2011 10:43 AM
To: Jim Walters
Subject: RE: Grasswood Estates Proposed Subdivision

Okay.

Jennifer Fertuck, P.Eng | Senior Project Manager | 306.933.8003

From: Jim Walters [mailto:jwalters@crosbyhanna.ca]
Sent: Thursday, December 22, 2011 10:42 AM
To: Fertuck, Jennifer HI
Subject: RE: Grasswood Estates Proposed Subdivision

In response to point 1, the development is the same, just a name change.

Jim Walters, PPS, MCIP
Crosby Hanna & Associates
407 1st Avenue North
Saskatoon, SK S7K 1X5
T (306)-665-3441
F (306) 652-9613
E jwalters@crosbyhanna.ca
www.crosbyhanna.ca

From: Fertuck, Jennifer HI [mailto:jennifer.fertuck@gov.sk.ca]
Sent: Thursday, December 22, 2011 10:02 AM
To: jwalters@crosbyhanna.ca
Subject: RE: Grasswood Estates Proposed Subdivision

Jim:

The Traffic Impact Assessment you sent Goran Saric on December 13 was forwarded to me for review. Before I provide any comments I have a few questions for you regarding the development:

1) The title of the email is for Grasswood Estates but the TIA title is for Casa Grande Development. Is this an error or are they the same subdivision?

2) The TIA you sent is three years old. Is it still valid? The 2010 RM Traffic Counts indicate the projected traffic volumes are somewhat close, but slightly low. For example, Baker Road had 590 vehicles in 2010 and that would need to be projected another year or two. The TIA used 450 vpd. The Preston Ave. extension (Range Rd 3052) used an ADT of 200, but the traffic map indicates 65 vpd closer to Saskatoon.

3) The TIA contained no information on how the development would impact the intersection of Baker Road and Highway 11. It only discussed the Baker Road and Range Road 3052 impacts. I would suspect that such a large

development generating left turns onto Highway 11 would have some impact and it should be looked at. Any thoughts on this?

Jennifer Fertuck, P.Eng | Senior Project Manager| 306.933.8003

From: Saric, Goran HI
Sent: Wednesday, December 14, 2011 12:27 AM
To: Fertuck, Jennifer HI
Cc: Harris, Brandon HI
Subject: FW: Grasswood Estates Proposed Subdivision

Please handle.

Goran Saric, P.Eng.
Director of Operations
Central Region
Ministry of Highways and Infrastructure
phone: 306.933.6217
cell: 306.221.6148
fax: 306.933.5188

From: Jim Walters [mailto:jwalters@crosbyhanna.ca]
Sent: December 13, 2011 9:41 PM
To: Saric, Goran HI
Subject: Grasswood Estates Proposed Subdivision

Hi Goran,

We are working for a developer for a proposed development in the RM of Corman Park No. 344. The proposed development would include 83 residential lots and be located in the W ½ Section 26-35-5-W3M, near the South Corman Park School. I have attached the proposed subdivision plan and Traffic Study for your information.

The RM requires proponents of development projects to consult with the Ministry of Highways and Infrastructure, as well as other agencies and Ministries as part of the subdivision application process. This referral is similar to the one you dealt with for the Greenbryre subdivision (also in RM 344, we were leading the approval process).

We are also coordinating the approval process for this project, please do not hesitate to contact me with any questions or feedback.

Jim Walters, PPS, MCIP
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F (306) 652-9613
E jwalters@crosbyhanna.ca
www.crosbyhanna.ca

Appendix Q
Fire and Protective Services Correspondence

Maggie Schwab

From: Darren Hagen [durban@sasktel.net]
Sent: December 2, 2011 1:38 PM
To: jwalters@crosbyhanna.ca; 'Maggie Schwab'
Cc: 'Neil Ketilson'; 'Neil Ketilson'; 'Richard King'; 'Marty Fletcher'; urbele
Subject: FW: RM of Corman Park - Grasswood Estates Proposed Subdivision

Hi Jim/Maggie,
Please find below the responses to your 4 questions of yesterday. Are you satisfied with the response to the issue concerning the roadways ability to handle the weight of pumper trucks. If need be we will agree to make sure the road is of suitable standards and capability to handle the trucks.
Thank you.
Darren

From: Neil Ketilson [mailto:nketilson@saskpork.com]
Sent: December 2, 2011 11:17 AM
To: Darren Hagen; Neil Ketilson; Richard King
Cc: Marty Fletcher
Subject: RE: RM of Corman Park - Grasswood Estates Proposed Subdivision

Darren, responses for questions.

Water supply; The DRWU main water line runs along the west and south perimeters of the proposed sub division. This line is a 12 inch pressure line feeding the entire southern portion of the DRWU rural water system. It is capable of a flow of 1,000 gallons a minute. The Grasswood sub division will be fed off this line. A hydrant is likely possible if required.

Roads are designed for a 30 meter right of way. The roads will be designed and built to RM standards for a sub division. I expect they would accommodate the fire truck weights.

Yes, the lots will be numbered.

From: Jim Walters [mailto:jwalters@crosbyhanna.ca]
Sent: December 1, 2011 2:57 PM
To: Darren Hagen
Cc: Maggie Schwab
Subject: FW: RM of Corman Park - Grasswood Estates Proposed Subdivision

Hi Darren, here are some more questions that I need you to look at.

Jim Walters, PPS, MCIP
Crosby Hanna & Associates
407 1st Avenue North
Saskatoon, SK S7K 1X5
T (306)-665-3441
F (306) 652-9613
E jwalters@crosbyhanna.ca
www.crosbyhanna.ca

From: Coffin, Bill (Fire) [mailto:Bill.Coffin@Saskatoon.ca]
Sent: Thursday, November 24, 2011 4:51 PM
To: 'Jim Walters'
Subject: RE: RM of Corman Park - Grasswood Estates Proposed Subdivision

Jim
The development looks interesting. Nice sized lots. I sat down with the Deputy and the Fire Marshall and only came up with the following:

1. Water supply?
2. Width of roads – (from your plan am I correct at 30ft.)
3. Will the roads be able to handle the weight of our apparatus? Pumper 54000lbs, Tanker 84000lbs
4. Will the lots have addresses visible at the end of the lot for emergency response?

Bill

Bill Coffin
Assistant Fire Chief
Saskatoon Fire and Protective Services
975-2520
221-5361
E-mail - Bill.Coffin@Saskatoon.ca

From: Jim Walters [mailto:jwalters@crosbyhanna.ca]
Sent: November 24, 2011 09:51
To: Coffin, Bill (Fire)
Subject: RM of Corman Park - Grasswood Estates Proposed Subdivision

Hi Bill,

I am sending you a referral on behalf of a group of developers in the RM of Corman Park. The proposed development would include 83 residential lots and be located in the W ½ Section 26-35-5-W3M, near the South Corman Park School. I have attached the proposed subdivision plan for your information.

Would Fire and Protective Services be able to provide fire protection to the development (through its agreement with the RM), and would the department have any concerns about this development?

Thanks and please let me know if you have any questions.

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Appendix R
Hydrogeological Report

Hydrogeological Investigation
Grasswood Estates Subdivision
W1/2 26-35-5 West of 3rd Meridian

R.M. of Corman Park, Saskatchewan

File S1607.7 17 July 2012

Clifton Associates Ltd.

engineering science technology

Executive Summary

Clifton Associates Ltd. was retained to conduct a hydrogeological investigation of the proposed Grasswood Estates subdivision development (Site) located south of the City of Saskatoon. The objective of the work was to characterize the groundwater conditions with particular emphasis on characterizing the cumulative impact of 80 individual proposed septic disposal fields on residential lots.

The stratigraphy at the Site consists of at least 15 m of surficial, stratified drift consisting of sand, silt and clay overlying till of the Battleford and Floral Formations. The surficial lacustrine deposits are primarily silty sand with stratified clay.

A regional piezometric surface was developed based on boundary conditions defined by field investigation of the surrounding groundwater wells within a 1 km radius. Groundwater elevations of these wells were tied into the newly drilled wells on site and a piezometric surface was created using Surfer Design and Mapping software. This surface was used in MODFLOW, a contaminant transport model to predict groundwater flow and associated contaminant plume development. Based on this analysis, groundwater flow is expected to occur regionally from the north east to the west.

Site investigations and piezometer installations were conducted on 26 June 2012 and 28 June 2012 with groundwater levels obtained within days of the installation. Thirteen piezometers were installed to a depth of between 6 m to 14 m to characterize the soil conditions and measure the groundwater level. An additional piezometer from a previous investigation completed in 2008 was also included in the monitoring program. Preliminary monitoring of groundwater depths, groundwater chemistry, and hydraulic conductivity analysis was performed on each piezometer.

Groundwater levels were measured in the piezometer network after one week of installation. One previously installed well provided background groundwater level conditions from 2008. Results indicated that groundwater elevations have been lowered in this piezometer by approximately 0.97 m.

Further monitoring would be recommended to further define groundwater fluctuations for this Site.

The depth from surface to the normal groundwater levels varied from 1.1 m to 5.8 m. The shallowest groundwater levels were observed near the north east corner of the Site and also in the South east low relief area of the Site. Deeper groundwater depths were observed in the central east portions of the Site.

Background groundwater chemistry was conducted for two purposes, one of which was to characterize baseline Site conditions, and second was to provide data for development of the contaminant transport model to simulate groundwater conditions based on our understanding of the effluent loading proposed. Baseline results indicate that existing nitrate loading has occurred near the north central region of the site, and throughout the site elevated levels of metals exist. The south eastern area has elevated TDS, alkalinity, sulphates and chloride. A land use investigation indicated that an intensive livestock farm existing in the area where nitrate concentrations are elevated. In the area where we see high alkalinity, the site is low lying, with potential for accumulation of alkali conditions. This may have occured as a result of evapotranspiration creating elevated concentrations as noted above.

Groundwater contaminant modeling results indicate that over a 100 year period, cumulative nitrate impact off site will be minimal based on the loading proposed. Two effluent loading scenarios were considered, first was a 350 mg/L as per Saskatoon Health Region recommendations and, secondly, 40 mg/L as recommended in the On-Site Wastewater Treatment Systems in Subdivisions 29 September 2009 Project No SH/SWA H01-2009 Final Report under developed conditions. These are very conservative loading rates because the package treatment system proposed to be used on Site estimates a 70% reduction in the nitrate concentrations. The proposed system is the FAST® Wastewater Treatment System. Modeling results indicate exceedances of assumed criteria of 10 mg/L under developed conditions due to background nitrate concentrations and existing nitrate source onsite. Modeling results where there is no consideration of this background source indicates that off-site concentrations are below Drinking Water objectives of 10 mg/L in both 40 mg/L and 350 mg/L loading scenarios.

Removal of the nitrogen source is recommended prior to development due to the elevated nitrates. Methodology would be to define and delineate the source and then potentially distribute the existing nitrate source for increased dilution potential and also provide a reduced point source.

Other groundwater exceedances were not modeled because the contaminant of concern in this case is nitrates. Elevated parameters are such as chromium, lead and arsenic exist on site. As such, this site is not suitable for domestic water well use.

Table of Contents

Table of Contents – Cont'd

1.0 Introduction

1.1 General

Clifton Associates Ltd. (CAL) was retained by Urban Elements Development Corporation to conduct a cumulative impact assessment of the proposed 80 lot residential subdivision, namely Grasswood Estates. The objective of the work was to assess the potential impacts of the proposed individual septic systems on the groundwater system. The potential contaminants of concern are constituents of domestic sewage, most notably nitrate.

As quoted by Brent Latimer with the Saskatoon Public Health Region via email:

Due to human health and environmental concerns related to the density of the development, it is recommended that the proponent determine the larger scale environmental impact of this and surrounding developments and to identify an appropriate method of onsite wastewater treatment and disposal…

The proposed Grasswood Estates subdivision (Site) is located 4 km south of Saskatoon, Saskatchewan east of Highway 11 on the corner of Grasswood Road and Preston Avenue. The site location is shown in Drawing S1607.7-01.

The legal land description is W1/2-26-35-5W3. The land is presently used as hay land but surrounds three residential acreages located near the western border of the Site which currently exist within the section. External land use is predominantly residential with Corman Park School neighbouring the Site to the south west.

1.2 Scope of Work

The objective of this investigation is to characterize the hydrogeologic conditions within the proposed Grasswood Estates subdivision with particular emphasis on the potential impact of groundwater quality resulting from treated effluent disposal in sewage mounds.

The scope of the investigation included the following:

- Review of existing site and regional geology information and compilation of the regional geology;

- Field drilling investigation including installation of piezometers, measurement of groundwater elevation, and response testing to assess soil hydraulic conductivity;
- Identify nearby wells and water sources within a 1 km radius;
- Identify effluent loading rates;
- Development of a fate and transport groundwater model to assess cumulative impacts; and,
- Report the hydrogeologic conditions and the model results.

1.3 Authorization

Authorization to proceed with this work was received from Mr. Darren Hagen, by email dated 25 June 2012.

2.0 Proposed Development

The proposed development consists of 80 lots on 2.47 hectare as shown in Drawing S1607.7-02. Individual waste water systems and a communal water supply system is proposed.

The proposed septic system for use on site is the MicroFast 0.5 Waste Water Treatment System with a Type II mound. System details were provided by Mr. Greg Plett with Tanksmart. System details can be found in Appendix A.

Many parameters are significant when considering effluent impact, such as Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), and nitrates. For the purposes of this analysis, nitrogen was used as the contaminant source to assess cumulative impact.

To calculate the areas that would be subject to loading on each residential lot, direction was provided by Greg Plett with Tanksmart. In summary, the loading area was assumed to be a Type II mound which consists of perforated laterals with a gravel bed and sand media.

Loading volumes were based on the estimated volume of flow per day per household. This volume was calculated based on 75 gal/person/day x 1.5 people/bedroom. It was assumed that a 4 bedroom house would be the average in this area, which may be conservative. Calculated volume was 450 gallons per day. Due to using a package treatment system, as per the Saskatchewan Onsite Wastewater Disposal Guidelines, a 30% reduction in the infiltrative surface is required. Actual infiltrative surface area required was calculated to be 450 sq ft/0.63 gallons/sq ft x 0.7. Total surface area of the Type II mound was calculated to be 500 square feet as provided by information provided by TankSmart. A 22.4 ft^2 footprint was used as the mound dimensions for the purposes of modeling.

Finally, concentration of the effluent needed to be defined. This was based on recommended loading rates according to the On-Site Wastewater Treatment Systems in Subdivisions 29 September 2009 Project No SH/SWA H01-2009 Final Report. Effluent nitrate concentration selected was 40 mg/L as N. TankSmart ® loading rates were discussed in the literature, however a loading rate could not be well defined, therefore to be conservative, the recommended loading rate of 40 mg/L was used.

3.0 Field and Laboratory Investigation

3.1 Field Drilling

The subsurface investigation was conducted in two drilling events dated 26 June 2012 and 28 June 2012. Prior subsurface investigation had been conducted in 2008 by Clifton Associates Ltd., however, an initial site investigation conducted on 24 June 2012 indicated that all previously installed piezometers had been destroyed with the exception of one, namely BH104. As such, updated groundwater data was required in response to the request from Saskatoon Health Region to comply to updated standards for approval.

The drilling and installation of the 200 series of piezometers was conducted using a truck-mounted drill rig and 125 mm diameter solid stem continuous flight auger completed from surface to a depth of between 6.0 m to 15.0 m.

Piezometers were logged at 1.5 m intervals and sampled where a change in stratigraphy was noted. Laboratory soil testing consisted of determination of moisture content on all samples and Unified Soil Classifications (USC) performed on selected samples. Results are provided in **Bore Hole Logs and Laboratory Test Data** appended.

Piezometers were constructed using 50 mm diameter Schedule 40 PVC pipe with PVC screens. The piezometers were installed with 1.52 m screen length and the screen was surrounded with either frac sand or slough material while the remainder of the annulus was backfilled with bentonite.

Piezometer locations and elevations were determined by GPS RTK survey. They were referenced to a local coordinate system developed on Site.

Observations made during the field investigations, visual descriptions and the results of laboratory tests are recorded in the **Bore Hole Logs and Laboratory Test Data**, and are appended to this report. An explanation of the symbols and terms used in the bore hole logs is included in the **Symbols and Terms** section of this report.

3.2 Groundwater Monitoring

Methodology

Groundwater elevations were monitored within 6 days of the holes being drilled. Table 3.2 presents the groundwater elevation measurements taken using a 30 m Solinst water level tape. Water levels ranged from 1.21 m to 5.78 m during the July monitoring program. Boreholes and Site Plan Drawing are included in Drawing S1607.7-02. A summary of the monitor well conditions are included in Table 3.2 Site Groundwater Elevations.

Prior to sampling, the groundwater levels in the monitor wells were measured using a 30 m Solinst groundwater level tape. The wells were then purged using dedicated bailers. Purging was intended to remove standing water from the well and surrounding sand pack to ensure that representative formation water was being retrieved from the wells. Approximately three volumes of standing water were purged from the groundwater monitor wells.

Groundwater samples were collected from BH104, BH201, BH202, BH203, BH204, BH206, BH207, BH208, BH210, BH211, BH212 and BH213 on 4 July 2012 and were submitted to ALS Analytical Labs, Saskatoon, Saskatchewan. BH209 was dry at time of sampling. Groundwater samples were analyzed for Routine- Potable Water, Health and Toxicity Metals, Total Coliforms including E. Coli and Heterotrophic Plate Count, and BOD.

Groundwater samples were collected using dedicated bailers and nitrile gloves for each monitor well to reduce any cross-contamination. All samples were preserved with the applicable acid supplied by ALS. The dedicated bailers remain in each monitor well for future monitoring and sampling.

Results

The groundwater sampling results are presented in Table 3.2-2 and the laboratory report attached in Appendix B. Drinking water quality guidelines are presented in Table 3.2-2 for comparison purposes only. Within the development, a communal water supply will be provided and no direct use of groundwater is anticipated.

Geochemistry indicates that exceedances occur most notably groundwater nitrate exceeded the drinking water guidelines in BH203.

Upon investigation of historical land uses, it has been reported that a stock yard was present on Site for a period of 10 years near BH203. Mr. Rick King who is a local to the area reported that there was a cattle and grain farmer in this area for a period of at least 10 years. During this time, a herd of up to 300 head of cattle were managed for long periods of time. Carcasses were reportedly buried on site as well which may create more concerns, particularly BOD loading. He also noted that manure and old hay was disposed in the northwest corner (low area near the pond). Sampling was not completed in this area, as it was not accessible at the time of the Site investigation. This means that there is a potential for a higher nitrate load than 51mg/L near the north area of the pond. In light of this information, consideration of this area and the associated nitrate loading had to be made in the analysis. Therefore in the area of BH203 a loading area of 5000 m^2 was used to simulate current conditions.

TDS, alkalinity, and chlorides were present in the south area near BH207. These elevated values are interpreted to be associated with concentrations due to groundwater evaporation as the water level is close to ground surface in this area.

Metals exceeded drinking water guidelines in several instances. There was no spatial pattern to the exceedances and no source could be identified. They are presumed to be background conditions at this time.

Coliforms and E. coli parameters exceeded guidelines in many of the boreholes. Although, all care was taken to sample without cross contamination of the sample, these results are suspect and not considered further in this report.

3.3 Hydraulic Conductivity

Falling head (slug) tests were performed in 9 of the piezometers installed in June 2012 (BH201, BH202, BH203, BH204, BH207, BH208, BH210, BH211 and BH212) as well as BH104 from the previous investigation. The test is used to determine the hydraulic conductivity of the soil immediately surrounding the piezometer screen. An automated Solinst levelogger was put down the hole, and a metal slug inserted into the groundwater to raise the water above its equilibrium level. The logger records the falling hydraulic head as it comes back to its equilibrium level. The data was analyzed manually by hand as well as using Waterloo Hydrogeologic Aquifer Test program, and the graphical representations of the Hvorslev method analysis are appended to this report in Graphical Analysis of Hydraulic Conductivity (Appendix C). The hydraulic conductivities of the bore holes including their piezometer tip elevation are included in Table 3.3. The piezometers presented in Table 3.3 all had their screen interval within a sand stratum, which generally was some silt to silty, and had trace clay. Most of the piezometers were installed in sloughing conditions. The average hydraulic conductivity of this sand is in the range of 6.9 x 10^{-6} m/s to 9.7 x 10^{-6} m/s.

Table 3.3
Hydraulic Conductivity Results

Piezometer	Bottom of Piezometer Elevation (masl)	Hydraulic Conductivity (Hvorslev)	
		Hand Calculated (m/s)	AquiferTest (m/s)
BH104	504.06	6.86E-06	3.28E-06
BH201	505.5	1.31E-05	1.12E-05
BH202	499.5	1.60E-05	6.57E-06
BH203	505.7	1.01E-06	1.21E-06
BH204	505.2	2.06E-05	1.52E-05
BH207	504.4	6.00E-06	4.53E-06
BH208	506.8	1.80E-05	1.32E-05
BH210	506.9	3.89E-06	1.13E-05
BH211	505.7	9.00E-06	1.58E-06
BH212	496.5	2.18E-06	1.19E-06
Average		9.66E-06	6.93E-06

3.4 Surrounding 1 Kilometer Water Well Investigation

Saskatchewan Watershed Authority website indicated that approximately 52 wells were located within 1 km of Site. Attempts to locate these wells occurred between 29 June 2012 and 3 July 2012. As a result, 30 were identified, geo-referenced and groundwater elevations recorded. Results for this investigation are provided in the attached Table 3.4 Surrounding 1 Kilometer Water Well Investigation. See Drawing S1607.7-04 for locations of the wells.

Pumping activities were not monitored prior to collection of groundwater elevations noted in this report and as such pumping influences were not considered. However, in spite of potential errors due to pumping of domestic wells, a consistent groundwater gradient was established.

4.0 Hydrogeology Analysis

4.1 Stratigraphy

4.1.1 Regional Stratigraphy

The regional stratigraphy was developed from a review of published literature and of regional bore hole logs from the Saskatchewan Watershed Authority water well database.

The bedrock in the area consists of the Snakebite Unit which is part of the Bearpaw Formation (Saskatchewan Watershed Authority, May 2011). Till of the Battleford formation overly this Unit. The Battleford formation is overlain by clay, silt and sand of the Haultain Unit. The surficial lithology consists of upper silt, sand and gravels of the Haultain Unit.

4.1.2 Site Stratigraphy

In the upper most 15 m, local surficial geology consists of interbedded sand and clay.

Stratigraphy on the Site was investigated by drilling and logging 13 boreholes. The stratigraphy generally consisted of about 6.0 m to 15.0 m of stratified glacial drift of clay, silt, and sand overlying glacial till of the Battleford Formation. The clay facies is more prevalent to the south. There is between 150 mm to 750 mm of organic topsoil at the surface.

Drawing No. S1607.7-02 depicts the Bore Hole Location and Site Plan with a stratigraphic cross section index to summarize the lithology of the Site.

Cross Section A-A′ to D-D’ (Drawing No. S1607.7-03) presents further details of geologic Site conditions.

4.2 Hydraulic Gradient

A piezometric surface was developed based on local bore hole groundwater elevations as well as from the regional water wells within a 1 km radius of the site. All groundwater elevations were tied into the local coordinate system developed on Site using RTK GPS data collectors accurate to within five centimeters and referenced to a local coordinate system. A hydraulic gradient was developed based on this surface which was used for modeling purposes.

The result of this analysis indicated that regional flow occurs from the north east, to the west across the central area of the site. The blue lines indicate the piezometric surface as presented in Drawings S1607.7-05 to S1607.7-09. Flow occurs from an elevation of 510.0 m in the north east and decreases to 503.0 m in the west. Flow from the north and south areas of the Site also appears to migrate with the central flow to the west, however flow from the south appears to be less due to a lower hydraulic gradient in this area.

4.3 Contaminant Transport Modeling

A 3D hydrogeologic model using MODFLOW software was developed using the data collected from the field program outlined above. Some of the assumptions made during the development of the model included:

- Source concentration of 40 mg/L and 350 mg/L for the sewage mounds.
- Daily sewage flow of 2045 L/day based on a 4 bedroom home.
- Infiltration is 4% of average precipitation, namely 350 mm yearly.
- 100 year assessment period.
- Zero decay rates.
- Conductivity values vary between 1.8 x10^{-5} m/s and 8.9 x10^{-6} m/s.
- Effective loaded surface area of each disposal mound of 46 m^2.
- Effective loading in existing waste pile area near BH203 assumed to be 5000m^2.

Four modeling scenarios are presented:

Current Conditions

- This included current nitrate impact (51mg/L) near BH203 after 100 years.

Development Conditions - 40 mg/L Loading with Source at BH203

- This included the package treatment system loading with existing nitrate impact near BH203 after 100 years.

Development Conditions - 40 mg/L Loading without Source at BH203

- This included the package treatment system loading without existing nitrate impact near BH203 after 100 years.

Conventional - 350 mg/L Loading Source at BH203

- This included the conventional loading (which is comparable to raw sewage) with existing nitrate impact near BH203. The loading used was recommended by Saskatoon Public Health.

Conventional - 350 mg/L Loading Without Source at BH203

- This included the conventional loading system with without nitrate impact near BH203 after 100 years.

The results are presented in Drawings S1607.7-05 to S1607.7-09.

5.0 Discussion

Maximum localized on site nitrate concentrations of up to 250 mg/L are predicted. This occurred at BH212 in the south east region of the Site under a high nitrate load of 350 mg/L. In these conditions however, off site concentrations did not exceed 1.0 mg/L in this area. This scenario is presented for comparison only as the proposed development is proposing to load the Type II mounds with approximately 10% of this concentration.

Due to what appears to be historical land use practices, background concentrations of nitrates currently exceed Saskatchewan Drinking Water Standards and Objectives. In all model scenarios that consider this, which are presented in Drawing numbers S1607.7-05, S1607.7-06 and S1607.7-08 the maximum nitrate concentrations off site remain the same, namely 30 mg/L, the only difference in these models, are the extent of the plumes. The Development Condition Models that do not consider this background nitrate concentration, namely Drawing numbers S1607.7-07 and S1607.7-09, effectively model conditions that can exist if this nitrate source is removed. In these scenarios, the proposed development causes a cumulative off site impact which does not exceed 1.0 mg/L.

Plume developments when a background source was not considered were predictably lower concentrations.

All modeling conducted was conservative in an effort to present the worst case scenario. The conservative nature of the parameters used in the modeling are summarized as follows:

- Loading concentrations used in the model Developed Conditions are likely 70% higher than the proposed FAST® Wastewater disposal systems that are proposed to be used.

- Rainfall precipitation was assumed to be 4% of average precipitation which is a conservative value.

- Decay rates were not considered although research has indicated that half-life of nitrate is in the range of 1-2.3 years. Source- *Almasri, Mohammad N., Kaluarachchi, Jagath J. Modeling nitrate contamination of groundwater in agricultural watersheds. Journal of Hydrology. 2007.*

Results from the modeling that do not include a background source at BH203 are presented for comparison purposes and to understand the potential result of mitigation of the nitrate source on Site. These results indicate that background impact can potentially be mitigated by removal of the nitrate source which based on our investigation is anticipated to be localized as a result of a previous stock yard and associated manure disposal practices.

In summary, the cumulative effects of the proposed sewage disposal systems do not result in off-site nitrate concentrations in excess of drinking water standards.

5.1 Recommendations

Existing conditions of the site appear to have background impact from several potential sources. In terms of nitrogen impacts, there does not appear to be a concern for cumulative impact due to the subdivision development. This assumption is based on available data presented from the subsurface investigation. However, it would be prudent to assess the following to manage and mitigate existing conditions on Site:

- Monitor upstream flow onto the Site, namely place piezometers on the eastern border of the Site for all parameters noted in this report.

- Delineate and remove the source of nitrogen in the north area, around BH203 and area where reported manure disposal occurred to prevent further impact and improve the aesthetic features of the land.

- Continuing groundwater monitoring to evaluate current Site conditions.

6.0 Closure

This report was prepared by Clifton Associates Ltd. for the use of the Urban Elements Development Corporation and their agents for specific application to the proposed Grasswood Subdivision. The material in it reflects Clifton Associates Ltd. best judgment available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Clifton Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report has been prepared in accordance with generally accepted engineering practice common to the local area. No other warranty, expressed or implied, is made.

Our conclusions and recommendations are preliminary and based upon the information obtained from the referenced subsurface exploration. The boreholes and associated laboratory testing indicate subsurface and groundwater conditions only at the specific locations and times investigated, only to the depth penetrated and only for the soil properties tested. The subsurface conditions may vary between the boreholes and with time. The subsurface interpretation provided is a professional opinion of conditions and not a certification of the site conditions. The nature and extent of subsurface variation may not become evident until construction or further investigation. If variations or other latent conditions do become evident, Clifton Associates Ltd. should be notified immediately so that we may re-evaluate our conclusions and recommendations.

The enclosed report contains the results of our investigations as well as certain recommendations arising out of such investigations. Our recommendations do not constitute a design, in whole or in part, of any of the elements of the proposed work. Incorporation of any or all of our recommendations into the design of any such element does not constitute us as designers or co-designers of such elements, nor does it mean that such design is appropriate in geotechnical terms. The designers of such elements must consider the appropriateness of our recommendations in the light of all design criteria known to them, many of which may not be known to us. Our mandate has been to investigate and recommend which we have completed by means of this report. We have had no mandate to design, or review the design of, any elements of the proposed work and accept no responsibility for such design or design review.

Clifton Associates Ltd.

Cindy Friesen, Geoscientist in Training

Natalya Sapova, P.Eng.

David D. Kent, P.Eng.

Association of Professional
Engineers of Saskatchewan
Cert. of Authorization No. 238

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Saskatchewan Watershed Authority, 3 July 2012. Water Well database search Well GIS Data Portal. https://gis.swa.ca/

On-Site Wastewater Treatment Systems in Subdivisions 29 September 2009

Project No SH/SWA H01-2009 Final Report

Almasri, Mohammad N., Kaluarachchi, Jagath J. Modeling nitrate contamination of groundwater in agricultural watersheds. Journal of Hydrology. 2007.

Saskatchewan Onsite Wastewater Disposal Guide. Saskatchewan Health. 2007.

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Symbols and Terms

Soil Descriptive Terms

A soil description for geotechnical applications includes a description of the following properties:

- texture
- color, oxidation
- consistency and condition
- primary and secondary structure

Texture

The soil texture refers to the size, size distribution and shape of the individual soil particles which comprise the soil. The Unified Soil Classification System (ASTM D2487-00) is a quantitative method of describing the soil texture. The basis of this system is presented overleaf. The following terms are commonly used to describe the soil texture.

Particle Size
(ASTM D2487-00)

Boulder	300 mm plus
Cobble	75 - 300 mm
Gravel	4.75 - 75 mm
Coarse	19 - 75 mm
Fine	4.75 - 19 mm
Sand	0.075 - 4.75 mm
Coarse	2 - 4.75 mm
Medium	0.425 - 2 mm
Fine	0.075 - 0.425 mm
Silt and Clay	Smaller than 0.075 mm

Relative Proportions
(CFEM, 3rd Ed., 1992)

Trace	1 - 10 %
Some	10 - 20 %
Gravelly, sandy, silty, clayey, etc.	20 - 35 %
And	>35 %
Gravel, Sand, Silt, Clay	>35 % and main fraction

Gradation

Well Graded	Having a wide range of grain sizes and substantial amount of all intermediate sizes.
Uniform or Poorly Graded	Possessing particles of predominantly one size.
Gap Graded	Possessing particles of two distinct sizes.

Particle Shape

Angular	Sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Similar to 'angular' but have rounded edges.
Subrounded	Well-rounded corners and edges, nearly plane sides.
Rounded	No edges and smoothly curved sides.

Also may be flat, elongated or both.

The term "TILL" may be used as a textural term to describe a soil which has been deposited by glaciers and contains an unsorted, wide range of particle sizes.

Color And Oxidation

The soil color at its natural moisture content is described by common colors and, quantitatively, in terms of the Munsell color notation; (eg. 5Y 3/1). The notation combines three variables, hue, value and chroma to describe the soil color. The hue indicates its relation to red, yellow, green, blue and purple. The value indicates its lightness. The chroma indicates its strength of departure from a neutral of the same lightness.

Departure of the soil color from a neutral color indicates the soil has been oxidized. Oxidation of a soil occurs in a oxygen rich environment where most commonly metallic iron, oxidizes and turns a neutral colored soil 'rusty' or reddish brown. Oxidized manganese gives a purplish tinge to the soil. Oxidation may occur throughout the entire soil mass or on fracture/joint/fissure surfaces.

Consistency And Condition

The consistency of a cohesive soil is a qualitative description of its resistance to deformation and can be correlated with the undrained shear strength of the soil. The condition of a coarse grained soil qualitatively describes the soil compactness and can be correlated with the standard penetration resistance (ASTM D1586-99).

Consistency Of Cohesive Soil (CFEM, 3rd Edit., 1992)

Consistency	Undrained Shear Strength (kPa) (CFEM, 3rd Edt., 1992)	Field Identification (ASTM D 2488-00)
Very Soft	<12	Thumb will penetrate soil more than 25 mm.
Soft	12-25	Thumb will penetrate soil about 25 mm.
Firm	25-50	Thumb will indent soil about 6 mm.
Stiff	50-100	Thumb will indent, but penetrate only with great effort (CFEM).
Very Stiff	100-200	Readily indented by thumbnail (CFEM).
Hard	>200	Thumb will not indent soil but readily indented with thumbnail.
Very Hard	N/A	Thumbnail will not indent soil.

Condition Of Coarse Grained Soil (CFEM, 3rd Edt., 1992)

Compactness Condition	SPT N - Index (Blows/300mm)
Very Loose	0 - 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very Dense	over 50

Moisture Conditions (ASTM D2488-00)

Description	Criteria
Dry	Absence of moisture, dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible, free water, usually soil is below water table

Structure

The soil structure is the manner in which the individual soil particles are assembled to form the soil mass. The primary soil structure is the arrangement of soil particles as originally deposited. The secondary soil structure refers to any rearrangement of the soil such as deformation and cracking which has taken place since deposition.

Primary Soil Structure (Depositional)

A. Geometry

Stratum - A single sedimentary 'layer', greater than 10 mm in thickness, visibly separable from other strata by a discrete change in lithology and/or sharp physical break.
Homogeneous - Same color and appearance throughout.
Stratified - Consisting of a sequence of layers which are generally of contrasting texture or color.
Laminated - Stratified with layer thicknesses between 2 mm and 10 mm.
Thinly laminated - Stratified with layer thickness less than 2 mm.
Bedded - Stratified with layer thicknesses greater than 10 mm.
Very Thinly Bedded (Flaggy) - Stratified with layer thicknesses between 10 and 50 mm.
Thinly Bedded (Slabby) - Stratified with layer thicknesses between 50 and 600 mm.
Thickly Bedded (Blocky) - Stratified with layer thicknesses between 600 and 1200 mm.
Thick-Bedded (Massive) - Stratified with layer thicknesses greater than 1200 mm.
Lensed - Inclusions of small pockets of different soils, such as small lenses of sand material throughout a mass of clay.

B. Bedding Structures

Cross-bedding - Internal 'bedding' inclined to the general bedding plane.
Ripple-bedding - Internal 'wavy bedding'.
Graded-bedding - Internal gradation of grain size from coarse at base to finer at top of bed.
Horizontal bedded - Internal bedding is parallel and flat lying

Secondary Soil Structure (Post-Depositional)

A. Accretionary Structures

Includes nodules, concretions, crystal aggregates, veinlets, color banding and

Cementation - Chemically precipitated material, commonly calcite ($CaCO_3$), binds the grains of soil, usually sandstone. Described as weak, moderate, strong (ASTM D2488-00).
Salt Crystals - Groundwater flowing through the soil/rock often precipitates visible amounts of salts. Calcite ($CaCO_3$), glauber salts ($Na_2Ca(SO_4)_2$), and gypsum ($CaSO_4*2H_2O$) are common.

B. Fracture Structures

Fracture - A break or discontinuity in the soil or rock mass caused by stress exceeding the materials strength.
Joint - A fracture along which no displacement has occurred.
Fissure - A gapped fracture, which may open and close seasonally. Usually an extensive network of closely spaced fractures, giving the soil a 'nuggetty' structure.
Slickensides - Fractures in a clay that are slick and glossy in appearance, caused by shear movements.
Brecciated - Contains randomly oriented angular fragments in a finer mass, usually associated with shear displacements in soils.
Fault - A fracture or fracture zone along which there has been displacement.
Blocky - A cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Symbols Used on Bore Hole Logs

Lithology Type

- ▤ CLAY
- ▒ SILT
- ▒ SAND
- ▒ GRAVEL
- ▒ COBBLES
- ▨ TILL-oxidized
- ▨ TILL-unoxidized
- ▒ PEAT
- ▨ TOPSOIL or ORGANIC SOIL
- ▒ COAL
- ▒ FILL (Undifferentiated)
- ▒ CONCRETE
- ■ ASPHALT
- ▤ CLAY SHALE
- ▒ SANDSTONE
- ▨ MUDSTONE
- ▨ BEDROCK (Undifferentiated)

Borehole Completion and Backfill Materials

- ■ Bentonite
- ▒ Concrete
- ▦ Cover
- ▨ Cuttings
- ▒ Grout
- ▒ Sand
- ▧ Slough
- □ Solid Pipe
- ▤ Slotted Pipe

Soil Sample Type

- ■ Thin Walled Tube
- ▨ Driven Spoon
- ▤ Disturbed
- ▥ Core (any type)
- ▨ No Recovery

Groundwater Symbols

▼ Piezometric elevation as determined by a piezometer installation

▽ Water levels measured in borings at the time and under the conditions noted

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Bore Hole Logs
and
Laboratory Test Data

Clifton Associates Ltd.
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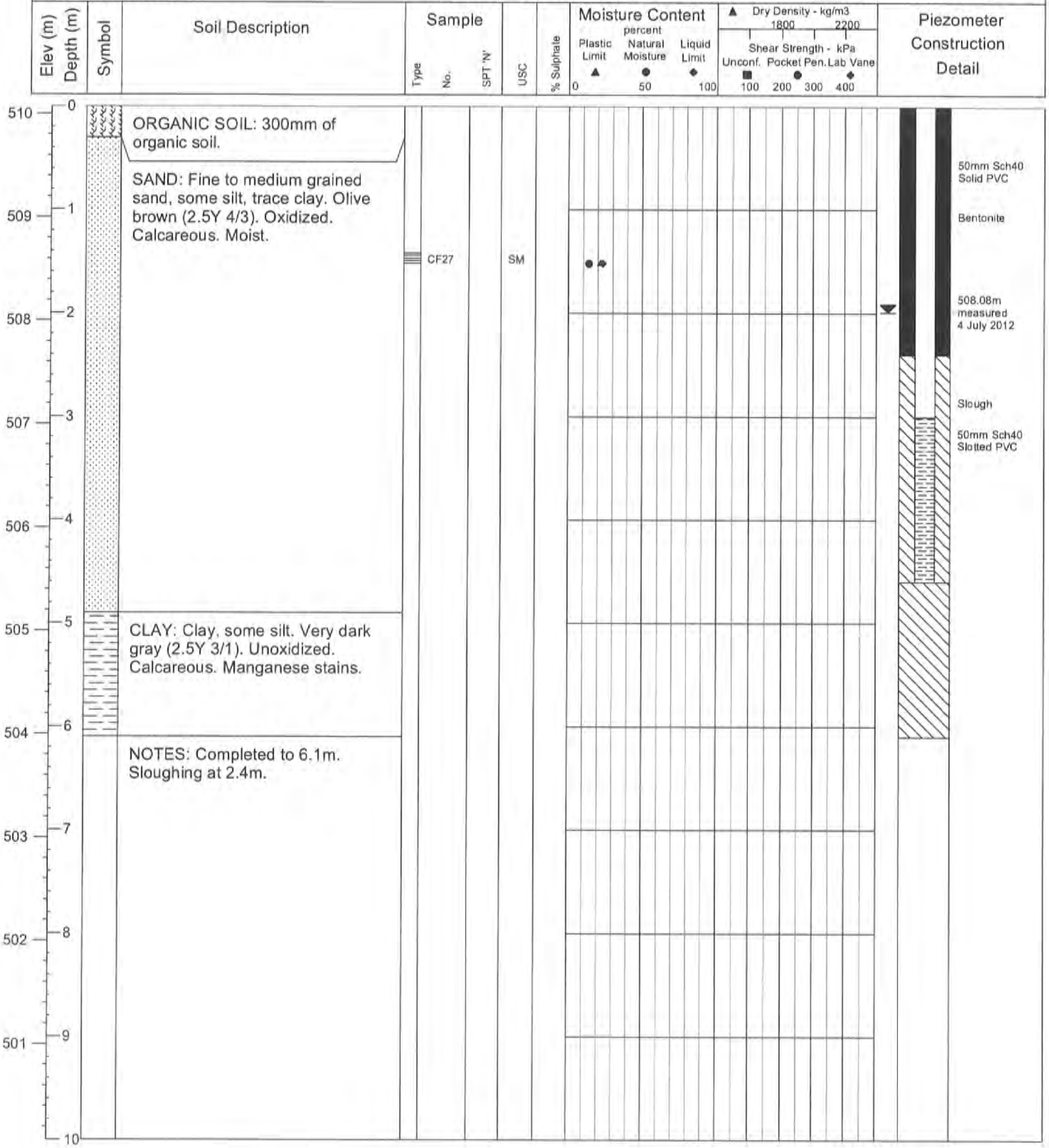
BORE HOLE LOG

Bore Hole: 201
Page: 1 of 1

Client:	Urban Elements Development Corp.	Northing:	10456.704m	Date Drilled:	28 June 2012
Project:	Grasswood Estates	Easting:	5699.239m	Drill:	CME
Location:	Saskatoon, SK	Ground Elev.:	510.074m	Drilling Method:	Solid Stem
Project No.:	S1607.7	Top Casing Elev.:	511.195m	Logged by:	JR



ORGANIC SOIL: 300mm of organic soil.

SAND: Fine to medium grained sand, some silt, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist.

CLAY: Clay, some silt. Very dark gray (2.5Y 3/1). Unoxidized. Calcareous. Manganese stains.

NOTES: Completed to 6.1m. Sloughing at 2.4m.

Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m³
1.52	CF27	Bag		13.7	21.6	23.0	1.3	SM	0.0	81.5	18.5						

Remarks:

Approved by:

Clifton Associates Ltd.
engineering science technology

Project Hydrogeology Investigation
Location Grasswood Area, near Saskatoon, SK
Project No. S1607.7

Borehole No.
201

Geotech BH m Elev CAL v07.ldf

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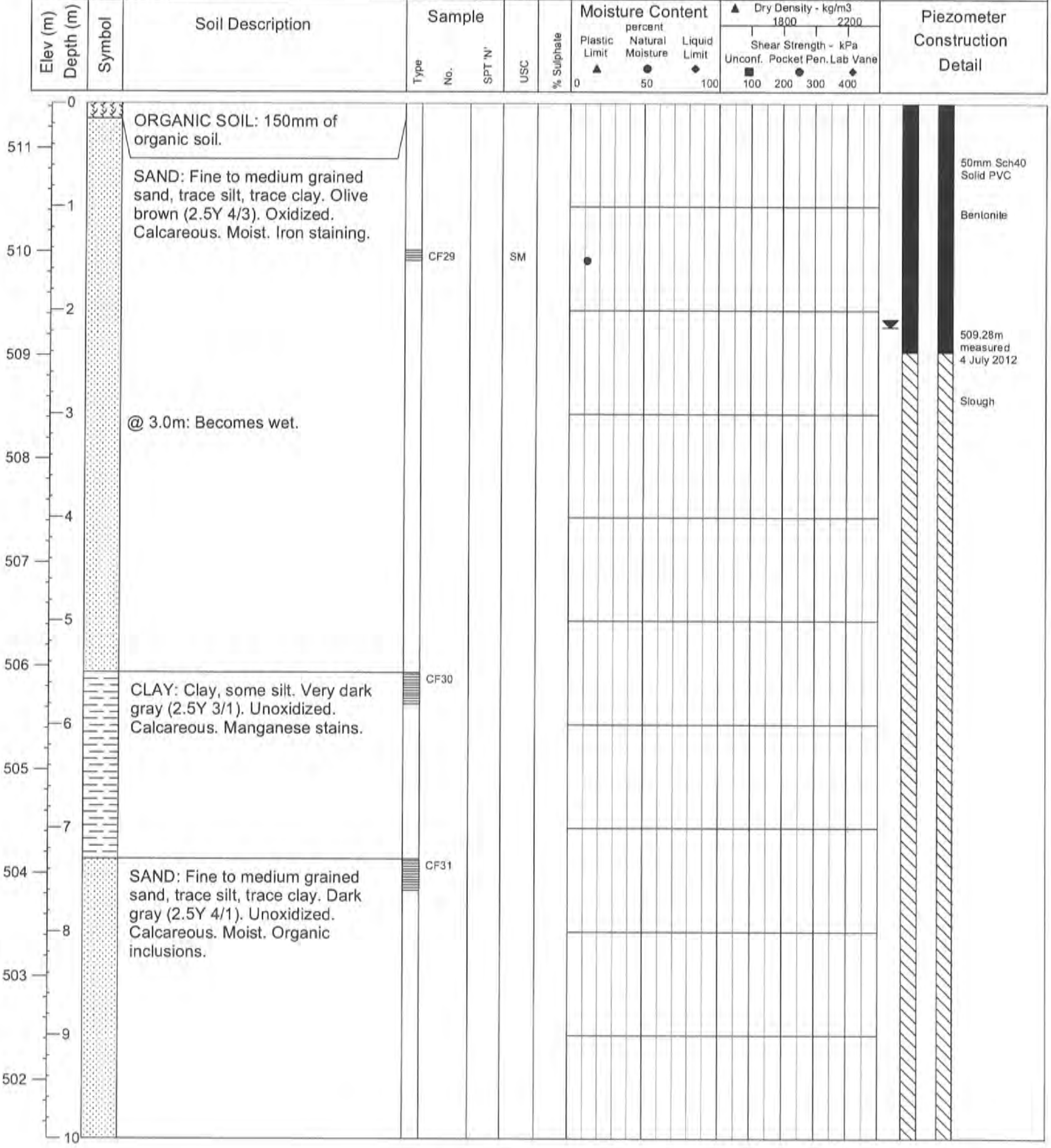
BORE HOLE LOG

Bore Hole: 202
Page: 1 of 2

Client:	Urban Elements Development Corp.	Northing:	10531.515m	Date Drilled:	28 June 2012
Project:	Grasswood Estates	Easting:	5500.573m	Drill:	CME
Location:	Saskatoon, SK	Ground Elev.:	511.436m	Drilling Method:	Solid Stem
Project No.:	S1607.7	Top Casing Elev.:	512.498m	Logged by:	JR



ORGANIC SOIL: 150mm of organic soil.

SAND: Fine to medium grained sand, trace silt, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.

@ 3.0m: Becomes wet.

CLAY: Clay, some silt. Very dark gray (2.5Y 3/1). Unoxidized. Calcareous. Manganese stains.

SAND: Fine to medium grained sand, trace silt, trace clay. Dark gray (2.5Y 4/1). Unoxidized. Calcareous. Moist. Organic inclusions.

Geotech BH m Elev CAL v07.ldf

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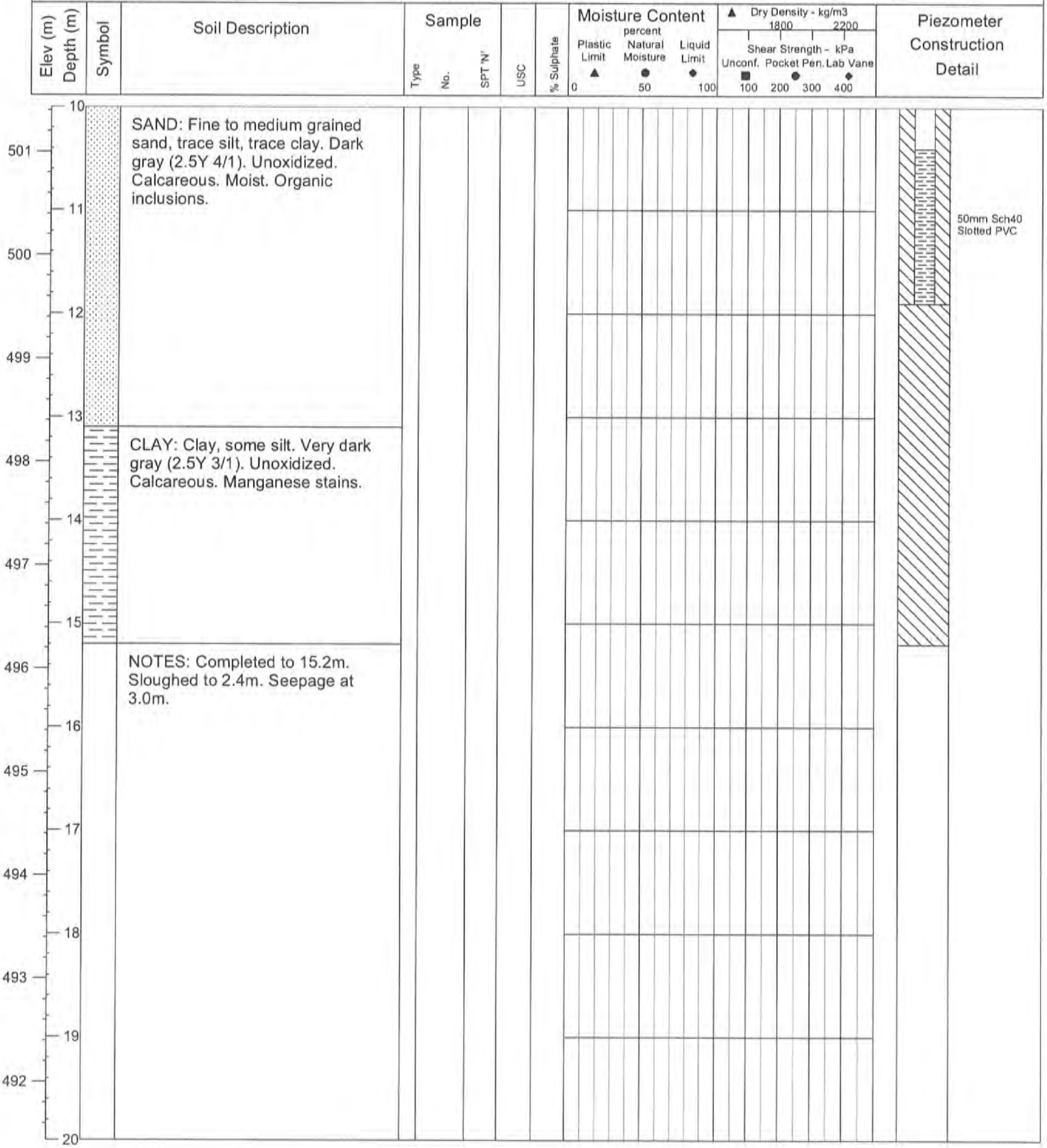
BORE HOLE LOG

Bore Hole: 202
Page: 2 of 2

Client:	Urban Elements Development Corp.	Northing:	10531.515m	Date Drilled:	28 June 2012
Project:	Grasswood Estates	Easting:	5500.573m	Drill:	CME
Location:	Saskatoon, SK	Ground Elev.:	511.436m	Drilling Method:	Solid Stem
Project No.:	S1607.7	Top Casing Elev.:	512.498m	Logged by:	JR



SAND: Fine to medium grained sand, trace silt, trace clay. Dark gray (2.5Y 4/1). Unoxidized. Calcareous. Moist. Organic inclusions.

CLAY: Clay, some silt. Very dark gray (2.5Y 3/1). Unoxidized. Calcareous. Manganese stains.

NOTES: Completed to 15.2m. Sloughed to 2.4m. Seepage at 3.0m.

Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
1.52	CF29	Bag		11.6		Non Plastic		SM	0.0	75.3	24.7						

Remarks:

Approved by:

Clifton Associates Ltd.
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Project	Hydrogeology Investigation
Location	Grasswood Area, near Saskatoon, SK
Project No.	S1607.7

Borehole No.

202

Geotech BH m Elev CAL v07.ldt

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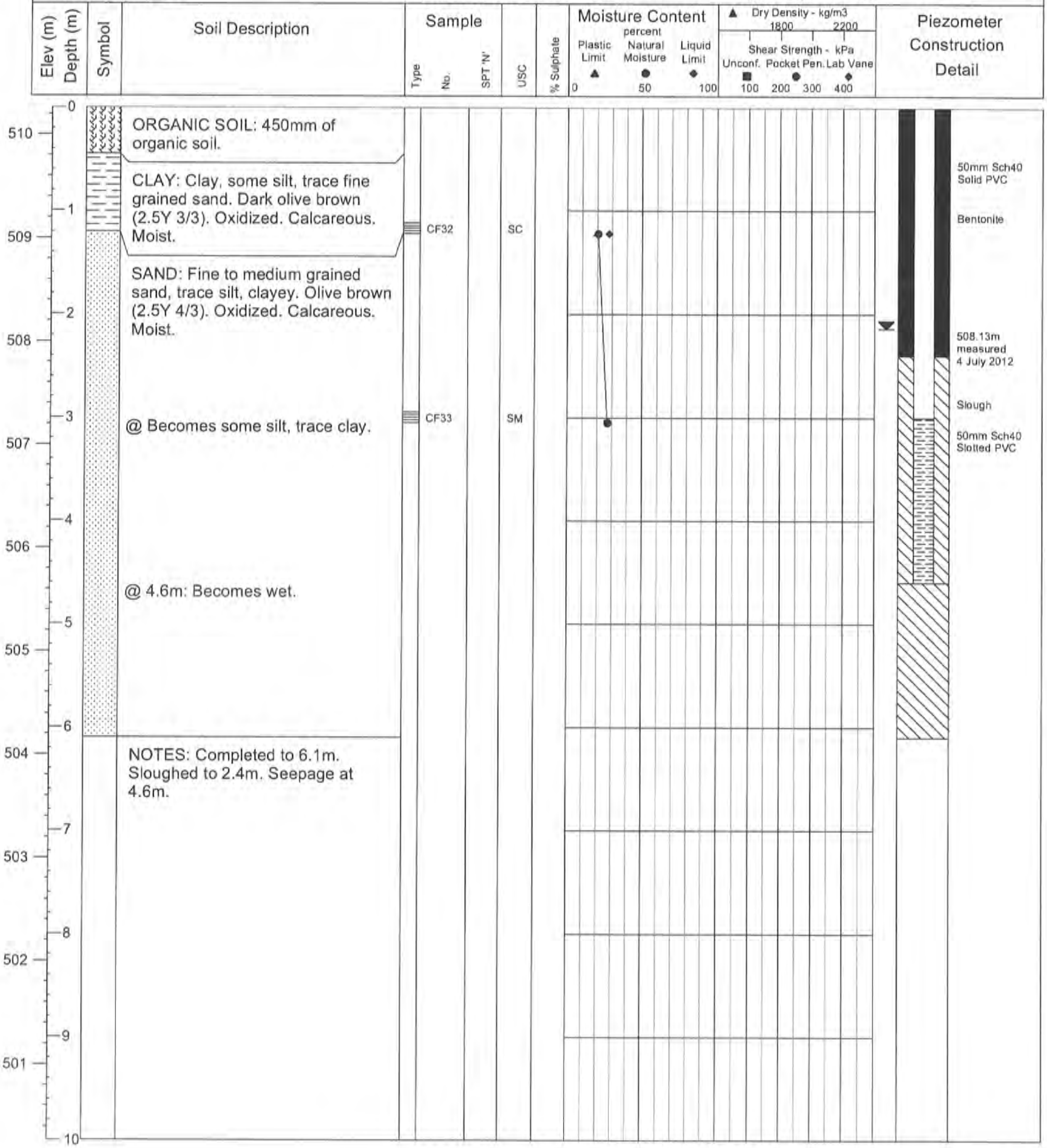
BORE HOLE LOG

Bore Hole: 203
Page: 1 of 1

Client: Urban Elements Development Corp.
Project: Grasswood Estates
Location: Saskatoon, SK
Project No.: S1607.7

Northing: 10336.175m
Easting: 5512.287m
Ground Elev.: 510.265m
Top Casing Elev.: 511.309m

Date Drilled: 28 June 2012
Drill: CME
Drilling Method: Hollow Stem
Logged by: JR



ORGANIC SOIL: 450mm of organic soil.

CLAY: Clay, some silt, trace fine grained sand. Dark olive brown (2.5Y 3/3). Oxidized. Calcareous. Moist.

SAND: Fine to medium grained sand, trace silt, clayey. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist.

@ Becomes some silt, trace clay.

@ 4.6m: Becomes wet.

NOTES: Completed to 6.1m. Sloughed to 2.4m. Seepage at 4.6m.

No.	USC
CF32	SC
CF33	SM

Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
1.22	CF32	Bag		20.6	19.4	27.7	8.3	SC	0.0	52.1	47.9						
3.05	CF33	Bag		26.9	Non Plastic			SM	0.0	80.8	19.2						

Remarks:

Approved by:

Clifton Associates Ltd.
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Project Hydrogeology Investigation
Location Grasswood Area, near Saskatoon, SK
Project No. S1607.7

Borehole No.
203

Geotech BH m Elev CAL v07.tdf

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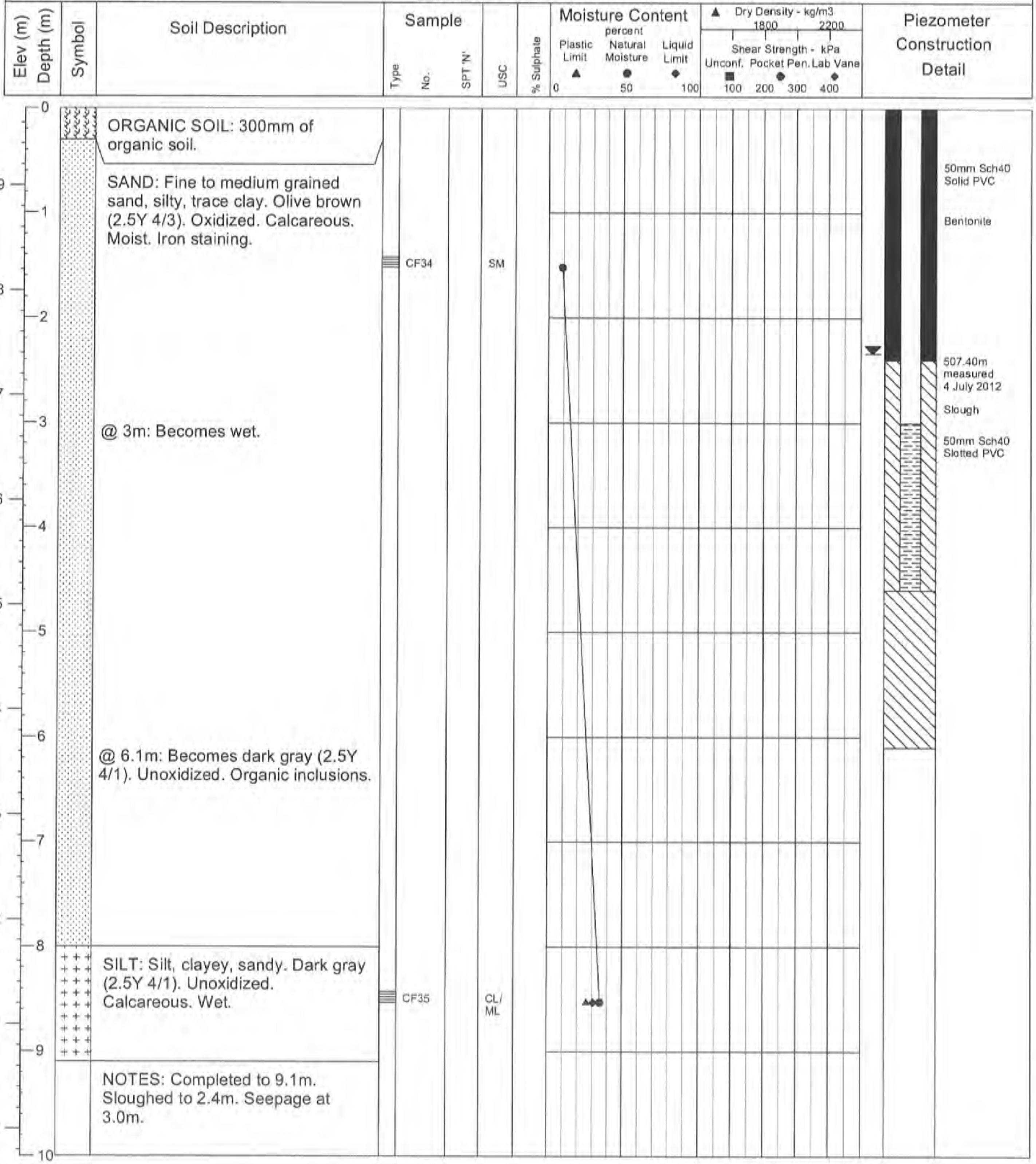
BORE HOLE LOG

Bore Hole: 204
Page: 1 of 1

Client:	Urban Elements Development Corp.	Northing:	10026.538m	Date Drilled:	28 June 2012
Project:	Grasswood Estates	Easting:	5597.994m	Drill:	CME
Location:	Saskatoon, SK	Ground Elev.:	509.740m	Drilling Method:	Solid Stem
Project No.:	S1607.7	Top Casing Elev.:	510.795m	Logged by:	JR



ORGANIC SOIL: 300mm of organic soil.

SAND: Fine to medium grained sand, silty, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.

@ 3m: Becomes wet.

@ 6.1m: Becomes dark gray (2.5Y 4/1). Unoxidized. Organic inclusions.

SILT: Silt, clayey, sandy. Dark gray (2.5Y 4/1). Unoxidized. Calcareous. Wet.

NOTES: Completed to 9.1m. Sloughed to 2.4m. Seepage at 3.0m.

Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
1.52	CF34	Bag		9.0	Non Plastic			SM	0.0	85.1	24.9						
8.53	CF35	Bag		35.3	26.1	30.6	4.5	CL-ML	0.0	29.4	70.6						

Remarks:

Approved by:

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Project Hydrogeology Investigation
Location Grasswood Area, near Saskatoon, SK
Project No. S1607.7

Borehole No.
204

Geotech BH m Elev CAL v07.ldf

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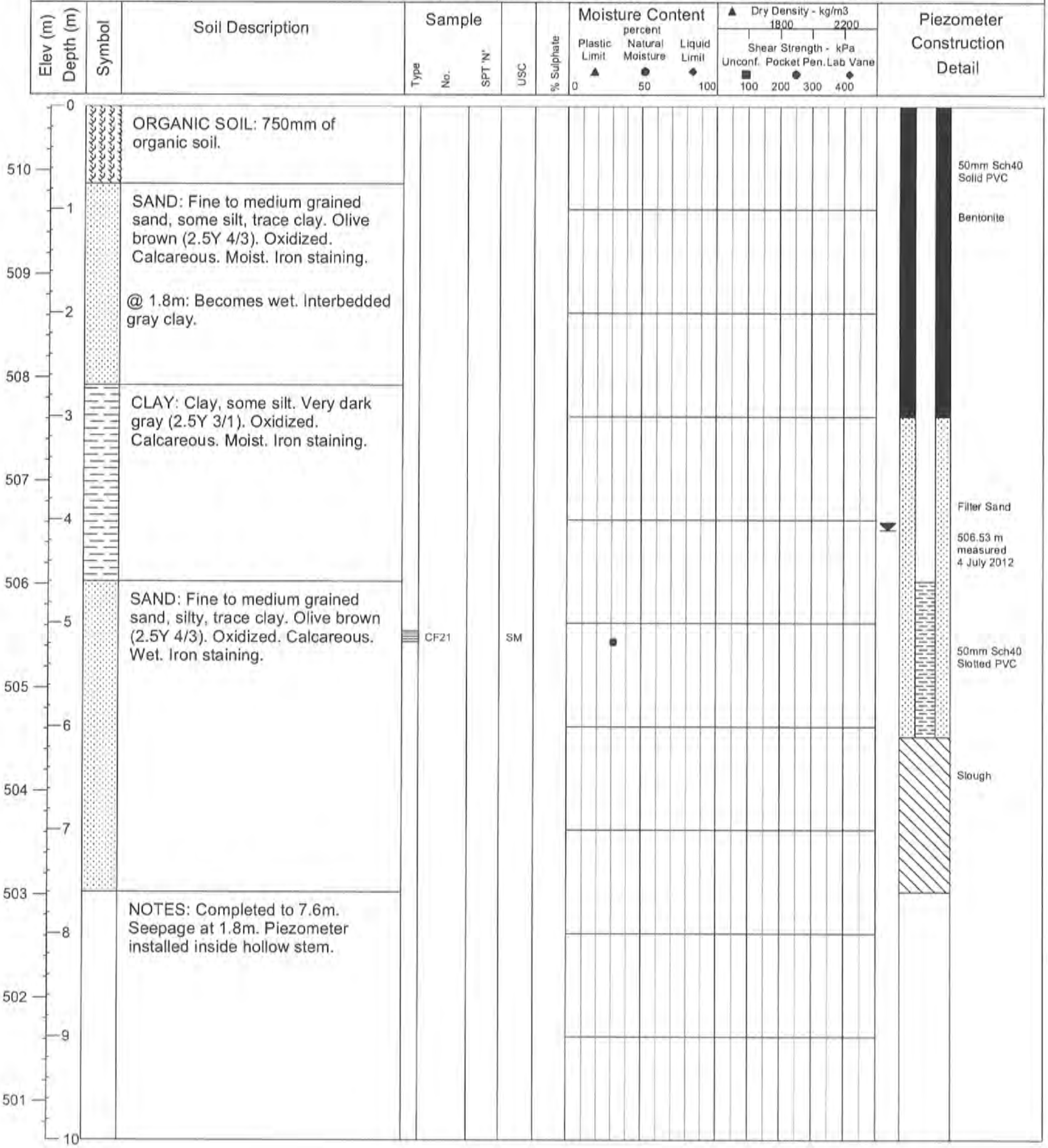
BORE HOLE LOG

Bore Hole: 205
Page: 1 of 1

Client: Urban Elements Development Corp.
Project: Grasswood Estates
Location: Saskatoon, SK
Project No.: S1607.7

Northing: 9789.895m
Easting: 5285.498m
Ground Elev.: 510.625m
Top Casing Elev.: 511.567m

Date Drilled: 28 June 2012
Drill: CME
Drilling Method: Hollow Stem
Logged by: JR



ORGANIC SOIL: 750mm of organic soil.

SAND: Fine to medium grained sand, some silt, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.

@ 1.8m: Becomes wet. Interbedded gray clay.

CLAY: Clay, some silt. Very dark gray (2.5Y 3/1). Oxidized. Calcareous. Moist. Iron staining.

SAND: Fine to medium grained sand, silty, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Wet. Iron staining.

NOTES: Completed to 7.6m. Seepage at 1.8m. Piezometer installed inside hollow stem.

Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
5.18	CF21	Bag		31.3	Non Plastic			SM	0.0	70.2	29.8						

Remarks:

Approved by:

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Project Hydrogeology Investigation
Location Grasswood Area, near Saskatoon, SK
Project No. S1607.7

Borehole No.
205

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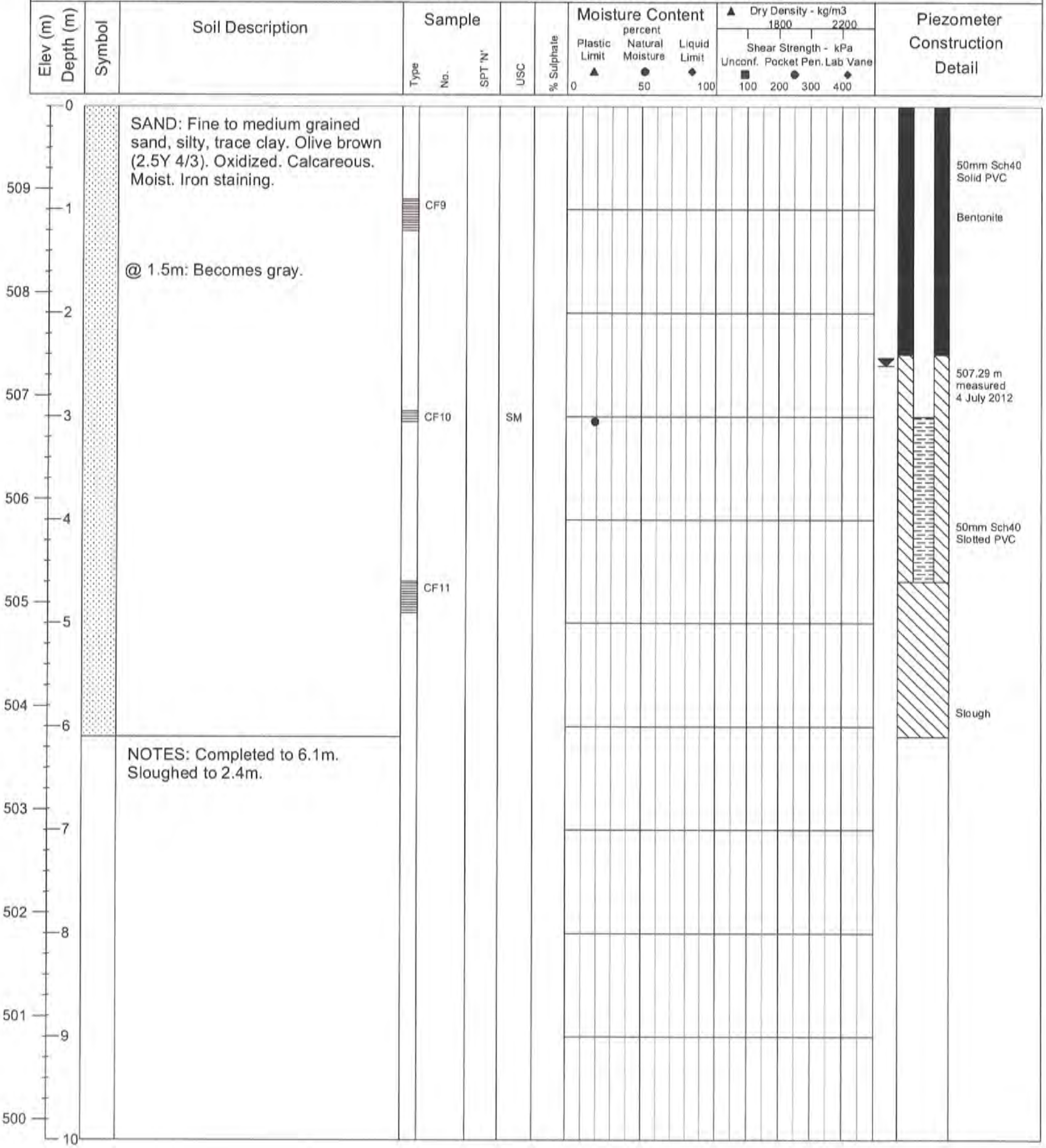
BORE HOLE LOG

Bore Hole: 206
Page: 1 of 1

Client:	Urban Elements Development Corp.	Northing:	9353.173m	Date Drilled:	28 June 2012
Project:	Grasswood Estates	Easting:	5281.355m	Drill:	CME
Location:	Saskatoon, SK	Ground Elev.:	509.803m	Drilling Method:	Solid Stem
Project No.:	S1607.7	Top Casing Elev.:	510.736m	Logged by:	JR



SAND: Fine to medium grained sand, silty, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.

@ 1.5m: Becomes gray.

NOTES: Completed to 6.1m. Sloughed to 2.4m.

Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
3.05	CF10	Bag		18.9		Non Plastic		SM	0.0	71.8	28.2						

Remarks:

Approved by:

Clifton Associates Ltd.
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Project	Hydrogeology Investigation
Location	Grasswood Area, near Saskatoon, SK
Project No.	S1607.7

Borehole No.

206

Geotech BH m Elev CAL v07.ldf

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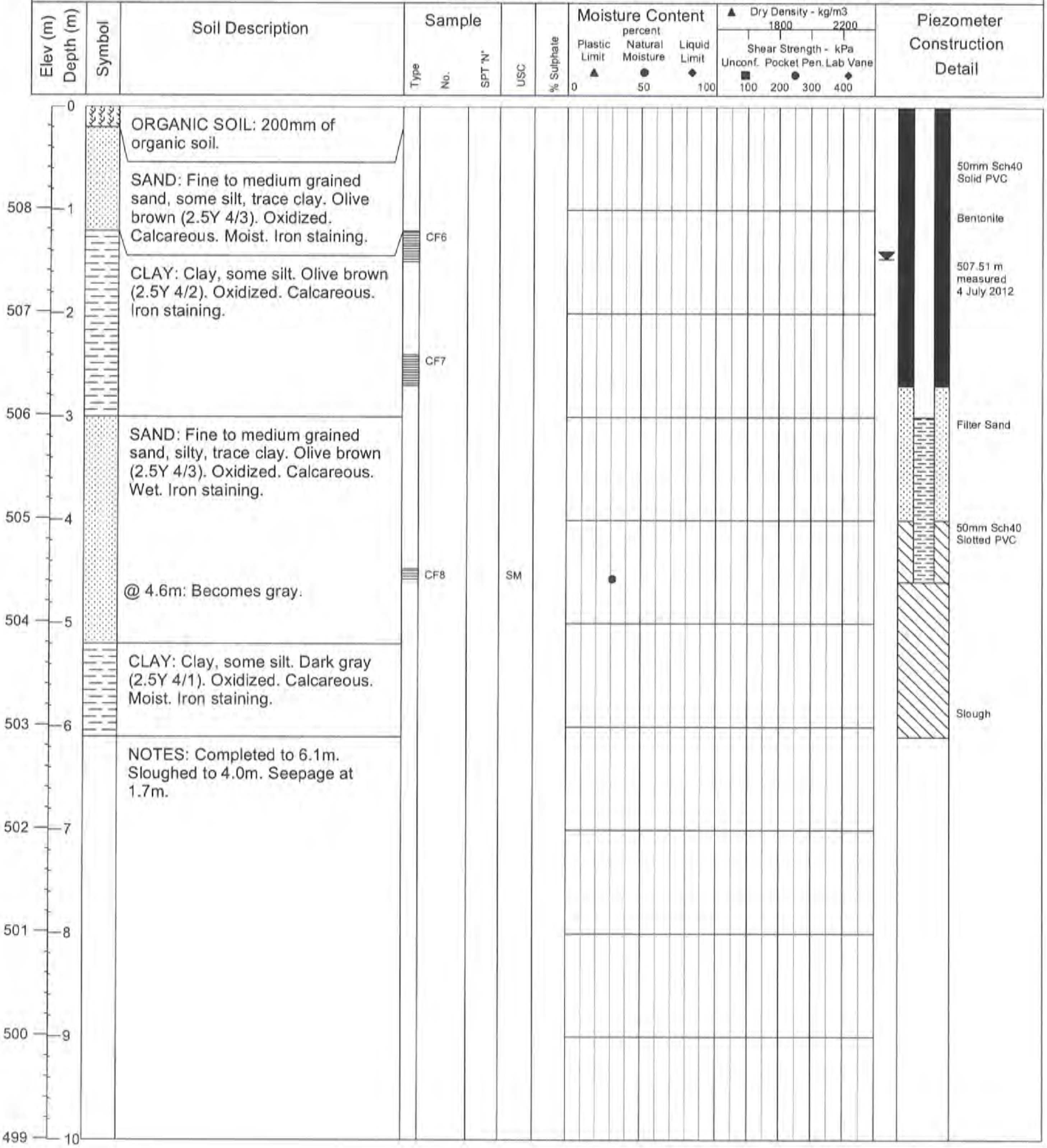
BORE HOLE LOG

Bore Hole: 207
Page: 1 of 1

Client: Urban Elements Development Corp.
Project: Grasswood Estates
Location: Saskatoon, SK
Project No.: S1607.7

Northing: 9457.629m
Easting: 5634.255m
Ground Elev.: 508.982m
Top Casing Elev.: 509.903m

Date Drilled: 28 June 2012
Drill: CME
Drilling Method: Solid Stem
Logged by: JR



ORGANIC SOIL: 200mm of organic soil.

SAND: Fine to medium grained sand, some silt, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.

CLAY: Clay, some silt. Olive brown (2.5Y 4/2). Oxidized. Calcareous. Iron staining.

SAND: Fine to medium grained sand, silty, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Wet. Iron staining.

@ 4.6m: Becomes gray.

CLAY: Clay, some silt. Dark gray (2.5Y 4/1). Oxidized. Calcareous. Moist. Iron staining.

NOTES: Completed to 6.1m. Sloughed to 4.0m. Seepage at 1.7m.

Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
4.57	CF8	Bag		30.8	Non Plastic			SM	0.0	80.3	19.7						

Remarks:

Approved by:

Clifton Associates Ltd.
engineering science technology

Project Hydrogeology Investigation
Location Grasswood Area, near Saskatoon, SK
Project No. S1607.7

Borehole No.
207

Geotech BH m Elev CAL v07.ldf

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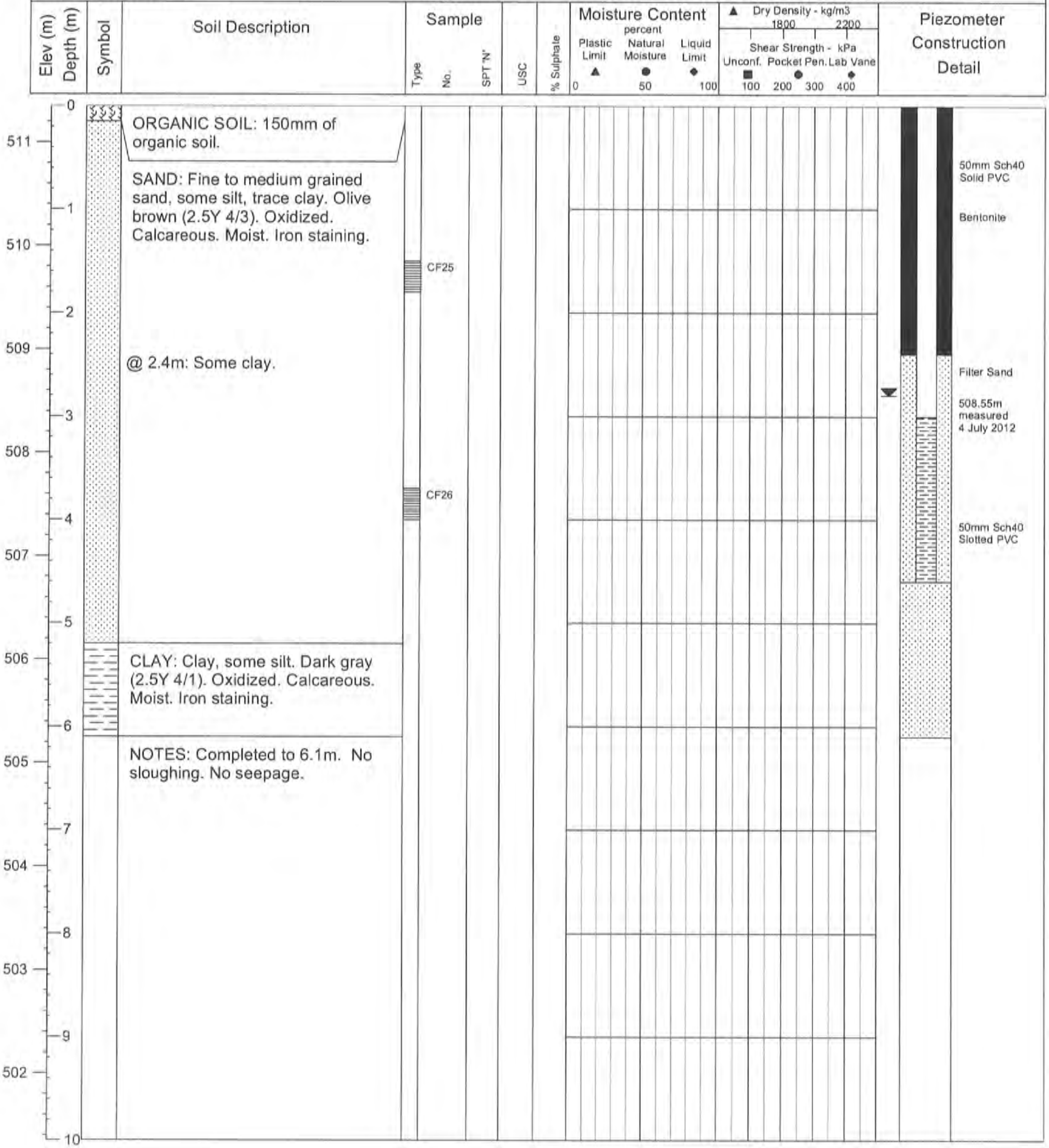
BORE HOLE LOG

Bore Hole: 208
Page: 1 of 1

Client:	Urban Elements Development Corp.	Northing:	10561.860m	Date Drilled:	28 June 2012
Project:	Grasswood Estates	Easting:	5202.471m	Drill:	CME
Location:	Saskatoon, SK	Ground Elev.:	511.351m	Drilling Method:	Solid Stem
Project No.:	S1607.7	Top Casing Elev.:	512.366m	Logged by:	JR



ORGANIC SOIL: 150mm of organic soil.

SAND: Fine to medium grained sand, some silt, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.

@ 2.4m: Some clay.

CLAY: Clay, some silt. Dark gray (2.5Y 4/1). Oxidized. Calcareous. Moist. Iron staining.

NOTES: Completed to 6.1m. No sloughing. No seepage.

Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m³

Remarks:

Approved by:

Clifton Associates Ltd.
engineering science technology

Project	Hydrogeology Investigation
Location	Grasswood Area, near Saskatoon, SK
Project No.	S1607.7

Borehole No.
208

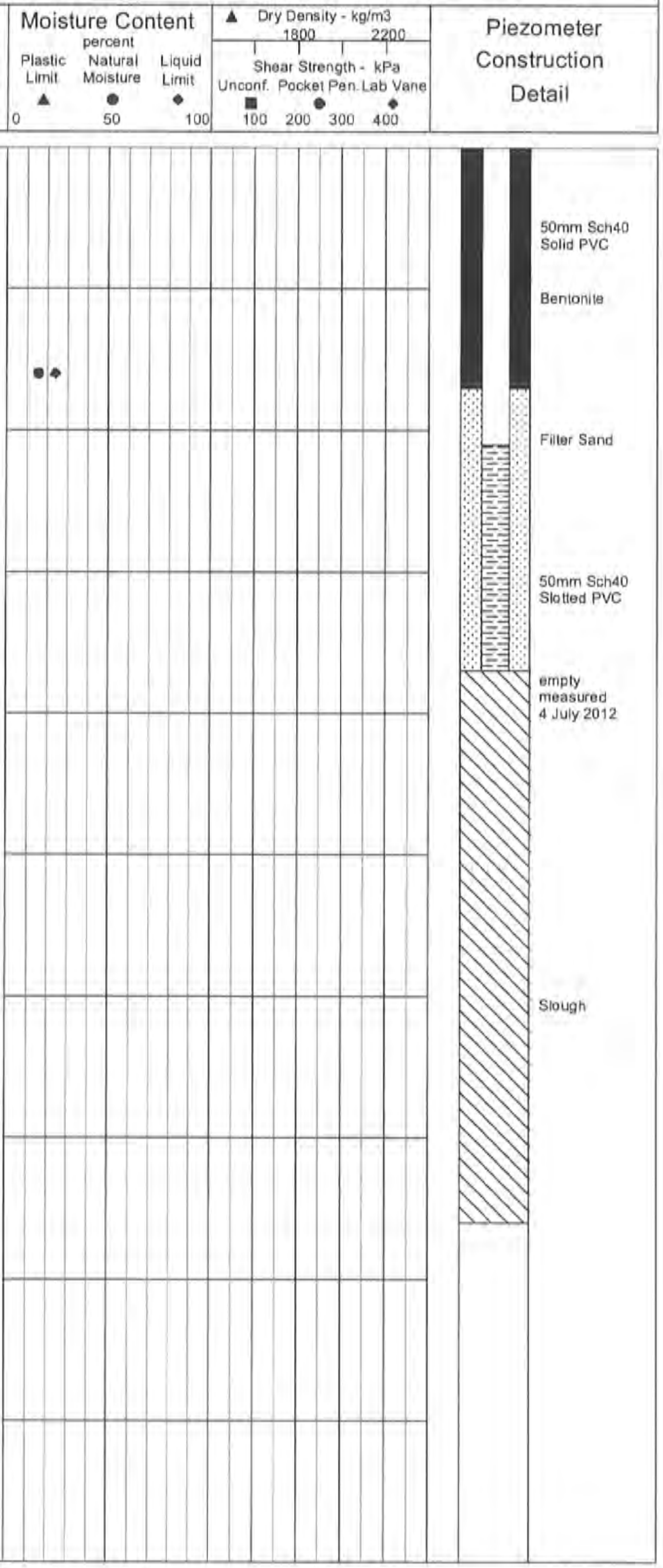
Clifton Associates Ltd.
engineering science technology

BORE HOLE LOG

Bore Hole: 209
Page: 1 of 1

Client:	Urban Elements Development Corp.	Northing:	9716.323m	Date Drilled:	28 June 2012
Project:	Grasswood Estates	Easting:	5113.209m	Drill:	CME
Location:	Saskatoon, SK	Ground Elev.:	512.626m	Drilling Method:	Solid Stem
Project No.:	S1607.7	Top Casing Elev.:	513.512m	Logged by:	JR

Depth (m)	Soil Description	Sample Type	No.	SPT 'N'	USC	% Sulphate
0	ORGANIC SOIL: 450mm of organic soil.					
0.45	SAND: Fine to medium grained sand, some silty, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.					
1.6		≡	CF20		SM	
3.0	@ 3.0m: Clayey.					
3.7	CLAY: Clay, some silt, trace sand. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.					
7.6	NOTES: Completed to 7.6m. Sloughed to 3.7m.					



Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
1.60	CF20	Bag		15.4	23.0	23.9	0.9	SM	0.0	70.2	29.8						

Remarks: No depth noted on grab bag for CF20.

Approved by:

Clifton Associates Ltd.
engineering science technology

Project Hydrogeology Investigation
Location Grasswood Area, near Saskatoon, SK
Project No. S1607.7

Borehole No.
209

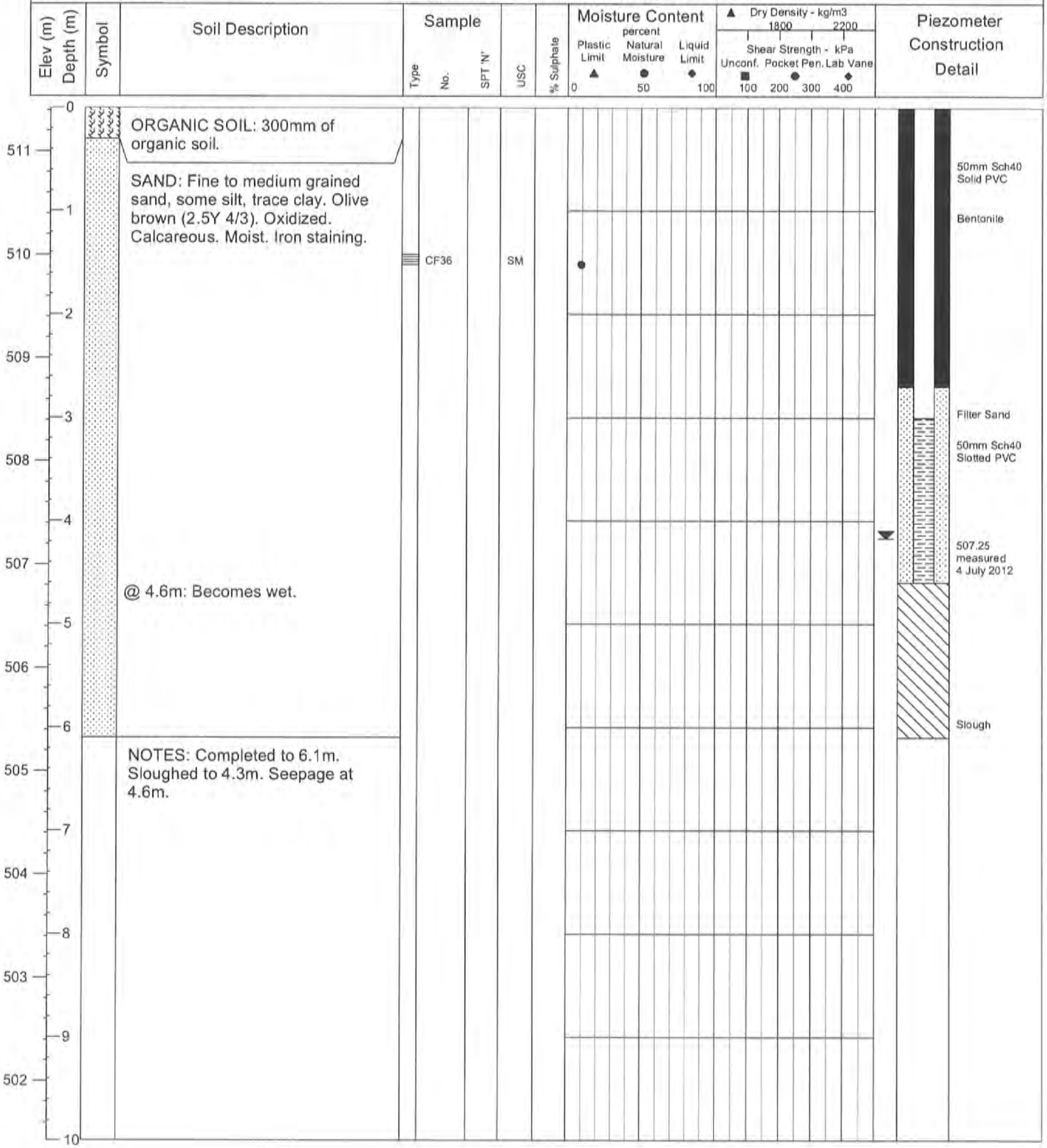
Geotech BH m Elev CAL v07.ldf

Clifton Associates Ltd.
engineering science technology

BORE HOLE LOG

Bore Hole: 210
Page: 1 of 1

Client:	Urban Elements Development Corp.	Northing:	10105.393m	Date Drilled:	28 June 2012
Project:	Grasswood Estates	Easting:	5102.667m	Drill:	CME
Location:	Saskatoon, SK	Ground Elev.:	511.424m	Drilling Method:	Solid Stem
Project No.:	S1607.7	Top Casing Elev.:	512.562m	Logged by:	JR



ORGANIC SOIL: 300mm of organic soil.

SAND: Fine to medium grained sand, some silt, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.

@ 4.6m: Becomes wet.

NOTES: Completed to 6.1m. Sloughed to 4.3m. Seepage at 4.6m.

Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
1.52	CF36	Bag		9.3		Non Plastic		SM	0.0	80.8	19.2						

Remarks:

Approved by:

Clifton Associates Ltd.
engineering science technology

Project Hydrogeology Investigation
Location Grasswood Area, near Saskatoon, SK
Project No. S1607.7

Borehole No.
210

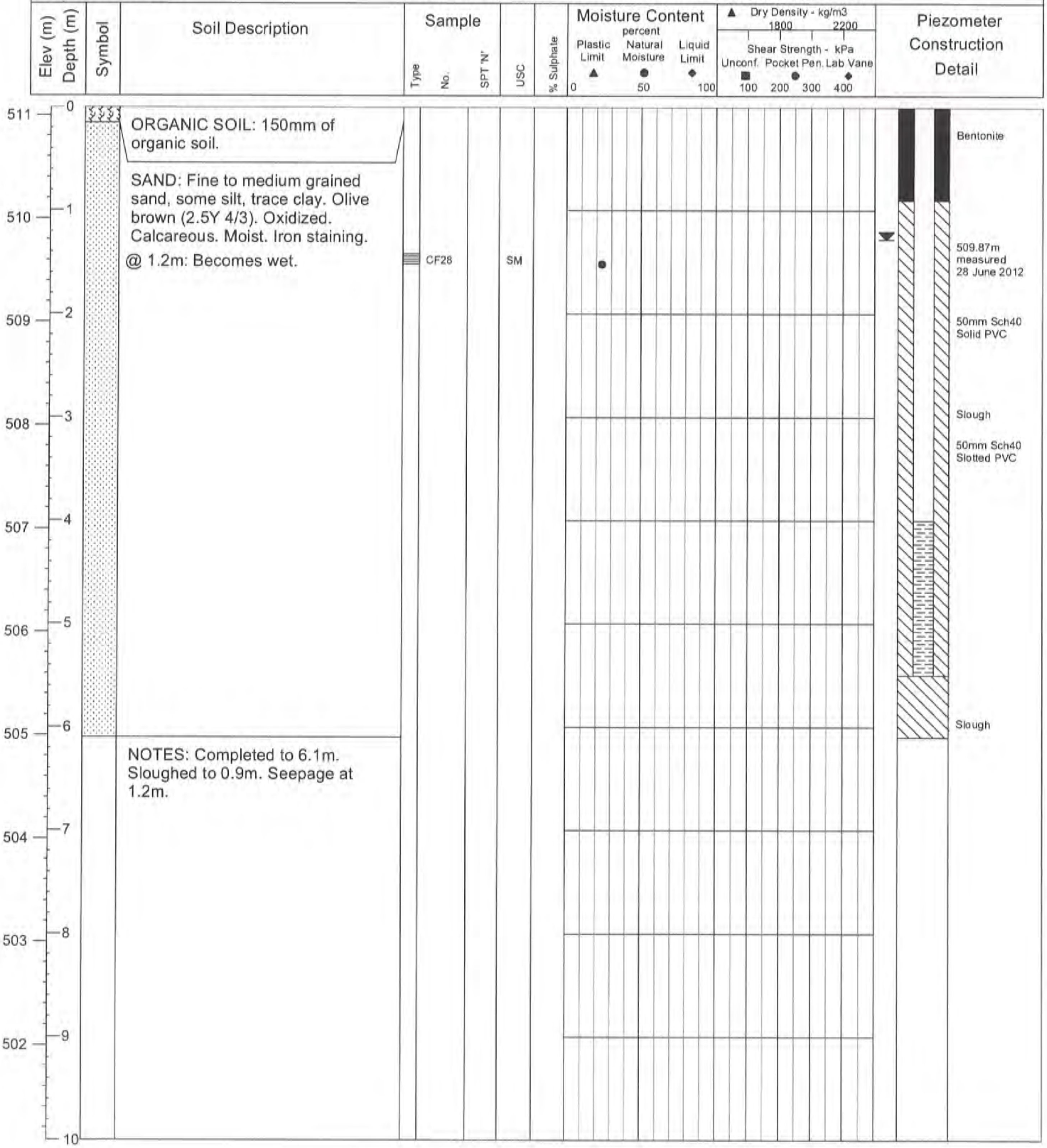
Geotech BH m Elev CAL v07.ldf

Clifton Associates Ltd.
engineering science technology

BORE HOLE LOG

Bore Hole: 211
Page: 1 of 1

Client:	Urban Elements Development Corp.	Northing:	10732.780m	Date Drilled:	28 June 2012
Project:	Grasswood Estates	Easting:	5727.468m	Drill:	CME
Location:	Saskatoon, SK	Ground Elev.:	511.078m	Drilling Method:	Solid Stem
Project No.:	S1607.7	Top Casing Elev.:	512.157m	Logged by:	JR



ORGANIC SOIL: 150mm of organic soil.

SAND: Fine to medium grained sand, some silt, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.

@ 1.2m: Becomes wet.

NOTES: Completed to 6.1m. Sloughed to 0.9m. Seepage at 1.2m.

Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
1.52	CF28	Bag		23.5	Non Plastic			SM	0.0	84.3	15.7						

Remarks:

Approved by:

Clifton Associates Ltd.
engineering science technology

Project Hydrogeology Investigation
Location Grasswood Area, near Saskatoon, SK
Project No. S1607.7

Borehole No.
211

Geotech BH m Elev CAL v07.ldt

Clifton Associates Ltd.
engineering science technology

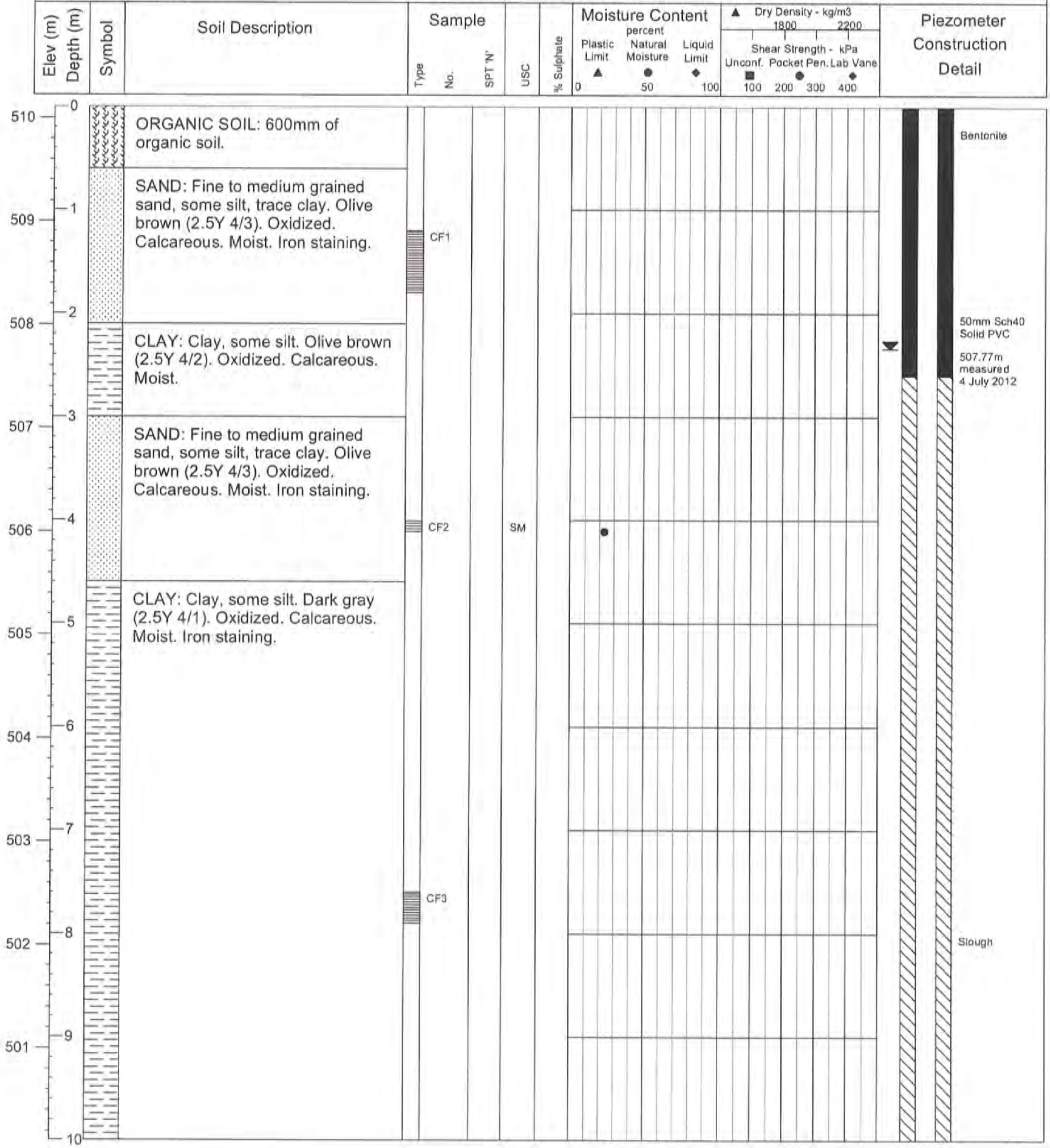
BORE HOLE LOG

Bore Hole: 212
Page: 1 of 2

Client: Urban Elements Development Corp.
Project: Grasswood Estates
Location: Saskatoon, SK
Project No.: S1607.7

Northing: 9247.058m
Easting: 5809.272m
Ground Elev.: 510.111m
Top Casing Elev.: 511.005m

Date Drilled: 28 June 2012
Drill: CME
Drilling Method: Solid Stem
Logged by: JR



ORGANIC SOIL: 600mm of organic soil.

SAND: Fine to medium grained sand, some silt, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.

CLAY: Clay, some silt. Olive brown (2.5Y 4/2). Oxidized. Calcareous. Moist.

SAND: Fine to medium grained sand, some silt, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist. Iron staining.

CLAY: Clay, some silt. Dark gray (2.5Y 4/1). Oxidized. Calcareous. Moist. Iron staining.

Geotech BH m Elev CAL v07.ldf

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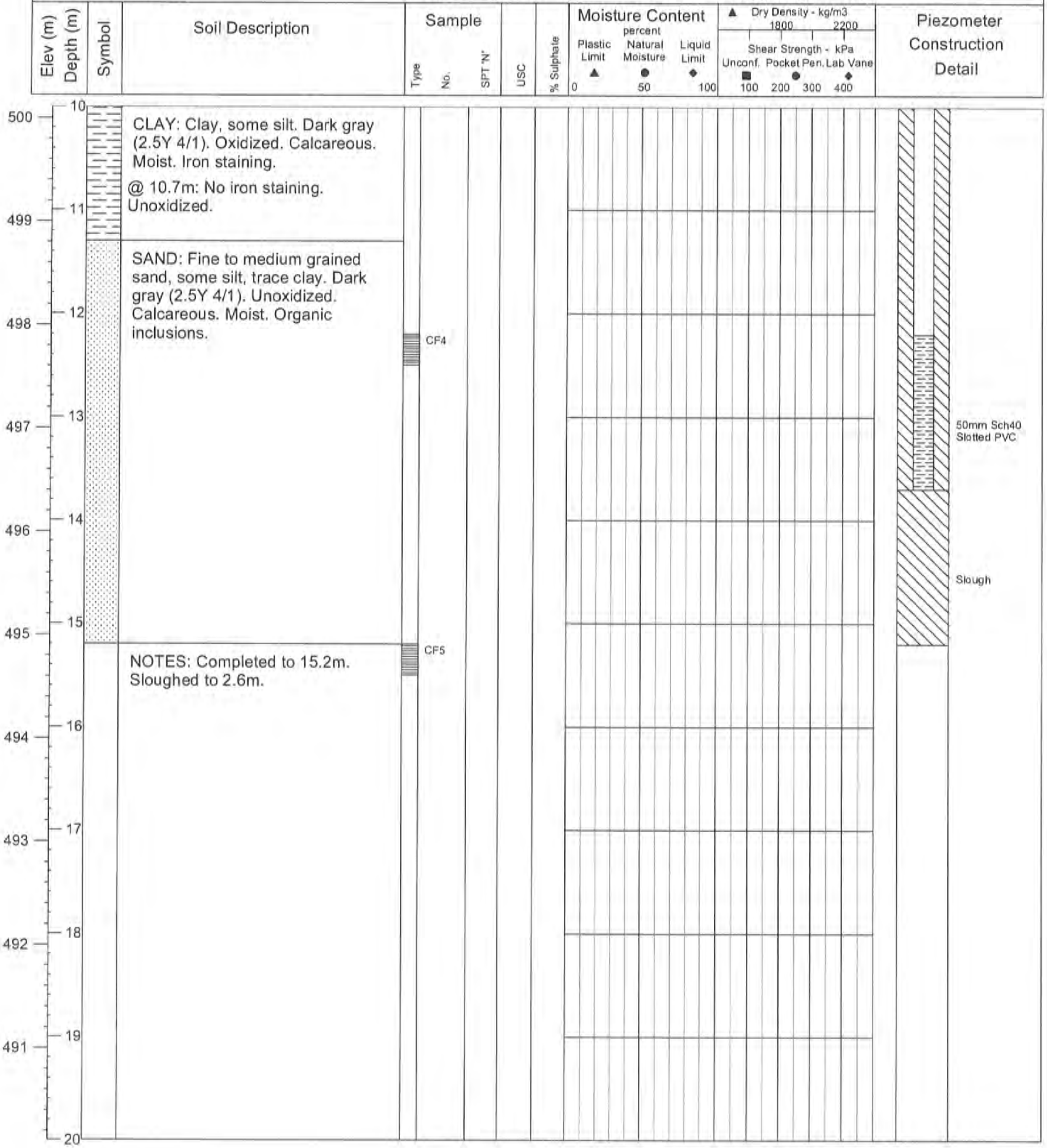
BORE HOLE LOG

Bore Hole: 212
Page: 2 of 2

Client: Urban Elements Development Corp.
Project: Grasswood Estates
Location: Saskatoon, SK
Project No.: S1607.7

Northing: 9247.058m
Easting: 5809.272m
Ground Elev.: 510.111m
Top Casing Elev.: 511.005m

Date Drilled: 28 June 2012
Drill: CME
Drilling Method: Solid Stem
Logged by: JR



CLAY: Clay, some silt. Dark gray (2.5Y 4/1). Oxidized. Calcareous. Moist. Iron staining.

@ 10.7m: No iron staining. Unoxidized.

SAND: Fine to medium grained sand, some silt, trace clay. Dark gray (2.5Y 4/1). Unoxidized. Calcareous. Moist. Organic inclusions.

NOTES: Completed to 15.2m. Sloughed to 2.6m.

Summary of Sampling and Laboratory Test Data

Sample				Water Content	Consistency				Gradation				Sulphate Content	Shear Strength			Dry Density
Depth	Number	Type	Recovery		Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay		Compression Test	Lab Vane	Pocket Penetrometer	
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
4.11	CF2	Bag		23.2	Non Plastic			SM	0.0	77.4	22.6						

Remarks:

Approved by:

Clifton Associates Ltd.
engineering science technology

Project Hydrogeology Investigation
Location Grasswood Area, near Saskatoon, SK
Project No. S1607.7

Borehole No.
212

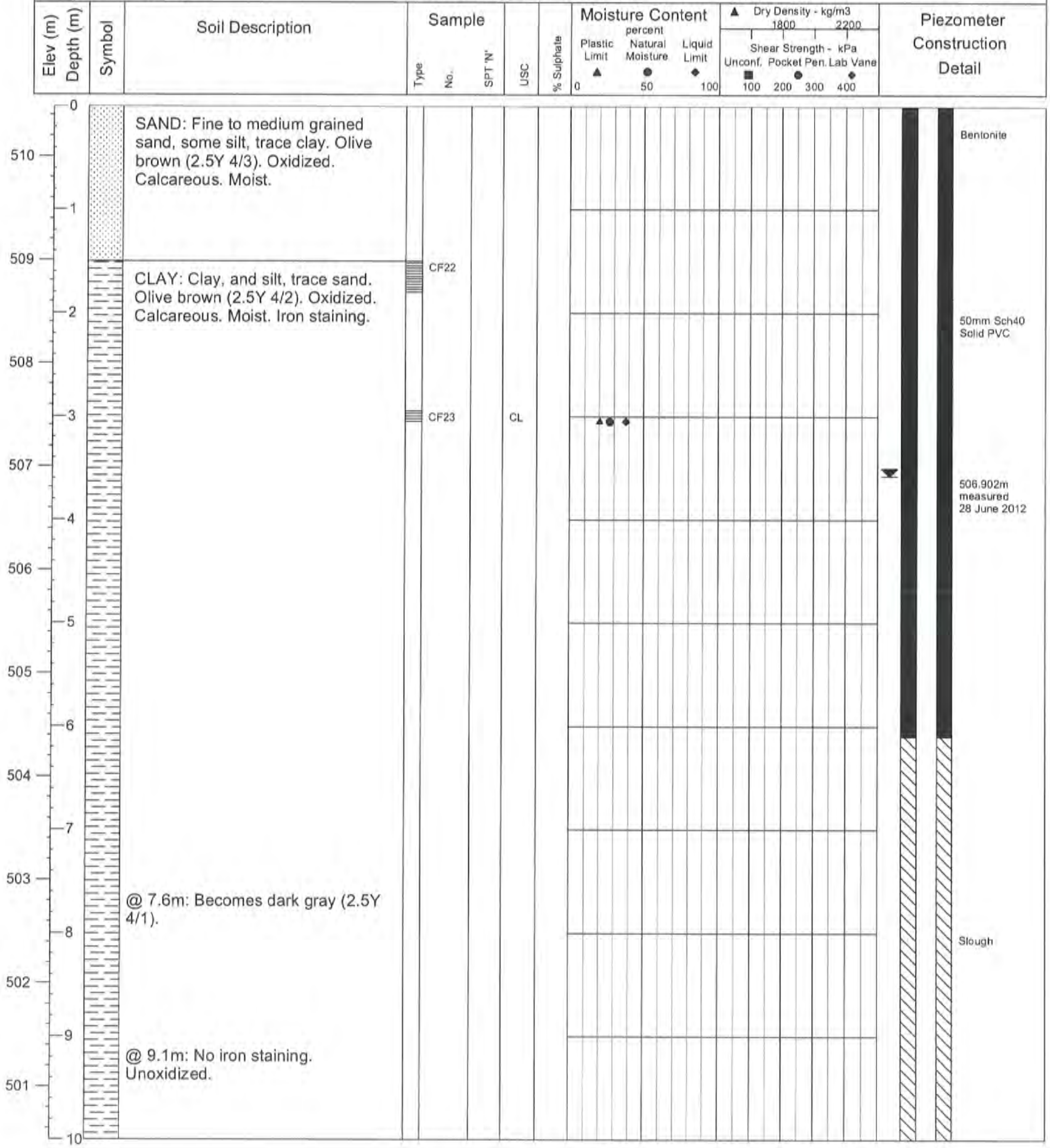
Geotech BH m Elev CAL v07.ldf

Clifton Associates Ltd.
engineering science technology

BORE HOLE LOG

Bore Hole: 213
Page: 1 of 2

Client:	Urban Elements Development Corp.	Northing:	9595.474m	Date Drilled:	28 June 2012
Project:	Grasswood Estates	Easting:	5498.802m	Drill:	CME
Location:	Saskatoon, SK	Ground Elev.:	510.485m	Drilling Method:	Solid Stem
Project No.:	S1607.7	Top Casing Elev.:	511.624m	Logged by:	JR



SAND: Fine to medium grained sand, some silt, trace clay. Olive brown (2.5Y 4/3). Oxidized. Calcareous. Moist.

CLAY: Clay, and silt, trace sand. Olive brown (2.5Y 4/2). Oxidized. Calcareous. Moist. Iron staining.

@ 7.6m: Becomes dark gray (2.5Y 4/1).

@ 9.1m: No iron staining. Unoxidized.

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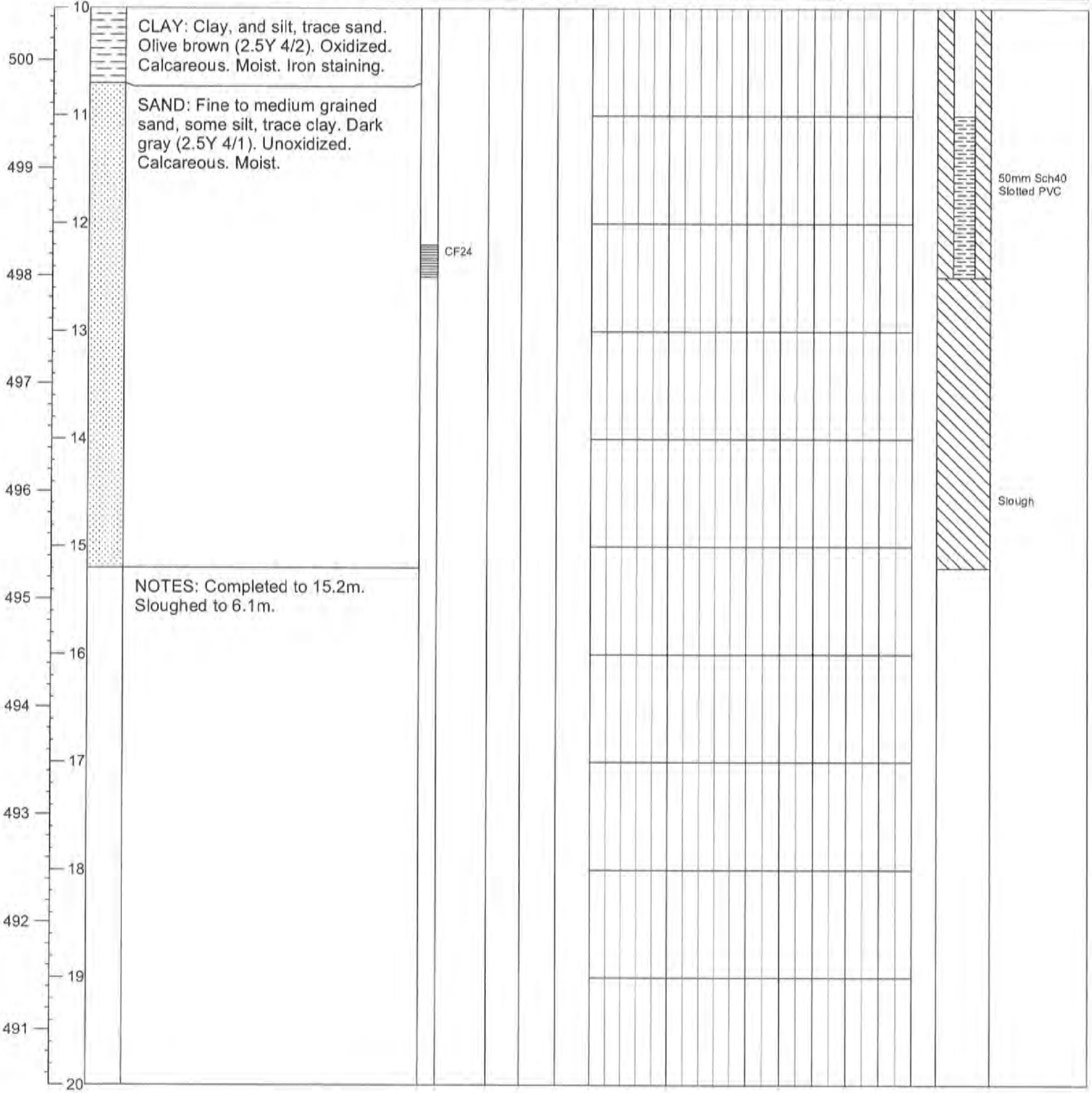
BORE HOLE LOG

Bore Hole: **213**
Page: 2 of 2

Client:	Urban Elements Development Corp.	Northing:	9595.474m	Date Drilled:	28 June 2012
Project:	Grasswood Estates	Easting:	5498.802m	Drill:	CME
Location:	Saskatoon, SK	Ground Elev.:	510.485m	Drilling Method:	Solid Stem
Project No.:	S1607.7	Top Casing Elev.:	511.624m	Logged by:	JR

Elev (m) Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content percent: Plastic Limit ▲, Natural Moisture ●, Liquid Limit ◆ (0, 50, 100)	▲ Dry Density - kg/m3 (1800, 2200); Shear Strength - kPa: Unconf. ■, Pocket Pen. ●, Lab Vane ◆ (100, 200, 300, 400)	Piezometer Construction Detail



CLAY: Clay, and silt, trace sand. Olive brown (2.5Y 4/2). Oxidized. Calcareous. Moist. Iron staining.

SAND: Fine to medium grained sand, some silt, trace clay. Dark gray (2.5Y 4/1). Unoxidized. Calcareous. Moist.

NOTES: Completed to 15.2m. Sloughed to 6.1m.

Summary of Sampling and Laboratory Test Data

Sample					Consistency				Gradation					Shear Strength			
Depth	Number	Type	Recovery	Water Content	Plastic Limit	Liquid Limit	Plasticity Index	USC	Gravel	Sand	Silt	Clay	Sulphate Content	Compression Test	Lab Vane	Pocket Penetrometer	Dry Density
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
3.05	CF23	Bag		26.9	20.2	37.8	17.6	CL	0.0	3.7	96.3						

Remarks:

Approved by:

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Project Hydrogeology Investigation
Location Grasswood Area, near Saskatoon, SK
Project No. S1607.7

Borehole No.
213

Unified Soil Classification

Borehole No. 201

Sample No. CF27

Depth 5

	PL	LL1	LL2
Tare No.	414	76	175
Wet Soil & Tare	53.02	61.36	65.70
Dry Soil & Tare	46.98	53.28	56.79
Wt of Water	6.04	8.08	8.91
Tare Wt.	19.04	18.92	18.81
Dry Soil	27.94	34.36	37.98
Water %	21.62	23.52	23.46
	Blow Count	20	22
	Corrected Limit	22.9	23.1

Results	
PL	21.6
LL	23.0
PI	1.3

Dry weight of sample 103.57

Weight after wash 85.46

Decant 18.11

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	85.46	103.57	100.00
5.0	85.46	103.57	100.00
2.0	85.46	103.57	100.00
0.900	85.43	103.54	99.97
0.400	85.28	103.39	99.83
0.160	63.14	81.25	78.45
0.071	1.08	19.19	18.53

Gradation	
Gravel	0.0
Sand	81.5
Clay/Silt	18.5
USC	
SM	

Approved By:

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engineering science technology

Project # S1607.7

Client

Project Hydrogeology Investigation

Tech EP **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 202

Sample No. CF29

Depth 5

	PL	LL1	LL2
Tare No.			
Wet Soil & Tare			
Dry Soil & Tare		Non Plastic	
Wt of Water			
Tare Wt.			
Dry Soil			
Water %			
Blow Count			
Corrected Limit			

Results	
PL	
LL	
PI	

Dry weight of sample 103.57

Weight after wash 82.53

Decant 21.04

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	82.53	103.57	100.00
5.0	82.53	103.57	100.00
2.0	82.53	103.57	100.00
0.900	82.51	103.55	99.98
0.400	82.36	103.40	99.84
0.160	67.06	88.10	85.06
0.071	4.53	25.57	24.69

Gradation	
Gravel	0.0
Sand	75.3
Clay/Silt	24.7
USC	
SM	

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Project # S1607.7

Client

Project Hydrogeology Investigation

Tech KB **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 203

Sample No. CF32

Depth 4

	PL	LL1	LL2
Tare No.	302	1801	313
Wet Soil & Tare	48.55	58.56	66.31
Dry Soil & Tare	44.24	49.86	56.47
Wt of Water	4.31	8.70	9.84
Tare Wt.	22.04	18.70	21.07
Dry Soil	22.20	31.16	35.40
Water %	19.41	27.92	27.80
	Blow Count	23	25
	Corrected Limit	27.6	27.8

Results	
PL	19.4
LL	27.7
PI	8.3

Dry weight of sample 101.05

Weight after wash 55.68

Decant 45.37

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	55.68	101.05	100.00
5.0	55.68	101.05	100.00
2.0	55.55	100.92	99.87
0.900	54.75	100.12	99.08
0.400	53.24	98.61	97.59
0.160	48.02	93.39	92.42
0.071	3.05	48.42	47.92

Gradation	
Gravel	0.0
Sand	52.1
Clay/Silt	47.9
USC	
SC	

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Project Hydrogeology Investigation

Tech KB **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 203
Sample No. CF33
Depth 10

	PL	LL1	LL2
Tare No.			
Wet Soil & Tare			
Dry Soil & Tare		Non Plastic	
Wt of Water			
Tare Wt.			
Dry Soil			
Water %			
Blow Count			
Corrected Limit			

Results	
PL	
LL	
PI	

Dry weight of sample 103.50
Weight after wash 85.85
Decant 17.65

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	85.85	103.50	100.00
5.0	85.85	103.50	100.00
2.0	85.85	103.50	100.00
0.900	85.85	103.50	100.00
0.400	85.82	103.47	99.97
0.160	76.94	94.59	91.39
0.071	2.19	19.84	19.17

Gradation	
Gravel	0.0
Sand	80.8
Clay/Silt	19.2
USC	
SM	

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Clifton Associates Ltd.
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Project # S1607.7
Client
Project Hydrogeology Investigation
Tech EP **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 204

Sample No. CF34

Depth 5

	PL	LL1	LL2
Tare No.			
Wet Soil & Tare			
Dry Soil & Tare		Non Plastic	
Wt of Water			
Tare Wt.			
Dry Soil			
Water %			
Blow Count			
Corrected Limit			

Results	
PL	
LL	
PI	

Dry weight of sample 101.86

Weight after wash 87.43

Decant 14.43

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	87.43	101.86	100.00
5.0	87.43	101.86	100.00
2.0	87.43	101.86	100.00
0.900	87.43	101.86	100.00
0.400	87.43	101.86	100.00
0.160	56.83	71.26	69.96
0.071	0.79	15.22	14.94

Gradation	
Gravel	0.0
Sand	85.1
Clay/Silt	14.9
USC	
SM	

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Project # S1607.7

Client

Project Hydrogeology Investigation

Tech KD **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 204

Sample No. CF35

Depth 28

	PL	LL1	LL2
Tare No.	437	1908	314
Wet Soil & Tare	28.26	70.93	72.45
Dry Soil & Tare	26.32	58.60	60.03
Wt of Water	1.94	12.33	12.42
Tare Wt.	18.88	18.95	20.20
Dry Soil	7.44	39.65	39.83
Water %	26.08	31.10	31.18
	Blow Count	21	23
	Corrected Limit	30.4	30.8

Results	
PL	26.1
LL	30.6
PI	4.5

Dry weight of sample 102.55

Weight after wash 33.13

Decant 69.42

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	33.13	102.55	100.00
5.0	33.13	102.55	100.00
2.0	33.13	102.55	100.00
0.900	33.07	102.49	99.94
0.400	32.95	102.37	99.82
0.160	31.91	101.33	98.81
0.071	3.03	72.45	70.65

Gradation	
Gravel	0.0
Sand	29.4
Clay/Silt	70.6

USC
CL-ML with Sand

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engineering science technology

Project # S1607.7

Client

Project Hydrogeology Investigation

Tech AS **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 205
Sample No. CF21
Depth 17

	PL	LL1	LL2
Tare No.			
Wet Soil & Tare			
Dry Soil & Tare		Non Plastic	
Wt of Water			
Tare Wt.			
Dry Soil			
Water %			
Blow Count			
Corrected Limit			

Results	
PL	
LL	
PI	

Dry weight of sample 101.07
Weight after wash 72.27
Decant 28.80

Sieve Size (mm)	**Cummulative Weight Passing (g)**	**Total Weight Passing (g)**	**Percent Passing**
9.0	72.27	101.07	100.00
5.0	72.27	101.07	100.00
2.0	72.27	101.07	100.00
0.900	72.24	101.04	99.97
0.400	72.19	100.99	99.92
0.160	66.85	95.65	94.64
0.071	1.27	30.07	29.75

Gradation	
Gravel	0.0
Sand	70.2
Clay/Silt	29.8
USC	
SM	

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Project # S1607.7
Client
Project Hydrogeology Investigation
Tech AS **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 206
Sample No. CF10
Depth 10

	PL	LL1	LL2
Tare No.			
Wet Soil & Tare			
Dry Soil & Tare		Non Plastic	
Wt of Water			
Tare Wt.			
Dry Soil			
Water %			
Blow Count			
Corrected Limit			

Results	
PL	
LL	
PI	

Dry weight of sample 103.89
Weight after wash 75.41
Decant 28.48

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	75.41	103.89	100.00
5.0	75.41	103.89	100.00
2.0	75.41	103.89	100.00
0.900	75.30	103.78	99.89
0.400	75.25	103.73	99.85
0.160	64.14	92.62	89.15
0.071	0.86	29.34	28.24

Gradation	
Gravel	0.0
Sand	71.8
Clay/Silt	28.2
USC	
SM	

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Project # S1607.7
Client
Project Hydrogeology Investigation
Tech EP **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 207

Sample No. CF08

Depth 15

	PL	LL1	LL2
Tare No.			
Wet Soil & Tare			
Dry Soil & Tare		Non Plastic	
Wt of Water			
Tare Wt.			
Dry Soil			
Water %			
Blow Count			
Corrected Limit			

Results	
PL	
LL	
PI	

Dry weight of sample 103.14

Weight after wash 83.98

Decant 19.16

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	83.98	103.14	100.00
5.0	83.98	103.14	100.00
2.0	83.93	103.09	99.95
0.900	83.85	103.01	99.87
0.400	83.79	102.95	99.82
0.160	65.52	84.68	82.10
0.071	1.16	20.32	19.70

Gradation	
Gravel	0.0
Sand	80.3
Clay/Silt	19.7
USC	
SM	

Approved By:

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Project # S1607.7

Client

Project Hydrogeology Investigation

Tech KB **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 209

Sample No. CF20

Depth

	PL	LL1	LL2
Tare No.	880	62	A500
Wet Soil & Tare	37.71	59.90	61.40
Dry Soil & Tare	34.26	52.92	54.98
Wt of Water	3.45	6.98	6.42
Tare Wt.	19.25	24.14	28.42
Dry Soil	15.01	28.78	26.56
Water %	22.98	24.25	24.17
	Blow Count	22	23
	Corrected Limit	23.8	23.9

Results	
PL	23.0
LL	23.9
PI	0.9

Dry weight of sample 101.94

Weight after wash 73.79

Decant 28.15

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	73.79	101.94	100.00
5.0	73.79	101.94	100.00
2.0	73.79	101.94	100.00
0.900	73.72	101.87	99.93
0.400	73.50	101.65	99.72
0.160	61.99	90.14	88.42
0.071	2.20	30.35	29.77

Gradation	
Gravel	0.0
Sand	70.2
Clay/Silt	29.8
USC	
SM	

Approved By:

Clifton Associates Ltd.
engineering science technology

Project # S1607.7

Client

Project Hydrogeology Investigation

Tech KB **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 210

Sample No. CF36

Depth 5

	PL	LL1	LL2
Tare No.			
Wet Soil & Tare			
Dry Soil & Tare		Non Plastic	
Wt of Water			
Tare Wt.			
Dry Soil			
Water %			
Blow Count			
Corrected Limit			

Results	
PL	
LL	
PI	

Dry weight of sample 101.67

Weight after wash 83.12

Decant 18.55

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	83.12	101.67	100.00
5.0	83.12	101.67	100.00
2.0	83.12	101.67	100.00
0.900	83.12	101.67	100.00
0.400	83.10	101.65	99.98
0.160	66.11	84.66	83.27
0.071	1.02	19.57	19.25

Gradation	
Gravel	0.0
Sand	80.8
Clay/Silt	19.2
USC	
SM	

Approved By:

Clifton Associates Ltd.
engineering science technology

Project # S1607.7

Client

Project Hydrogeology Investigation

Tech AS **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 211

Sample No. CF28

Depth 5

	PL	LL1	LL2
Tare No.			
Wet Soil & Tare			
Dry Soil & Tare		Non Plastic	
Wt of Water			
Tare Wt.			
Dry Soil			
Water %			
Blow Count			
Corrected Limit			

Results	
PL	
LL	
PI	

Dry weight of sample 101.91

Weight after wash 87.01

Decant 14.90

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	87.01	101.91	100.00
5.0	87.01	101.91	100.00
2.0	87.01	101.91	100.00
0.900	87.01	101.91	100.00
0.400	86.86	101.76	99.85
0.160	70.31	85.21	83.61
0.071	1.12	16.02	15.72

Gradation	
Gravel	0.0
Sand	84.3
Clay/Silt	15.7
USC	
SM	

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Project # S1607.7

Client

Project Hydrogeology Investigation

Tech AS **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 212

Sample No. CF02

Depth 13.5

	PL	LL1	LL2
Tare No.			
Wet Soil & Tare			
Dry Soil & Tare		Non Plastic	
Wt of Water			
Tare Wt.			
Dry Soil			
Water %			
Blow Count			
Corrected Limit			

Results	
PL	
LL	
PI	

Dry weight of sample 101.38

Weight after wash 79.65

Decant 21.73

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	79.65	101.38	100.00
5.0	79.65	101.38	100.00
2.0	79.65	101.38	100.00
0.900	79.63	101.36	99.98
0.400	79.39	101.12	99.74
0.160	58.69	80.42	79.33
0.071	1.20	22.93	22.62

Gradation	
Gravel	0.0
Sand	77.4
Clay/Silt	22.6
USC	
SM	

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Project # S1607.7

Client

Project Hydrogeology Investigation

Tech KB **Date** 29-Jun-12

Unified Soil Classification

Borehole No. 213

Sample No. CF23

Depth 10

	PL	LL1	LL2
Tare No.	319	218	432
Wet Soil & Tare	33.50	64.41	74.82
Dry Soil & Tare	31.50	51.95	59.47
Wt of Water	2.00	12.46	15.35
Tare Wt.	21.61	18.69	18.97
Dry Soil	9.89	33.26	40.50
Water %	20.22	37.46	37.90
Blow Count		25	26
Corrected Limit		37.5	38.1

Results	
PL	20.2
LL	37.8
PI	17.6

Dry weight of sample 102.50

Weight after wash 4.10

Decant 98.40

Sieve Size (mm)	Cummulative Weight Passing (g)	Total Weight Passing (g)	Percent Passing
9.0	4.10	102.50	100.00
5.0	4.10	102.50	100.00
2.0	4.05	102.45	99.95
0.900	4.02	102.42	99.92
0.400	3.58	101.98	99.49
0.160	2.83	101.23	98.76
0.071	0.31	98.71	96.30

Gradation	
Gravel	0.0
Sand	3.7
Clay/Silt	96.3
USC	
CL	

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Project # S1607.7

Client

Project Hydrogeology Investigation

Tech EP **Date** 29-Jun-12

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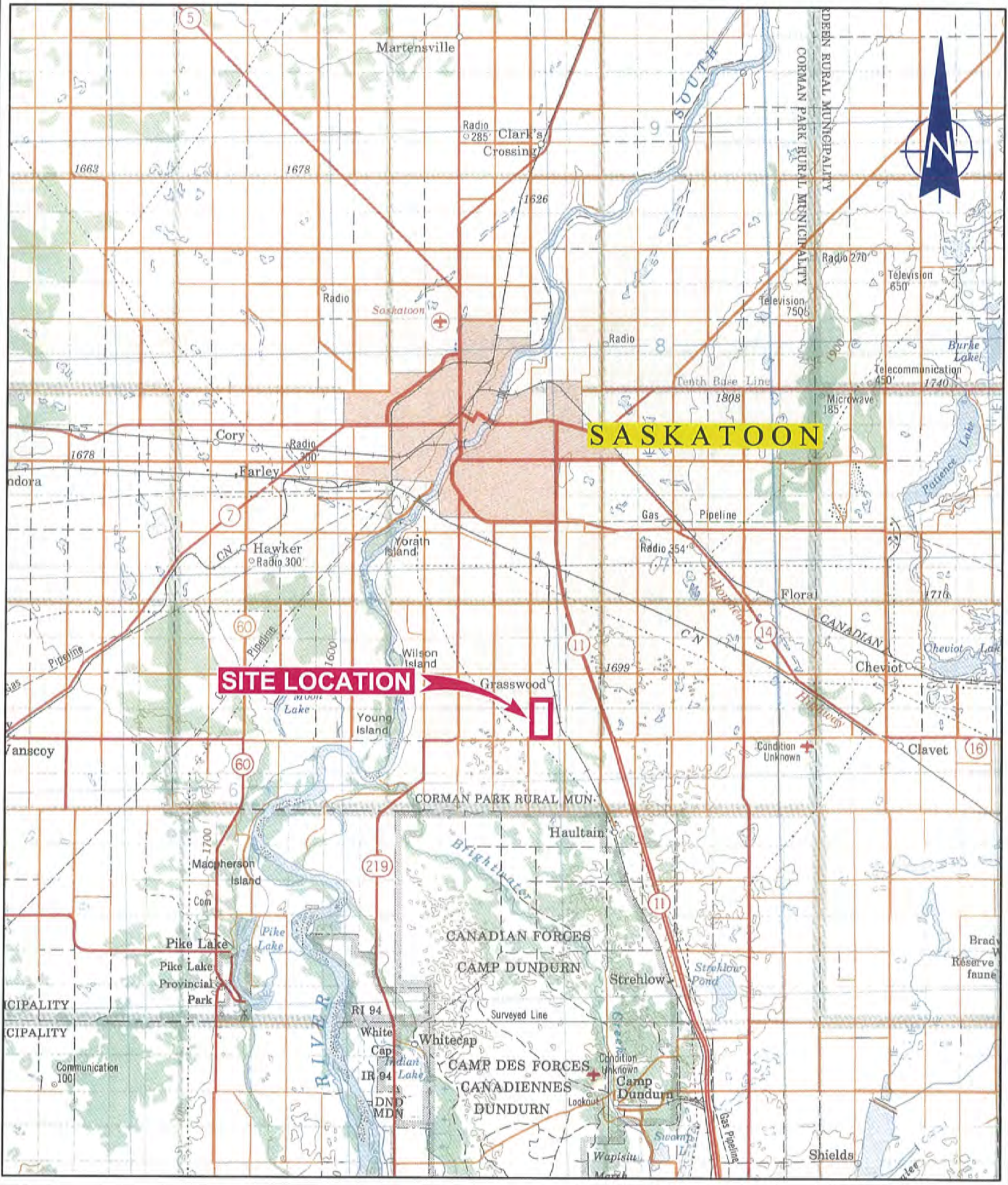
Drawings



DRAWING REVISIONS

REV	DESCRIPTION	BY	DATE

DATE 2012-07-17 | DESIGN BY C.F | DRAWN BY Z.Y | CHECKED BY J.G

Clifton Associates Ltd.
engineering science technology

SCALE N.T.S
PROJECT NO. S1607.7
LAND LOCATION W1/2 26-35-S W3

CLIENT
URBAN ELEMENTS DEVELOPMENTS CORP.

PROJECT
GRASSWOOD ESTATES HYDROGEOLOGICAL INVESTIGATION

TITLE
SITE LOCATION

DWG. NO.
01

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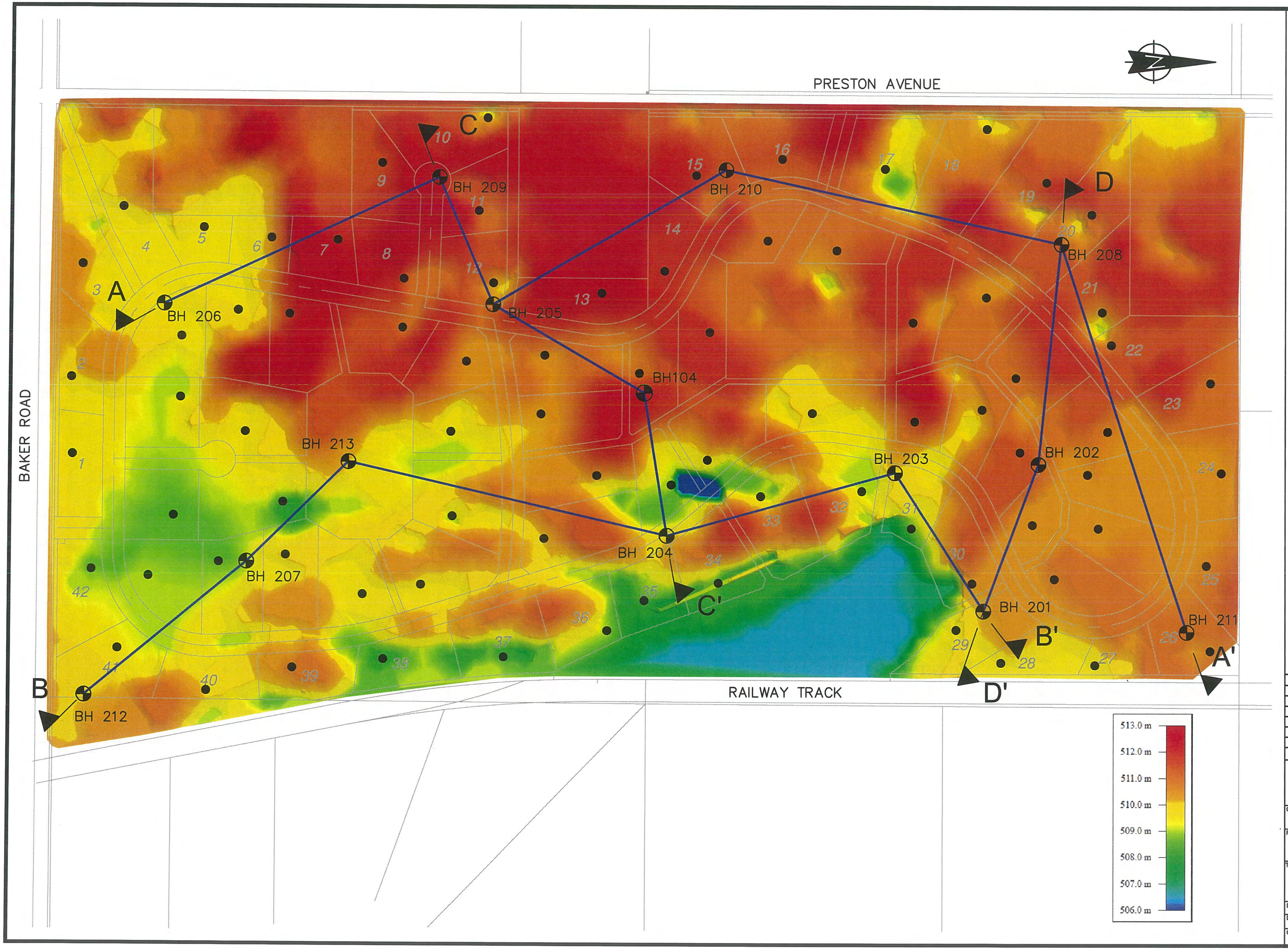

LEGEND

◐ BOREHOLE LOCATIONS

● APPROXIMATE SEPTIC MOUND LOCATIONS

DRAWING REVISIONS

REV	DESCRIPTION	BY	DATE

Clifton Associates Ltd.
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CLIENT
URBAN ELEMENTS DEVELOPMENT CORP.

PROJECT
GRASSWOOD ESTATES
HYDROGEOLOGICAL INVESTIGATION

TITLE
BORE HOLE LOCATION
AND SITE PLAN

DESIGN M.N
SCALE 1:5000
DATE 2012-07-17
DWN. BY O.Z&Z.Y
PROJECT NO. S1607.7
DWG. NO. 02
CHECKED J.G
LAND LOCATION W1/2 26-35-SW3

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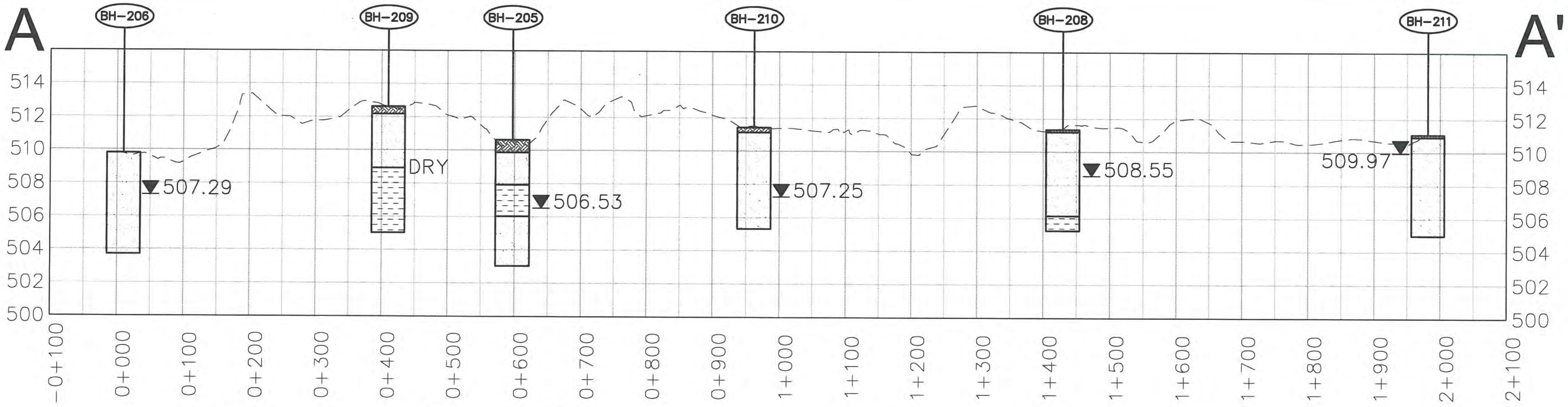

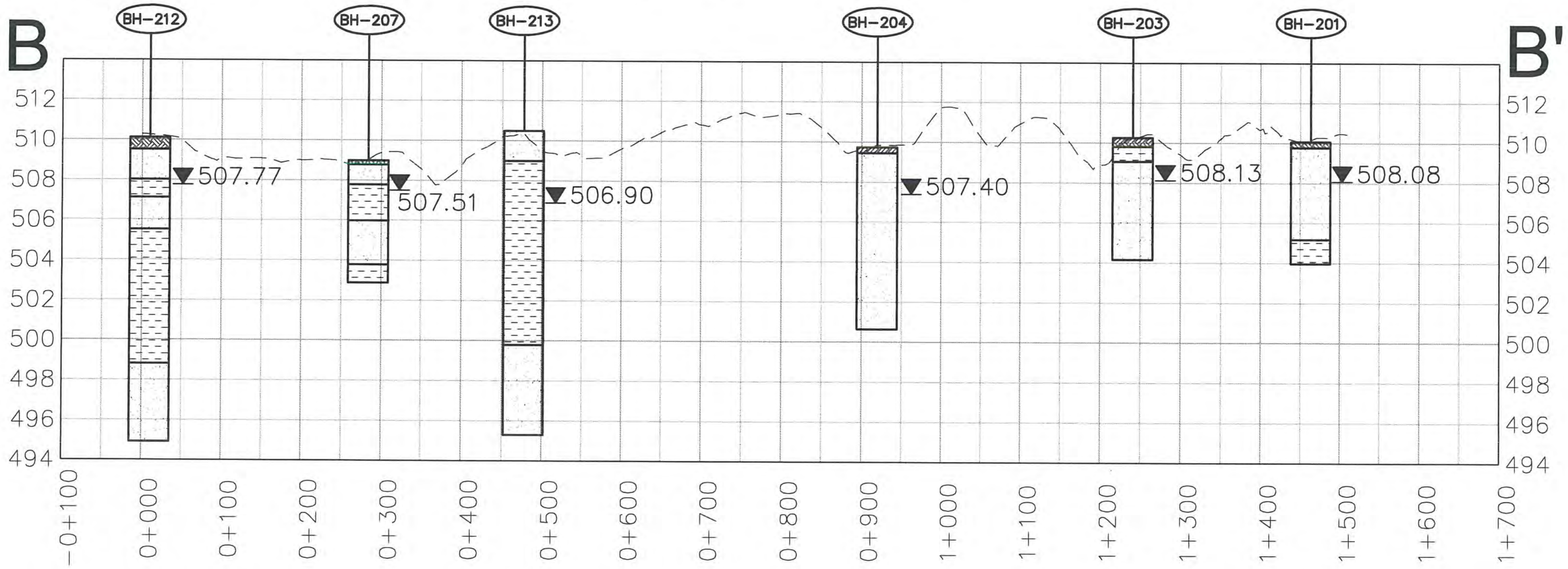

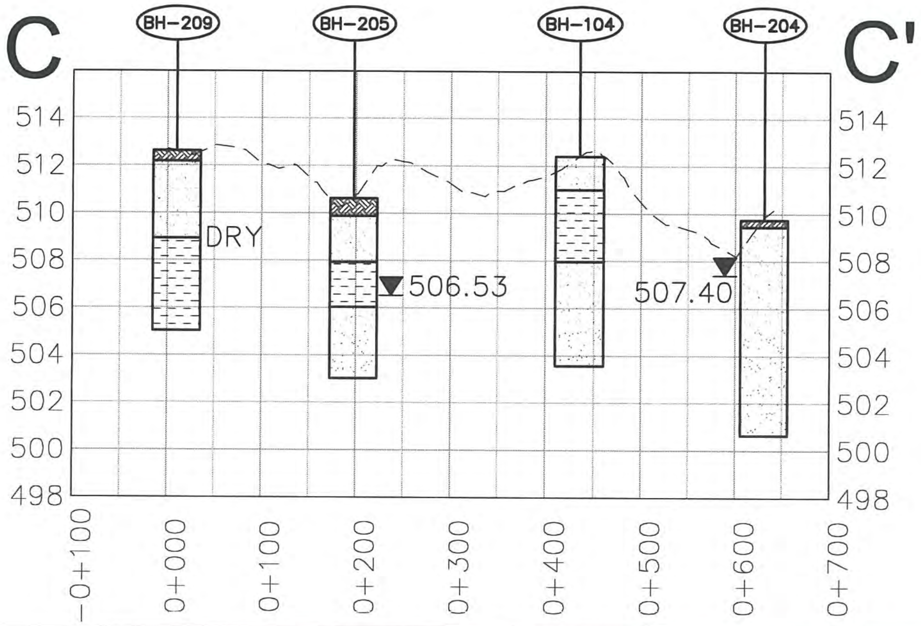

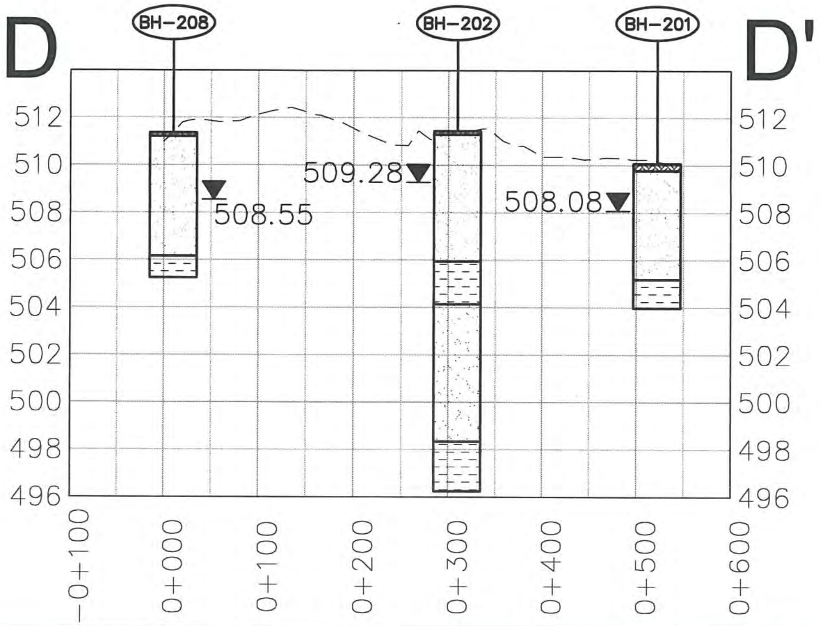

LEGEND

ORGANIC SOIL	▨
SAND	░
CLAY	▤

SCALE
HORIZ: 1:8000
VERT: 1:320

DRAWING REVISIONS

REV	DESCRIPTION	BY	DATE

Clifton Associates Ltd.
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CLIENT
URBAN ELEMENTS DEVELOPMENT CORP.

PROJECT
GRASSWOOD ESTATES
HYDROGEOLOGICAL INVESTIGATION

TITLE
CROSS SECTION A–A'
THRU
CROSS SECTION D–D'

DESIGN	SCALE AS SHOWN	DATE 2012–07–17	
DWN. BY O.Z&Z.Y	PROJECT NO. S1607.7		DWG. NO. 03
CHECKED J.G	LAND LOCATION W1/2 26–35–SW3		

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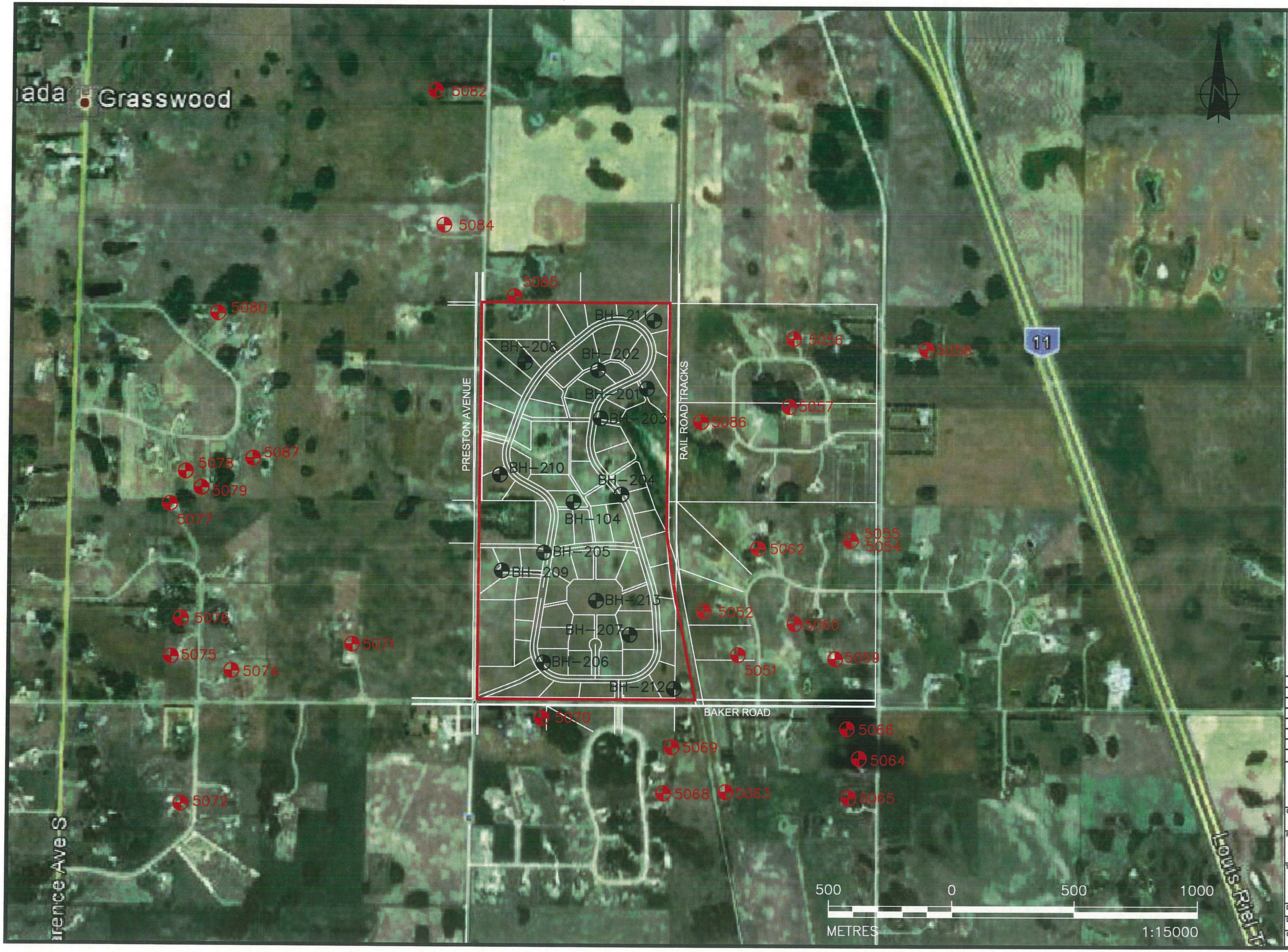

LEGEND

DOMESTIC WATER WELL	●
ON-SITE PIEZOMETER	●
APPROXIMATE SITE BOUNDARY	—

DRAWING REVISIONS

REV	DESCRIPTION	BY	DATE
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CLIENT
URBAN ELEMENTS DEVELOPMENT CORP.

PROJECT
GRASSWOOD ESTATES
HYDROGEOLOGICAL INVESTIGATION

TITLE
1 KM RADIUS
WATER WELL LOCATION PLAN

DESIGN J.O.	SCALE 1:15000	DATE 2012-07-17	
DWN. BY Z.Y.	PROJECT NO. S1607.4		DWG. NO. 04
CHECKED J.G.	LAND LOCATION W1/2 26-35-SW3		

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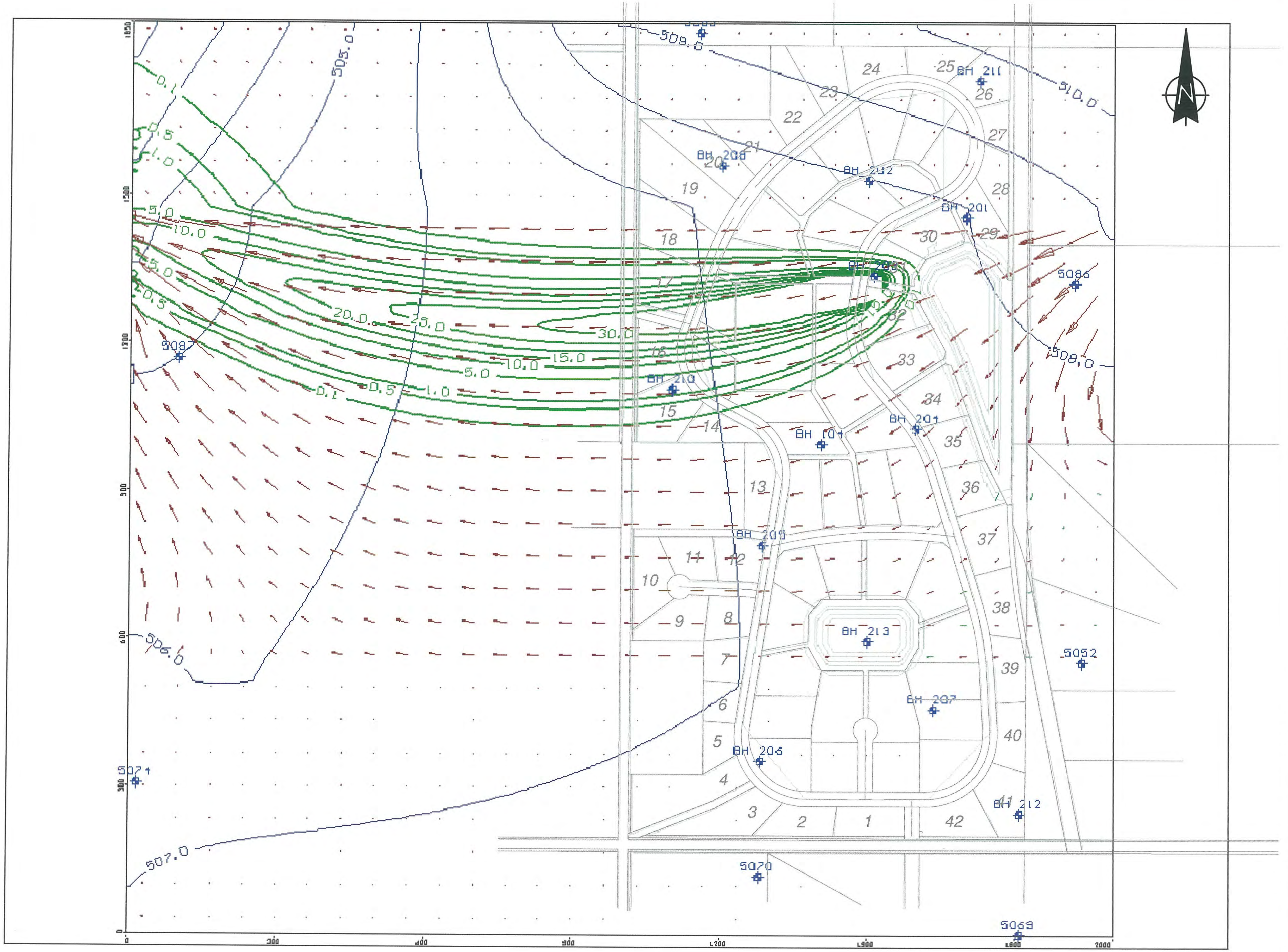

LEGEND

—	PIEZOMETRIC SURFACE CONTOUR
—	CONTAMINANT CONTOUR
←	GROUND WATER FLOW DIRECTION
⊕	PIEZOMETER/WELL LOCATION
■	MOUND LOCATION

DRAWING REVISIONS

REV	DESCRIPTION	BY	DATE

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CLIENT
URBAN ELEMENTS DEVELOPMENT CORP.

PROJECT
GRASSWOOD ESTATES
HYDROGEOLOGICAL INVESTIGATION

TITLE
CURRENT CONDITIONS

DESIGN C.F	SCALE 1:8000	DATE 2012-07-17	
DWN. BY O.Z&Z.Y	PROJECT NO. S1607.7		DWG. NO. 05
CHECKED J.G	LAND LOCATION W1/2 26-35-SW3		

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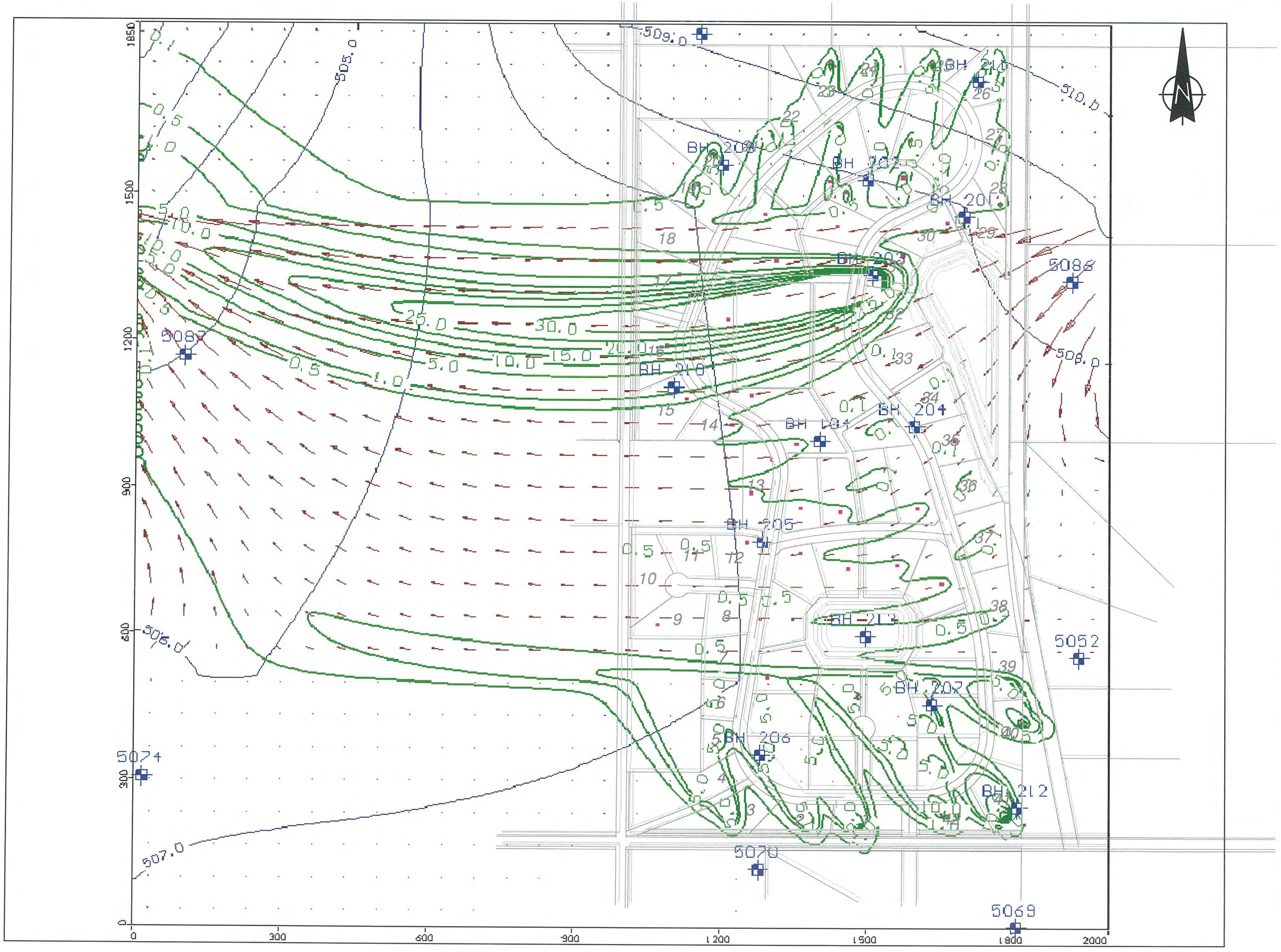

LEGEND

— PIEZOMETRIC SURFACE CONTOUR

— CONTAMINANT CONTOUR

← GROUND WATER FLOW DIRECTION

⌖ PIEZOMETER/WELL LOCATION

▪ MOUND LOCATION

DRAWING REVISIONS

REV	DESCRIPTION	BY	DATE

Clifton Associates Ltd.
engineering science technology

CLIENT
URBAN ELEMENTS DEVELOPMENT CORP.

PROJECT
GRASSWOOD ESTATES
HYDROGEOLOGICAL INVESTIGATION

TITLE
DEVELOPMENT CONDITION–40mg/L
LOADING SOURCE AT BH203

DESIGN C.F	SCALE 1:8000	DATE 2012–07–17	
DWN. BY O.Z&Z.Y	PROJECT NO. S1607.7		DWG. NO. 06
CHECKED J.G	LAND LOCATION W1/2 26–35–SW3		

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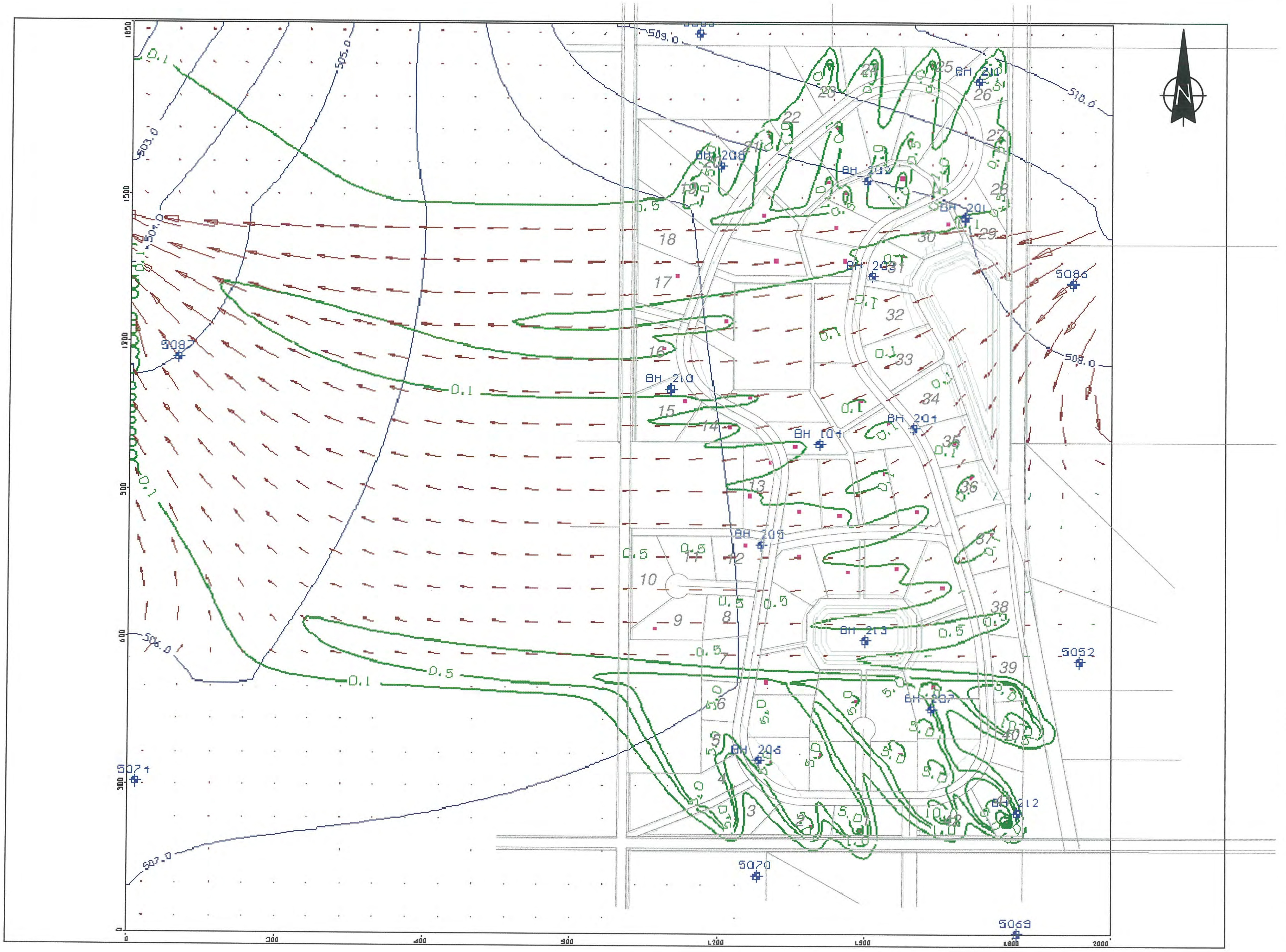

LEGEND

—	PIEZOMETRIC SURFACE CONTOUR
—	CONTAMINANT CONTOUR
←	GROUND WATER FLOW DIRECTION
⊕	PIEZOMETER/WELL LOCATION
■	MOUND LOCATION

DRAWING REVISIONS

REV	DESCRIPTION	BY	DATE

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CLIENT
URBAN ELEMENTS DEVELOPMENT CORP.

PROJECT
GRASSWOOD ESTATES
HYDROGEOLOGICAL INVESTIGATION

TITLE
DEVELOPMENT CONDITIONS–
40mg/L LOADING WITHOUT
SOURCE AT BH203

DESIGN C.F	SCALE 1:8000	DATE 2012–07–17
DWN. BY O.Z&Z.Y	PROJECT NO. S1607.7	DWG. NO. 07
CHECKED J.G	LAND LOCATION W1/2 26–35–SW3	

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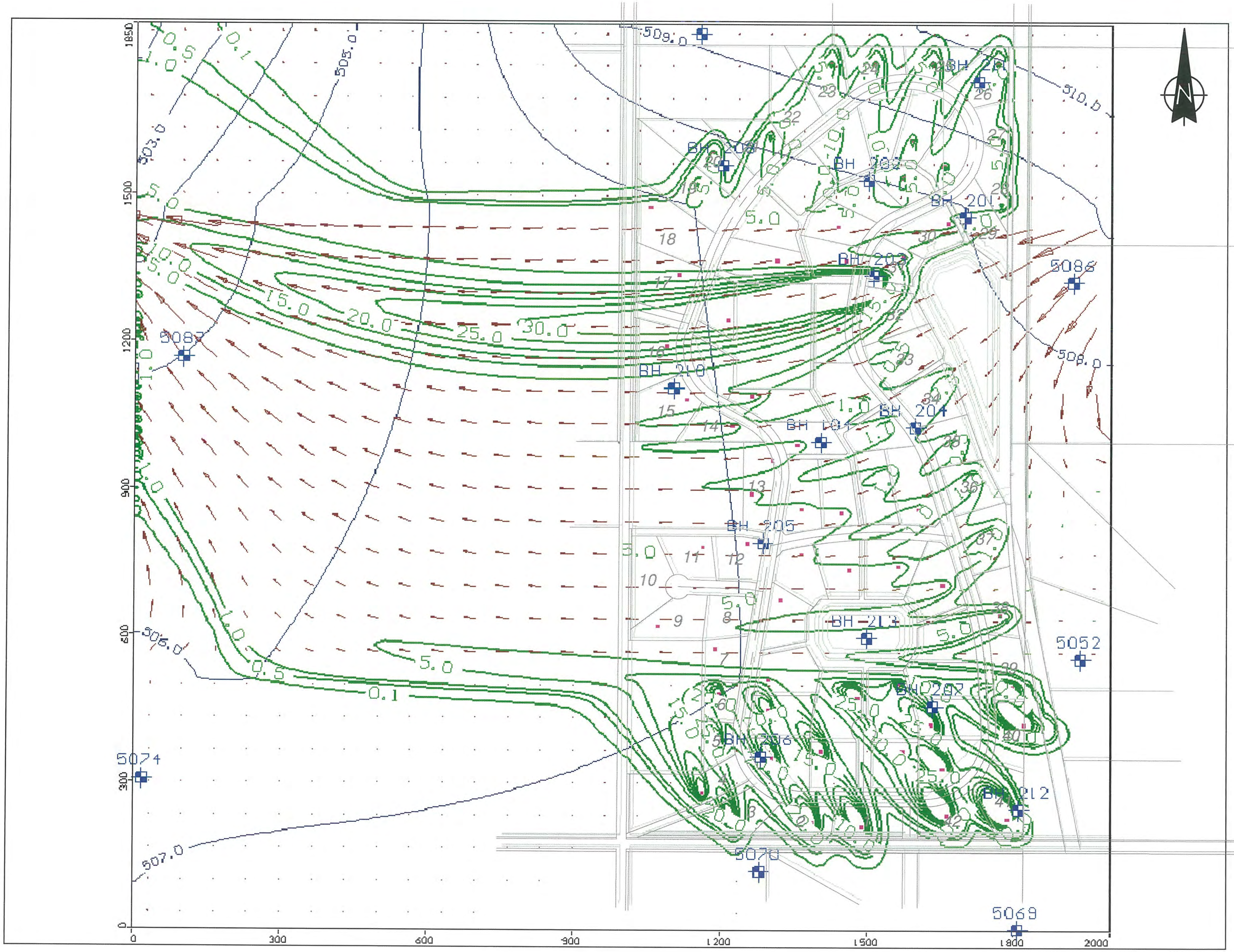

LEGEND

— PIEZOMETRIC SURFACE CONTOUR

— CONTAMINANT CONTOUR

← GROUND WATER FLOW DIRECTION

⊕ PIEZOMETER/WELL LOCATION

■ MOUND LOCATION

DRAWING REVISIONS

REV	DESCRIPTION	BY	DATE

Clifton Associates Ltd.
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CLIENT
URBAN ELEMENTS DEVELOPMENT CORP.

PROJECT
GRASSWOOD ESTATES
HYDROGEOLOGICAL INVESTIGATION

TITLE
CONVENTIONAL–350mg/L
LOADING SOURCE AT BH203

DESIGN C.F	SCALE 1:8000	DATE 2012-07-17	
DWN. BY O.Z&Z.Y	PROJECT NO. S1607.7		DWG. NO. 08
CHECKED J.G	LAND LOCATION W1/2 26-35-SW3		

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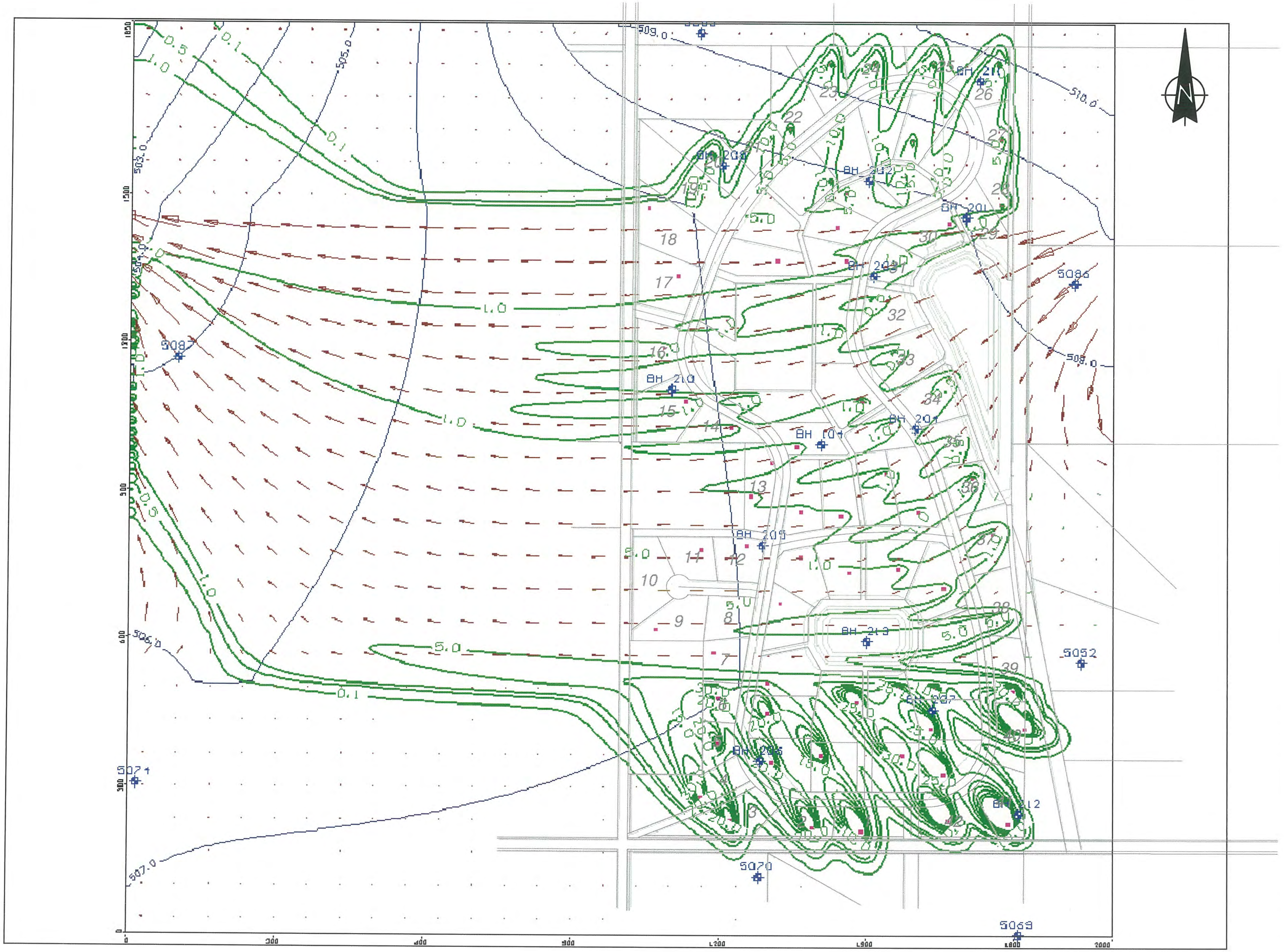

LEGEND

🟦	PIEZOMETRIC SURFACE CONTOUR
🟩	CONTAMINANT CONTOUR
←	GROUND WATER FLOW DIRECTION
⊕	PIEZOMETER/WELL LOCATION
■	MOUND LOCATION

DRAWING REVISIONS

REV	DESCRIPTION	BY	DATE

Clifton Associates Ltd.
engineering science technology

CLIENT
URBAN ELEMENTS DEVELOPMENT CORP.

PROJECT
GRASSWOOD ESTATES
HYDROGEOLOGICAL INVESTIGATION

TITLE
CONVENTIONAL–350mg/L LOADING
WITHOUT SOURCE AT BH203

DESIGN C.F	SCALE 1:8000	DATE 2012–07–17	
DWN. BY O.Z&Z.Y	PROJECT NO. S1607.7		DWG. NO. 09
CHECKED J.G	LAND LOCATION W1/2 26–35–SW3		

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Tables

Table 3.2
Site Groundwater Elevations
Grasswood Hydrogeology

Piezometer #	Top Casing Elevation (m)	Ground Elevation (m)	Casing Height (m)	Water Elevation	Mbgs
BH104	513.34	512.42	0.92	506.64	5.78
BH201	511.20	510.07	1.12	508.08	1.99
BH202	512.50	511.44	1.06	509.28	2.16
BH203	511.31	510.27	1.04	508.13	2.13
BH204	510.80	509.74	1.06	507.40	2.34
BH205	511.57	510.63	0.94	506.53	4.10
BH206	510.74	509.80	0.93	507.29	2.51
BH207	509.90	508.98	0.92	507.51	1.47
BH208	512.37	511.35	1.01	508.55	2.80
BH209	513.51	512.63	0.89	empty	-
BH210	512.56	511.42	1.14	507.25	4.17
BH211	512.16	511.08	1.08	509.87	1.21
BH212	511.01	510.11	0.89	507.77	2.34
BH213	511.62	510.49	1.14	506.90	3.59

Table 3.2-2
Water and Soil Lab Results
Grasswood Hydrogeology

Parameter	Units	Sample ID ALS ID Date Sampled Detection Limit	Criteria Saskatchewan Drinking Water Standards & Objectives	CAL104 L1172891-8 04/07/2012 Water	BH201 L1172891-3 04/07/2012 Water	BH202 L1172891-2 04/07/2012 Water	BH203 L1172891-5 04/07/2012 Water	BH204 L1172891-7 04/07/2012 Water	BH205 L1172891-9 04/07/2012 Water	BH206 L1172891-11 04/07/2012 Water	BH207 L1172891-12 04/07/2012 Water	BH208 L1172891-4 04/07/2012 Water	BH210 L1172891-6 04/07/2012 Water	BH211 L1172891-1 04/07/2012 Water	BH213 L1172891-10 04/07/2012 Water	BH212 L1172891-13 04/07/2012 Water	DUP 1 L1172891-15 04/07/2012 Water	DUP 2 L1172891-14 04/07/2012 Water
Health and Toxicity Metals																		
Total Mercury in Water by CRC ICPMS																		
Mercury (Hg)-Total	mg L	0.00005	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	-	<0.000050
Total Metals in Water by CRC ICPMS			-															
Aluminum (Al)-Total	mg L	0.01	-	37.4 *	10.5 *	1.24 *	150 *	8.21 *	72.6 *	88.0 *	0.76 *	8.33 *	58.9 *	4.64 *	0.586 *	79.6 *	-	89.5 *
Arsenic (As)-Total	mg L	0.0002	0.025	**0.0516 ***	0.0103 *	0.00346 *	**0.268 ***	0.0164 *	**0.0629 ***	**0.0756 ***	0.0023 *	0.0119 *	**0.0779 ***	0.00444 *	0.00213 *	**0.0811 ***	-	**0.0881 ***
Barium (Ba)-Total	mg L	0.0002	1	**2.75 ***	0.709 *	0.0686 *	**23.1 ***	0.683 *	**3.20 ***	**4.93 ***	0.0412 *	0.834 *	**4.80 ***	0.352 *	0.136 *	**2.64 ***	-	**3.04 ***
Boron (B)-Total	mg L	0.02	5	<0.10 *	0.060 *	0.188 *	0.23 *	0.052 *	<0.20 *	<0.20 *	0.43 *	0.025 *	<0.10 *	0.035 *	0.038 *	<0.20 *	-	<0.20 *
Cadmium (Cd)-Total	mg L	0.00002	-	0.00138 *	0.000302 *	0.000081 *	**0.0108 ***	0.000624 *	0.00179 *	0.00491 *	<0.00020 *	0.000332 *	0.00282 *	0.000332 *	0.000025 *	0.00247 *	-	0.00273 *
Chromium (Cr)-Total	mg L	0.0002	-	**0.0615 ***	0.0155 *	0.00205 *	**0.265 ***	0.0131 *	**0.115 ***	**0.147 ***	<0.0020 *	0.0125 *	**0.0978 ***	0.00745 *	0.00127 *	**0.132 ***	-	**0.147 ***
Copper (Cu)-Total	mg L	0.001	1	0.0629 *	0.0278 *	0.0032 *	0.319 *	0.0172 *	0.149 *	0.200 *	<0.010 *	0.0158 *	0.160 *	0.0060 *	0.0021 *	0.178 *	-	0.201 *
Iron (Fe)-Total	mg L	0.02	0.3	**89.0 ***	**16.4 ***	**2.45 ***	**430 ***	**21.1 ***	**160 ***	**207 ***	**1.47 ***	**17.7 ***	**175 ***	**6.69 ***	**1.25 ***	**178 ***	-	**203 ***
Lead (Pb)-Total	mg L	0.0001	0.01	**0.0727 ***	**0.0257 ***	0.00150 *	**0.383 ***	**0.0190 ***	**0.118 ***	**0.177 ***	0.0013 *	**0.0134 ***	**0.162 ***	0.00416 *	0.00085 *	**0.115 ***	-	**0.138 ***
Manganese (Mn)-Total	mg L	0.0006	0.05	**1.29 ***	**0.998 ***	**0.695 ***	**29.6 ***	**1.12 ***	**2.78 ***	**5.50 ***	**0.247 ***	**1.89 ***	**4.12 ***	**0.826 ***	**0.617 ***	**4.37 ***	-	**4.95 ***
Selenium (Se)-Total	mg L	0.0002	0.01	0.0023 *	0.00072 *	<0.00020 *	0.0069 *	0.00034 *	0.0096 *	<0.0020 *	<0.0020 *	0.00800 *	**0.0195 ***	<0.00020 *	<0.00020 *	0.0099 *	-	0.0098 *
Uranium (U)-Total	mg L	0.00002	0.02	0.0134 *	**0.0276 ***	**0.0270 ***	**0.0256 ***	0.00163 *	**0.0265 ***	**0.0300 ***	**0.195 ***	0.00397 *	0.00942 *	0.00520 *	0.00284 *	0.0159 *	-	0.0181 *
Zinc (Zn)-Total	mg L	0.006	5	0.401 *	0.0910 *	0.0134 *	1.78 *	0.0736 *	0.667 *	0.974 *	<0.060 *	0.0691 *	0.631 *	0.0311 *	0.0080 *	0.685 *	-	0.771 *
Miscellaneous Parameters																		
Turbidity	NTU	0.1	-	1740	424	55.8	>4000	>4000	613	>4000	134	1340	>4000	372	13.5	>4000	927	-
Routine Potable Water																		
Alkalinity, Total																		
Alkalinity, Total (as CaCO3)	mg L	5	500	227	296	383	314	282	294	423	**508**	341	224	294	190	374	**512**	-
Bicarbonate (HCO3)	mg L	5	-	277	361	467	383	344	359	516	620	417	274	359	231	456	625	-
Hydroxide (OH)	mg L	5	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	-
Carbonate (CO3)	mg L	5	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	-
Chloride (Cl)																		
Chloride (Cl)	mg L	1	250	7.4	6.7	5	40.6	3.4	5.2	1.8	98 *	7.9	5.2	1.9	2.3	9.1	101 *	-
Fluoride (F)																		
Fluoride (F)	mg L	0.1	-	0.23	0.2	0.22	0.2	<0.10	0.22	0.14	0.32	<0.10	<0.10	0.3	0.2	0.21	0.31	-
ICP Cations																		
Calcium (Ca) Dissolved	mg L	1	-	73.4	88.8	127	173	89.9	106	110	467 *	140	63.4	84.2	76.2	109	459 *	-
Magnesium (Mg) Dissolved	mg L	1	200	28.8	25.7	54.2	53.7	35.8	30.9	41.7	**817 ***	32.5	14.9	26.1	21.3	35.2	**815 ***	-
Potassium (K) Dissolved	mg L	1	-	4	3.4	6.9	7.2	10.5	2.9	3.4	51 *	4.7	2.3	2.5	3.1	5.5	51 *	-
Sodium (Na) Dissolved	mg L	2	300	29.2	15.8	66	44.7	9.4	7.7	7.6	**1180 ***	16.5	5.4	7.2	8.6	27.5	**1160 ***	-
Sulfur (as SO4) Dissolved	mg L	3	500	112	35.9	263	186	104	95.3	18.3	**6240 ***	139	18	30.2	95.5	87.7	**6400 ***	-
Iron (Fe) & Manganese (Mn) - Dissolved																		
Iron (Fe)-Dissolved	mg L	0.03	-	<0.030	<0.030	0.082	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.035	<0.030	<0.030	0.07	<0.030	-
Manganese (Mn)-Dissolved	mg L	0.001	-	0.0309	0.602	0.574	0.0895	0.297	0.163	0.184	0.254	0.0057	0.113	0.538	0.526	0.386	0.244	-
Nitrate, Nitrite and Nitrate+Nitrite-N																		
Nitrate+Nitrite-N	mg L	0.5		<0.50	<0.50	<0.50	51.3	<0.50	0.83	<0.50	<0.50	7.12	0.67	<0.50	<0.50	<0.50	<0.50	-
Nitrate-N	mg L	0.5	10	<0.50	<0.50	<0.50	**51.0**	<0.50	0.72	<0.50	<0.50	7.1	0.61	<0.50	<0.50	<0.50	<0.50	-
Nitrite-N	mg L	0.05	3.2	<0.050	<0.050	<0.050	0.276	<0.050	0.11	<0.050	0.058	<0.050	0.065	<0.050	<0.050	<0.050	0.08	-
pH and Conductivity																		
pH	pH	0.1	-	7.46 *	7.28 *	7.19 *	7.51 *	7.59 *	7.66 *	7.49 *	7.39 *	7.24 *	7.33 *	7.37 *	7.52 *	7.58 *	7.42 *	-
Conductivity (EC)	uS cm	10	-	651	639	1150	1420	711	721	786	8800	920	443	588	550	834	8800	-
Total Coliform, Ecoli Mcoli Blue & HPC																		
Escherichia Coli mcoli blue MF																		
E. Coli	CFU 100mL	1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	**10**	-	-
Heterotrophic Plate Count																		
Heterotrophic Plate Count	CFU mL	10	-	>3000	>3000	>3000	>3000	>3000	>3000	>3000	>3000	>3000	-	>3000	>3000	>3000	-	-
Total Coliforms																		
Total Coliforms	CFU 100mL	1	0 , no OVERGROWN	**190**	**890**	**OVERGROWN**	<1	**30**	**70**	**40**	**210**	<1	-	**OVERGROWN**	**OVERGROWN**	**10**	-	-
Miscellaneous																		
Biochemical Oxygen Demand	mg L	2	-	23	6	8	10	26	7	7	5	7	-	12	55	4	-	-
TDS (Calculated)	mg L	n a	1500	391	354	752	921	422	428	437	**9160**	577	247	329	321	499	**9290**	-
Cation - Anion Balance	%	n a	-	2.2	3.2	2.1	0.7	1.3	1	2.4	0.1	0.2	-3.9	1.1	1.3	0.6	-1.6	-
Hardness (as CaCO3)	mg L	n a	800	302	328	540	653	372	392	446	**4530**	483	220	318	278	417	4500	-
Soils																		
Total Available Nitrogen	mg kg	2.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen by LECO	%	0.02	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-
Available Ammonium-N	mg kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate+Nitrite-N	mg kg	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate-N	mg kg	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite-N	mg kg	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* = Result Qualified   **Bold**-Exceeds Guidelines

Table 3.2-2
Water and Soil Lab Results
Grasswood Hydrogeology

		Sample ID	**DUP 3**	**DUP 4**	**BH207-CF07**	**BH208-CF25**
		ALS ID	**L1172891-16**	**L1172891-17**	**L1171379-2**	**L1171379-1**
		Date Sampled	**04/07/2012**	**04/07/2012**	**26/06/2012**	**28/06/2012**
			Water	**Water**	**Soil**	**Soil**
Parameter	**Units**	**Detection Limit**				
Health and Toxicity Metals						
Total Mercury in Water by CRC ICPMS						
Mercury (Hg)-Total	mg L	0.00005	-	-	-	-
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	mg L	0.01	-	-	-	-
Arsenic (As)-Total	mg L	0.0002	-	-	-	-
Barium (Ba)-Total	mg L	0.0002	-	-	-	-
Boron (B)-Total	mg L	0.02	-	-	-	-
Cadmium (Cd)-Total	mg L	0.00002	-	-	-	-
Chromium (Cr)-Total	mg L	0.0002	-	-	-	-
Copper (Cu)-Total	mg L	0.001	-	-	-	-
Iron (Fe)-Total	mg L	0.02	-	-	-	-
Lead (Pb)-Total	mg L	0.0001	-	-	-	-
Manganese (Mn)-Total	mg L	0.0006	-	-	-	-
Selenium (Se)-Total	mg L	0.0002	-	-	-	-
Uranium (U)-Total	mg L	0.00002	-	-	-	-
Zinc (Zn)-Total	mg L	0.006	-	-	-	-
Miscellaneous Parameters						
Turbidity	NTU	0.1	-	-	-	-
Routine Potable Water					-	-
Alkalinity, Total						
Alkalinity, Total (as CaCO3)	mg L	5	-	-	-	-
Bicarbonate (HCO3)	mg L	5	-	-	-	-
Hydroxide (OH)	mg L	5	-	-	-	-
Carbonate (CO3)	mg L	5	-	-	-	-
Chloride (Cl)						
Chloride (Cl)	mg L	1	-	-	-	-
Fluoride (F)						
Fluoride (F)	mg L	0.1	-	-	-	-
ICP Cations						
Calcium (Ca) Dissolved	mg L	1	-	-	-	-
Magnesium (Mg) Dissolved	mg L	1	-	-	-	-
Potassium (K) Dissolved	mg L	1	-	-	-	-
Sodium (Na) Dissolved	mg L	2	-	-	-	-
Sulfur (as SO4) Dissolved	mg L	3	-	-	-	-
Iron (Fe) & Manganese (Mn) - Dissolved						
Iron (Fe)-Dissolved	mg L	0.03	-	-	-	-
Manganese (Mn)-Dissolved	mg L	0.001	-	-	-	-
Nitrate, Nitrite and Nitrate+Nitrite-N						
Nitrate+Nitrite-N	mg L	0.5	-	-	-	-
Nitrate-N	mg L	0.5	-	-	-	-
Nitrite-N	mg L	0.05	-	-	-	-
pH and Conductivity						
pH	pH	0.1	-	-	-	-
Conductivity (EC)	uS cm	10	-	-	-	-
Total Coliform, Ecoli Mcoli Blue & HPC					-	-
Escherichia Coli mcoli blue MF						
E. Coli	CFU 100mL	1	<1	-	-	-
Heterotrophic Plate Count						
Heterotrophic Plate Count	CFU mL	10	>3000	-	-	-
Total Coliforms						
Total Coliforms	CFU 100mL	1	**OVERGROWN**	-	-	-
Miscellaneous					-	-
Biochemical Oxygen Demand	mg L	2	-	5	-	-
TDS (Calculated)	mg L	n a	-	-	-	-
Cation - Anion Balance	%	n a	-	-	-	-
Hardness (as CaCO3)	mg L	n a	-	-	-	-
Soils						
Total Available Nitrogen	mg kg	2.2	-	-	5.2	4.6
Total Nitrogen by LECO	%	0.02	-	-	0.051	0.033
Available Ammonium-N	mg kg	1	-	-	5.2	4.6
Nitrate+Nitrite-N	mg kg	2	-	-	<2.0	<2.0
Nitrate-N	mg kg	2	-	-	<2.0	<2.0
Nitrite-N	mg kg	0.4	-	-	<0.40	<0.40

* = Result Qualified   **Bold**-Exceeds Guidelines

Table 3.4
Surrounding Water Well Elevations
Grasswood Hydrogeology

Point #'s	Northing	Easting	OG Elev.	Water Elev.	Notes
5051	9377.513	6075.313	510.182	507.362	15 South Point Road
5052	9553.765	5936.28	508.153	507.283	25 South Point Road
5053	9857.034	6431.537	510.213	N/A	N/A
5054	9842.159	6534.961	509.977	508.307	65 South Point Road (Bitz)
5055	9842.105	6535.021	510.599	509.269	GA3-P Pizo
5056	10660.71	6297.974	513.732	511.357	85 Ashwood Drive
5057	10385.191	6281.368	511.445	509.255	98 Ashwood Drive
5058	10618.674	6838.906	514.752	509.932	25-35-5W3
5059	9361.743	6472.99	510.128	506.998	(North of lot 35404)
5060	9503.665	6305.784	508.493	507.028	58 South Point Lane
5062	9808.879	6155.499	508.827	507.177	45 Ashwood Drive
5063	8820.795	6026.795	509.993	507.113	NE35-35-5W3
5064	8958.519	6571.47	508.088	505.208 when pump is running	505.788 when pump is off
5065	8799.128	6529.506	507.022	506.172	Lot 35362
5066	9078.634	6521.865	508.366	506.636	35362 Along TWP 3051
5068	8815.114	5774.974	510.736	507.446	19 Mandalay Drive
5069	9002.033	5808.279	508.646	508.106	25 Mandalay Drive
5070	9118.833	5279.528	510.405	507.415	Howard Butlers
5071	9414.796	4508.94	510.194	506.536	1751 Baker Road (Water was measured by farmer not witnessed)
5072	8764.306	3818.562	513.27	506.74	1450 Baker Road
5074	9305.192	4019.07	511.884	507.084	60 Casa Rio Road
5075	9362.539	3773.915	509.906	507.136	47 Casa Rio Road
5076	9516.415	3813.345	507.577	505.457	N/A
5077	9981.731	3764.573	508.464	503.994	22 Casa Rio Road
5078	10113.704	3827.195	508.923	503.493	75 Casa Rio Road
5079	10047.932	3891.604	509.475	503.505	65 Casa Rio Road
5080	10756.979	3952.047	503.823	501.183	15 Casa Rio Road
5081	10754.451	3958.523	503.809	501.183	Right Beside Point 5080
5082	11666.533	4830.799	508.237	505.737	Lot North 5044 Preston Drive
5084	11118.486	4869.115	513.176	507.016	N/A
5085	10830.083	5157.474	511.476	509.376	5196 Preston Drive
5086	10322.118	5921.655	510.823	508.028	45 Ashwood Drive
5087	10167.566	4099.522	506.781	505.016	55 Elderodo Lane

Clifton Associates Ltd.
engineering science technology

Appendix A

BIO-MICROBICS®
INCORPORATED

8450 Cole Parkway • Shawnee, KS 66227 • Phone: 913-422-0707 • Fax: 913-422-0808
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        iii. Buzzard's Bay - Massachusetts Alternative Septic System Test Center
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    b. RetroFAST® Data Summary

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EXECUTIVE SUMMARY

Testing of the Bio-Microbics, Inc. (formerly Scienco/FAST®) Single Home FAST Treatment Plant Model 23-001-750 was conducted under the provisions of NSF Standard 40 for Individual Aerobic Wastewater Treatment Plants (July 1990). NSF Standard 40 was developed by the NSF Joint Committee on Wastewater Technology.

The performance evaluation was conducted at the NSF Wastewater Technology Test Facility in Chelsea, Michigan, using wastewater diverted from the Chelsea municipal wastewater collection system. The evaluation consisted of six months of testing, during which a seven week stress test was conducted. The evaluation consisted of three weeks of dosing without sampling to allow for plant start-up, sixteen weeks of dosing at design flow, seven weeks of stress test and five weeks of dosing at design flow. Sampling started in the fall and continued through the winter and into spring, covering a full range of operating temperatures.

Standard 40, in Section H. (3) of Appendix A, provides for exclusion of up to ten percent of the effluent sample days, not to exceed one during stress testing, in completing the pass/fail determination. No sample days were excluded in this evaluation. Over the course of the evaluation, the average effluent BOD_5 was 9 mg/L, ranging between <5 and 24 mg/L, and the average effluent suspended solids was 7 mg/L, ranging between <5 and 27 mg/L. The pH ranged from 7.5 to 8.2.

The Single Home FAST Treatment Plant Model 23-011-750 produced an effluent that successfully met the performance requirements established by NSF Standard 40 for Class I effluent:

> The maximum arithmetic mean of seven consecutive sample days was 14 mg/L for BOD_5 and 12 mg/L for suspended solids, both well below the allowed maximum of 45 mg/L. The maximum arithmetic mean of 30 consecutive sample days was 12 mg/L for BOD_5 and 8 mg/L for suspended solids, both well below the allowed maximum of 30 mg/L. Removal rates ranged from 92 to 95 percent for BOD_5 and 95 to 97 percent for suspended solids, consistently above the requirement of 85 percent.

The effluent pH during the entire evaluation ranged between 7.5 and 8.2, within the required range of 6.0 to 9.0. The plant also met the requirements for noise levels (less than 60 dbA at a distance of 20 feet) and color, threshold odor, oily film and foam.

Prepared 8/28/96

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NITROGEN SERIES TEST RESULTS

(All results reported as mg/L as N)

Plant: Bio-Microbics, Inc. (formerly Scienco/FAST®) Model 23-001-0750

Sample Date	Ammonia - N		Nitrate - N		Total Kjeldahl - N	
	Influent	Effluent	Influent	Effluent	Influent	Effluent
9/17	22	3.3	<0.5	0.7	32	6.1
9/20	29	2.2	0.8	4.1	36	4.7
9/24	34	4.0	<0.5	4.6	39	6.2
9/27	25	3.5	<0.5	3.9	33	5.4
10/1	28	4.7	<0.5	1.5	35	8.0
10/4	21	6.0	<0.5	1.4	31	9.4

Prepared 8/26/96

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This is the Official Listing recorded on April 25, 2005.

BIO-MICROBICS, INC.
8450 COLE PARKWAY
SHAWNEE, KS 66227
800-753-FAST
913-422-0707

Facility : SHAWNEE, KS

Model Number	Rated Capacity Gallons/Day	Classification
MicroFast 0.5[1]	500	Class I
MicroFast 0.75[2]	750	Class I
MicroFast 0.9[3]	900	Class I
MicroFast 1.5[4]	1500	Class I

[1] Beginning with serial number MCF2265B
[2] Beginning with serial number MCF4000B
[3] Beginning with serial number MCF3026B
[4] Beginning with serial number MCF6006B

NOTE: Units accepted with either concrete or fiberglass tanks.

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Contact the Listed company directly for further product information and availability in your area.

Onsite Wastewater Nutrient Reduction Systems (OWNRS) For Nutrient Sensitive Environments

Damann L. Anderson*
Mark B. Tyl
Richard J. Otis
Timothy G. Mayer
Kevin M. Sherman

ABSTRACT

Negative impacts to the Florida Keys coral reef ecology have been documented in recent years, and water quality degradation from nutrient overloading is a suspected cause. To protect the waters of the Florida Keys from further degradation, the Florida Keys National Marine Sanctuary (FKNMS) was established by the federal government in 1990. In 1993 the U.S. Environmental Protection Agency (EPA) identified domestic wastewater as a major source of nutrient loading to FKNMS waters. Many dwellings and commercial establishments in the Keys use onsite wastewater treatment systems (OWTS), so the Florida Keys Onsite Wastewater Nutrient Reduction Systems (OWNRS) Demonstration Project was initiated in 1995 to demonstrate the use of OWTS which could significantly improve treatment and reduce the concentrations of nutrients discharged to the near-shore environment of the Keys.

To meet this objective, a unique test facility was designed and constructed to evaluate various OWNRS processes simultaneously, under controlled conditions, using a common wastewater source. Five principle wastewater treatment process streams were operated concurrently at the test facility, with several unit processes in each stream. Unit processes evaluated included attached growth and suspended growth biological processes (both aerobic and anaerobic), physical/chemical processes (adsorption, precipitation, ion exchange) and natural systems utilizing drip irrigation for plant uptake and evapotranspiration. Influent and effluent quality were monitored monthly with 24-hour flow-composite samples. Results after the first year of operation indicate that OWNRS effluent concentrations of 5 mg/L $CBOD_5$, 5 mg/L TSS, 10 mg/L total nitrogen, and 1 mg/L total phosphorus are achievable without chemical addition using combinations of the processes tested. Although excellent treatment was achieved with OWNRS, significant additional construction, operation, and maintenance was required for these systems in comparison with conventional OWTS.

Keywords: Onsite wastewater treatment, Nutrient removal, Nitrogen removal, Phosphorus removal, Advanced wastewater treatment

INTRODUCTION

The Florida Keys are an environmentally sensitive chain of islands extending from the southern tip of Florida southwestward to Key West and the Dry Tortugas. The clear waters surrounding this area contain the only living coral reefs in the continental United States. Over 80,000 people make their homes in the Florida Keys and more than 3 million tourists visit the Keys annually.

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Background

In 1990, the United States Congress recognized the national and international significance of resources in the Florida Keys with the passage of The Florida Keys National Marine Sanctuary and Protection Act (Public Law 101-605). The sanctuary established by this legislation consists of approximately 9,500 km^2 of coastal and oceanic waters and the submerged land beneath them. The shoreward boundary of the sanctuary is the mean high-water mark.

Under the sanctuary designation, the National Oceanic and Atmospheric Administration (NOAA) is charged with developing a comprehensive management plan and implementation regulations. The U.S. Environmental Protection Agency (EPA), in conjunction with the State of Florida and NOAA, must develop and implement a water quality protection program.

The water quality protection program has identified nutrient loading from wastewater sources as one of the major water quality concerns in the Keys. Onsite wastewater treatment systems (OWTS) have been targeted as one of the primary wastewater sources of nitrogen and phosphorus. The Water Quality Protection Program Report (Continental Shelf Associates, 1993) to the EPA documented the need for a demonstration of nutrient-reducing OWTS in the Florida Keys. The Florida Department of Health initiated the Florida Keys Onsite Wastewater Nutrient Reduction System (OWNRS) Demonstration Project in response to this need.

Project Objectives

The Florida Keys OWNRS Demonstration Project was designed to demonstrate the capability and use of alternative OWTS technologies for the Florida Keys. Wastewater treatment processes which provide a level of treatment superior to conventional OWTS were tested to evaluate their potential to reduce organic, solids, and nutrient loading to near-shore waters of the Keys. An additional goal of the project was to determine if Florida advanced wastewater treatment (AWT) standards of 5 milligrams per liter (mg/L) for Carbonaceous Biological Oxygen Demand (CBOD) and Total Suspended Solids (TSS), 3 mg/L for Total Nitrogen, and 1 mg/L for Total Phosphorus, are feasible for OWTS.

MATERIALS AND METHODS

Central Test Facility

A central test facility was constructed at a minimum security correctional institution in the Florida Keys to test various processes for onsite wastewater treatment removal. The central test facility was designed to allow comparative testing of numerous onsite wastewater treatment processes simultaneously, under controlled conditions, with a common wastewater source. Use of a common source eliminated the difficulty of making valid comparisons of technology performance based on a limited number of installations with widely varying wastewater characteristics. The test facility allows accurate monitoring of influent wastewater quality and flow, and the capability for flow-composited effluent sampling to determine treatment performance.

The test facility was initially set up to evaluate five principle wastewater treatment process streams. Electronically activated dose systems provide each of the process streams with influent wastewater, diverted from the correctional institution's wastewater collection systems. The dosing schedule is shown in Figure 1 and mimics the typical wastewater flow from a home, with peaks in the morning and early evening. Under normal operating conditions, each of the treatment streams receives 200 gallons per day. The facility is designed so this volume can be adjusted for stress testing and other special purpose research. The central test facility was activated in October of 1996.

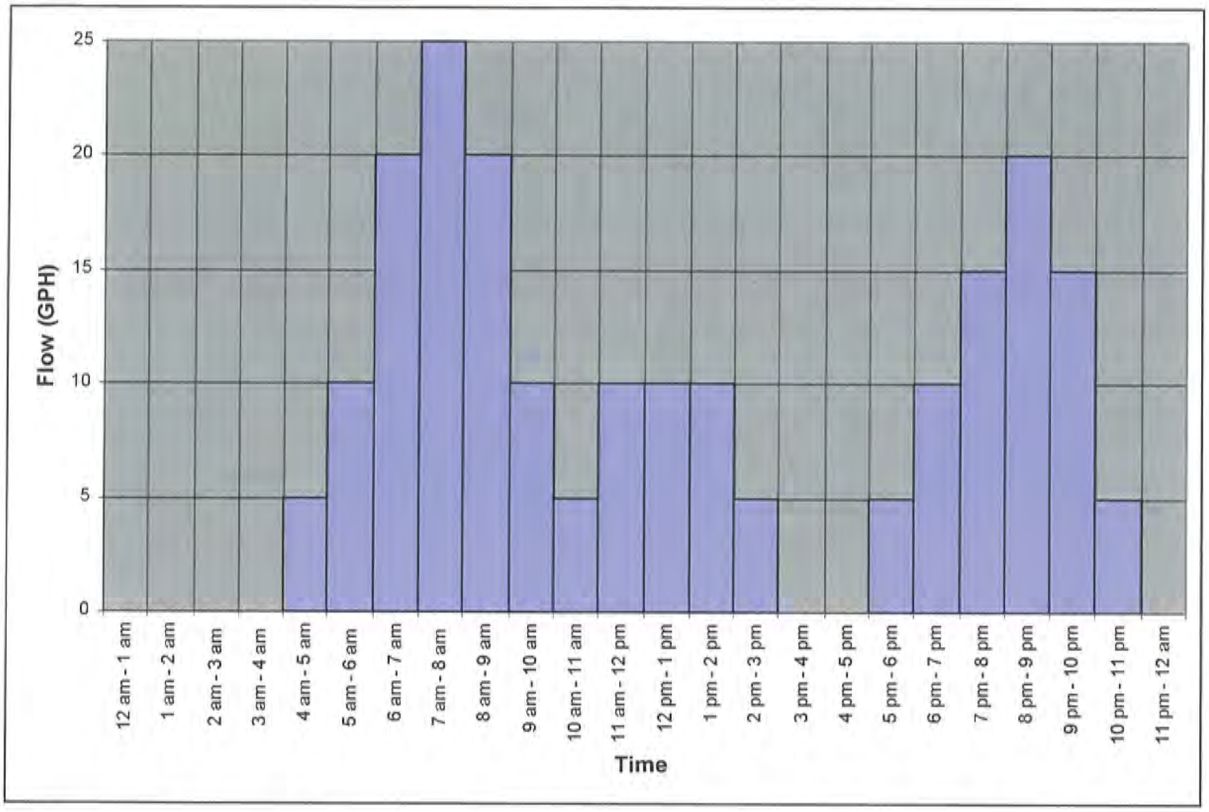

Figure 1: Daily Dose Schedule to Treatment Systems (5 gallons per dose)

Treatment Processes

The principle treatment technologies currently under evaluation are physical, chemical, and aerobic and anaerobic biological treatment processes. One "passive" technology stream and four "active" technology process streams are currently under evaluation. A description of the five principle process streams follows. Figure 2 provides a schematic of the test facility and process streams currently in operation.

Process Stream 1 consists of a septic tank (ST-1) followed by a recirculating sand filter (RSF) and an anoxic bio-filter (ABF). Effluent from the system is discharged to an unlined drip irrigation bed. Treatment occurs through digestion and settling in the septic tank and physical, chemical, and attached growth aerobic biological processes in the RSF. Adsorption by the RSF media removes limited quantities of phosphorus. The nitrified RSF effluent is mixed with anoxic septic tank effluent in the recirculation chamber (RC) to encourage denitrification. The effluent also undergoes further nutrient reduction in an anoxic bio-filter and by plant uptake in the drip bed as well as adsorption on the drip field media.

Process Stream 2 is a relatively passive technology consisting of a septic tank (ST-2) with effluent discharged to a lined drip irrigation field. A commercially available subsurface drip irrigation (SDI) system by Aztex™ Products is used for effluent distribution to the root zone. This process stream represents the most "low tech" of the systems. Reduction of nutrients and other parameters is accomplished by preliminary digestion and settling in the septic tank with additional

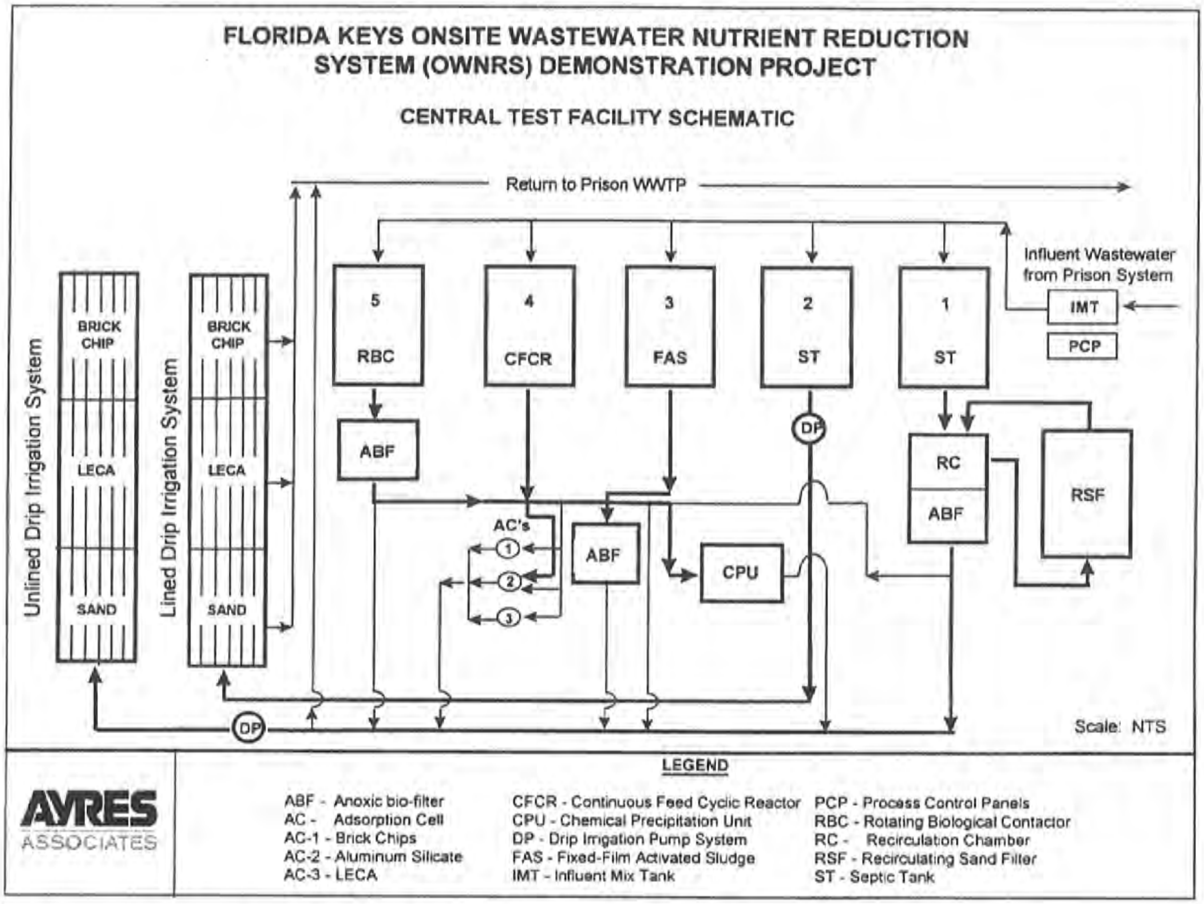

Figure 2: Central Test Facility Schematic

physical, chemical, and biological treatment processes occurring in the lined bed underlying the drip field and by plant uptake. The lined bed contains a one foot thickness of saturated media under 1.5 feet of unsaturated media. The effluent undergoes nitrification in the upper unsaturated (aerobic) portion of the drip bed and limited denitrification in the saturated (anaerobic) lower portion of the drip bed. Three treatment media (crushed red brick, silica sand, and an expanded clay aggregate from Norway, commercially known as LECA™) underlie distinct zones of the drip field. Two of these, the bricks and LECA, were selected for their phosphorus adsorption potential. Because these media beds have been built over an impermeable liner, the program includes an assessment of the effectiveness of evapo-transpiration in reducing effluent volumes.

The principle treatment unit in *process stream 3* is a proprietary unit known as the Bio-Microbics FAST™ aerobic unit. This unit uses fixed-film activated sludge (FAS) treatment. The treatment is a combination suspended growth and attached growth aerobic biological process. This system provides nitrification of the effluent before discharge, and also provides denitrification by mixing anaerobic conditions that favor the growth of denitrifying microorganisms and conversion of nitrate to nitrous oxide or nitrogen gas. Additional processes would be required for phosphorus removal following this system.

Process stream 4 consists of proprietary treatment unit known as the AES BESTEP- IDEA™ system. This system is a suspended growth biological treatment process that operates as a continuous feed cyclic reactor (CFCR). The process is similar to a sequencing batch reactor (SBR), but is unique in that it allows continuous flow while using only one process tank. Aeration to the tank is cyclical, which causes alternating aerobic and anaerobic conditions. This fluctuating environment results in nitrification followed by denitrification and also luxury uptake of phosphorus by the activated sludge biomass.

Process stream 5 consists of a proprietary treatment unit known as the Klargester Biodisc™. It is a rotating biological contactor (RBC), followed by an anoxic bio-filter (ABF). The RBC is an attached growth, aerobic biological treatment process that provides internal recycle for nitrification and denitrification. It produces a nitrified effluent that then undergoes further denitrification in the ABF. Additional processes would be required for phosphorus removal following this system.

Additional unit processes are available for testing at the facility. These include chemical precipitation, supplemental carbon addition for denitrification, and additional phosphorus adsorption media. The test facility was designed so that the effluent from the principle treatment process streams described above can be routed to any of these additional processes for further treatment and evaluation. These additional processes are currently under evaluation and are not included in this paper. Effluents from the various process streams are discharged to a sump tank after water quality sampling and returned to the correctional institution's wastewater treatment plant.

Treatment Performance Monitoring

Twenty-four hour flow composited samples were collected from the influent mix tank and from each of the five treatment process effluents from November 1996 through August 1997. Samples were analyzed according to Standard Methods (APHA, 1992) for biochemical oxygen demand (BOD_5), carbonaceous biochemical oxygen demand ($CBOD_5$), total suspended solids (TSS), total kjeldahl nitrogen (TKN), nitrate + nitrite-nitrogen (NO_2NO_3-N), and total phosphorus (TP). Total nitrogen (TN) was obtained by summation.

RESULTS

Results of the water quality analyses for the influent and five process stream effluents are provided in Table 1. For the lined bed drip irrigation system (Process Stream 2), only the results of the crushed brick media (LBRICK) are reported here.

Influent wastewater quality was typical of that reported in the literature for domestic wastewater (Metcalf and Eddy, 1991) with mean $CBOD_5$, TSS, TN, and TP values of 137.8, 117.5, 38.4, and 8.4 mg/L, respectively. Significant variations about these mean values were measured over the 12 sampling events, also typical of domestic wastewater from individual homes.

Effluent quality for all treatment processes was excellent in terms of traditional wastewater treatment parameters, $CBOD_5$, and TSS.

$CBOD_5$: All five process streams met the AWT $CBOD_5$ effluent standard of 5 mg/L. Figure 3 shows the 95% confidence intervals about the mean for the five processes. These data illustrate the stability of fixed-film attached growth biological processes such as the RSF and RBC.

TSS: Only the CFR and the RBC systems did not meet the AWT effluent TSS standard of 5 mg/L, but they were within 2 mg/L of the standard. Figure 4 shows the 95% confidence intervals for TSS. These data indicate the stability of biological filter type processes such as the RSF for TSS removal. The crushed brick media also indicated stable TSS removals later in the study period, once the fine media particles stabilized and grass growth took hold.

Effluent quality for the nutrients, nitrogen and phosphorus, showed significantly more variation between processes, and typically did not meet AWT effluent standards.

Table 1: Summary of Influent and Effluent Water Quality Data

Parameter	Statistic	Influent (IMT)	System 1 (RSF-ABF)	System 2 (LBRICK)	System 3 (FAS)	System 4 (CFCR)	System 5 (RBC-ABF)
BOD$_5$	mean	170.90	2.27	4.17	5.58	4.16	2.42
	Std. Dev.	73.85	2.51	6.29	3.90	5.45	1.38
	min	62.00	1.00	1.00	1.00	1.00	1.00
	max	299.00	9.70	21.30	14.00	17.20	5.00
	n	10	12	11	11	8	11
CBOD$_5$	mean	137.80	1.50	2.81	2.70	3.19	1.68
	Std. Dev.	60.13	0.90	4.04	3.11	5.18	1.24
	min	59.00	1.00	1.00	1.00	1.00	1.00
	max	220.00	4.00	14.40	9.01	15.90	5.00
	n	10	12	11	11	8	11
TSS	mean	117.50	2.25	4.09	4.63	6.85	5.75
	Std. Dev.	92.09	1.76	3.83	3.93	6.62	4.47
	min	17.00	1.00	1.00	1.00	2.00	1.00
	max	345.00	6.00	11.00	14.00	20.00	16.00
	n	12	12	11	12	10	12
TKN	mean	38.58	1.01	1.75	1.55	1.16	2.75
	Std. Dev.	10.67	1.44	2.10	0.82	0.52	2.62
	min	19.20	0.26	0.34	0.49	0.56	0.42
	max	62.50	5.30	8.19	3.40,	2.20	7.40
	n	12	11	12	12	9	11
NO$_2$NO$_3$-N	mean	0.03	21.09	18.3.6	9.42	14.30	9.77
	Std. Dev.	0.02	6.76	10.56	4.06	6.49	3.69
	min	0.01	14.00	1.60	3.90	2.54	3.60
	max	0.05	35.20	36.60	19.70	23.00	17.00
	n	10	11	11	12	9	11
TN	mean	38.61	20.76	20.24	10.97	15.46	12.52
	Std. Dev.	10.67	5.61	11.64	4.05	6.60	5.98
	min	19.25	14.46	3.00	4.55	3.53	4.05
	max	62.55	30.23	44.79	20.19	24.20	23.00
	n	12	10	11	12	9	11
TP	mean	8.39	1.76	0.60	5.38	6.24	4.67
	Std. Dev.	5.79	0.48	0.23	1.44	1.59	1.05
	min	4.32	0.92	0.34	3.22	4.80	2.50
	max	26.00	2.40	1.20	8.70	9.90	5.90
	n	12	10	11	12	10	12

Nitrogen: None of the five process streams met the AWT nitrogen standard of 3 mg/L. The FAS and RBC-ABF systems performed best for nitrogen removal, with mean effluent TN values of 11.0 and 12.5 mg/L, respectively. Figure 5 shows the 95% confidence intervals for TN.

These results are excellent considering they were obtained without supplemental carbon addition to enhance denitrification. In fact, the RBC-ABF effluent was not significantly different from the RBC effluent alone, indicating insufficient residual carbon for denitrification in the ABF tank following the RBC.

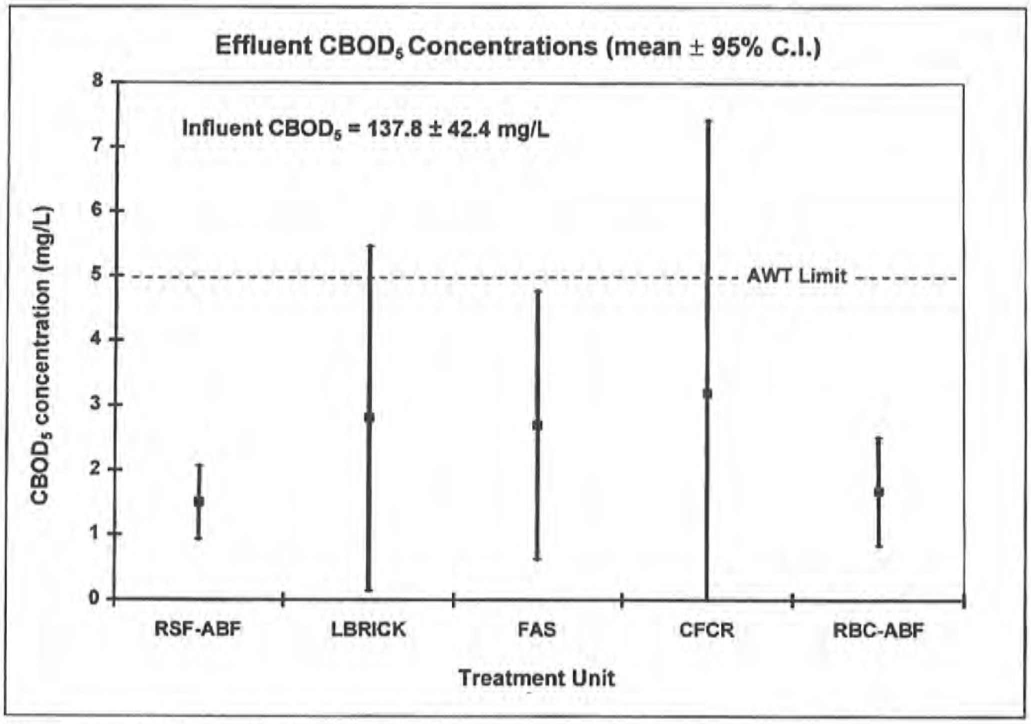

Figure 3: Effluent CBOD$_5$ Concentrations (mean ± 95% C.I.)

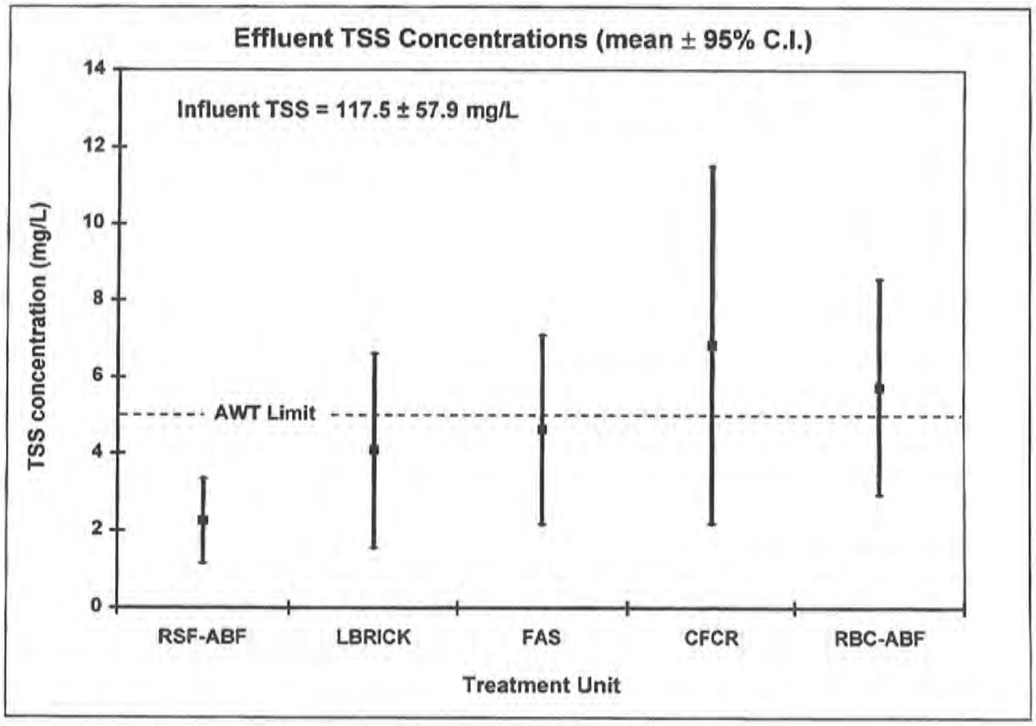

Figure 4: Effluent TSS Concentrations (mean ± 95% C.I.)

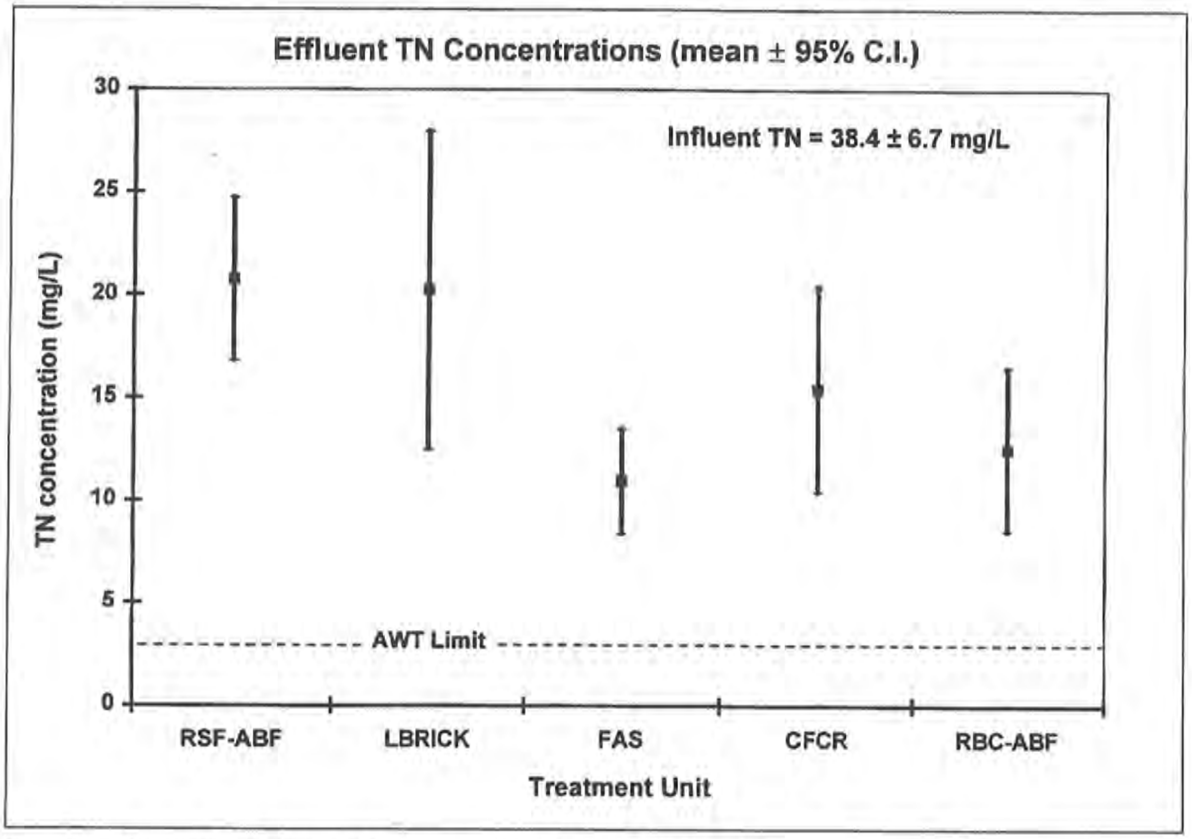

Figure 5: Effluent Total Nitrogen Concentrations (mean ± 95% C.I.)

Supplemental carbon addition is currently being evaluated at the Keys test facility, and preliminary results indicate that an effluent TN value of 5 mg/L may be achievable by adding carbon to an ABF unit following the FAS or RBC.

Phosphorus: Only the lined drip irrigation system with crushed brick (LBRICK) media met the AWT effluent standard for phosphorus. The LBRICK and RSF-ABF systems both provided excellent TP removals with mean effluent TP values of 0.60 and 1.8 mg/L, respectively. Figure 6 shows the 95% confidence intervals for TP. These data suggest that adsorption of phosphorus on the RSF sand and drip field crushed brick media are also the most stable phosphorus removal mechanisms tested. It remains to be seen, however, how long these removal efficiencies will last. Once the media adsorption sites reach capacity, breakthrough of phosphorus at higher concentrations may occur.

SUMMARY AND CONCLUSIONS

A field evaluation of several onsite wastewater nutrient reduction systems (OWNRS) was conducted to evaluate the potential for improved treatment effectiveness of onsite wastewater treatment systems (OWTS) in the Florida Keys. Results indicated that the systems tested provided excellent treatment performance ($CBOD_5$ and TSS <5 mg/L), but no individual system was capable of meeting the Florida advanced waste treatment (AWT) effluent standards of 5 mg/L $CBOD_5$, 5 mg/L TSS, 3 mg/L TN, and 1 mg/L of TP.

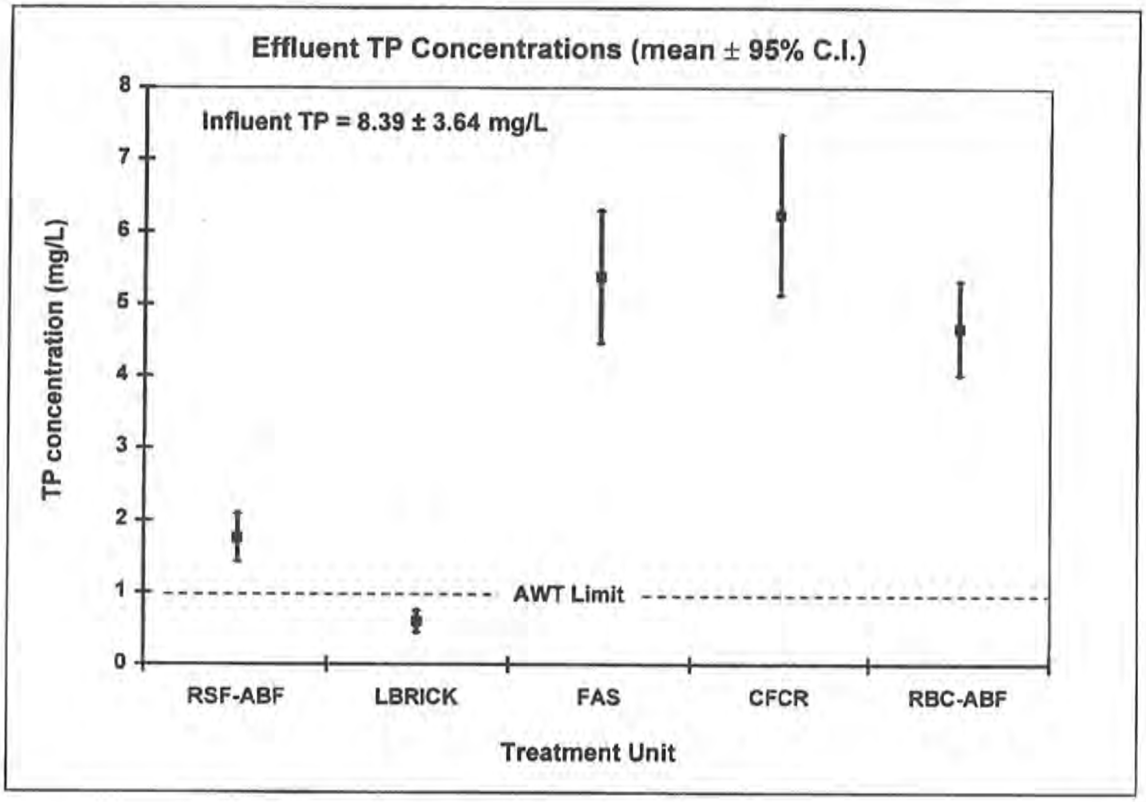

Figure 6: Effluent Total Phosphorus- Concentrations (mean ± 95% C.I.)

It appeared that a combination of processes, such as an aerobic biological treatment unit followed by an anoxic bio-filter (ABF) with supplemental carbon addition, discharging to an engineered media drip irrigation bed could meet the AWT standards for $CBOD_5$, TSS, and TP and come very close to the standard for TN. The duration of the TP removals by the drip irrigation bed is unknown; however, continued monitoring of these systems is recommended to address longevity issues and solids handling requirements. Based on the evaluation conducted to date, following conclusions are drawn:

- AWT effluent standards for $CBOD_5$, TSS, and TP can be consistently met with combinations of the technologies tested;
- TN reductions of>70% are achievable without supplemental carbon addition and 90% with carbon addition;
- Continued monitoring of the OWNRS are required to quantify phosphorus removal duration and treatment performance longevity, solids handling requirements, and maintenance requirements;
- Construction of the OWNRS and operation for one year has indicated that OWNRS will require considerably greater capital, operation and maintenance expenditures in comparison to conventional OWTS.

ACKNOWLEDGEMENTS

This project was funded by the Florida Department of Health (Contract #LP988) under a grant from the US Environmental Protection Agency (Cooperative Agreement #X994394-93-0), and this financial support is acknowledged. The Florida Department of Corrections, and specifically the staff of the Big Pine Key Road Prison, are gratefully acknowledged for the cooperation and assistance on the OWNRS Demonstration Project. Finally, the time and material provided by the numerous equipment manufacturers made this study possible, and their support is acknowledged.

REFERENCES

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2. Continental Shelf Associates, Inc., Batelle Ocean Services, Lindahl, Browning, Ferrari & Hellstrom, Inc., Batelle Pacific Northwest Division and Batelle Seattle Research Center, 1993. Water Quality Protection Program, Florida Keys National Marine Sanctuary, Phase II Report. Report to the US Environmental Protection Agency, Oceans and Coastal Protection Division under Contract 68-C2-0134.
3. Metcalf & Eddy, Inc. Wastewater Engineering: Treatment Disposal, and Reuse. 3rd ed., McGraw-Hill, New York, 1991.

FLORIDA OWNRS PROJECT PHASE 1 - TEST DATA

PARAMETER		UNITS	SAMPLE DATES												AVG	% RED
			11/20/96	12/18/96	1/29/97	2/26/97	4/2/97	4/23/97	[1]5/8/97	5/21/97	[2]5/29/97	6/11/97	7/17/97	8/28/97		
BOD (5-Day@20°C)																
	INFLUENT	mg/L	137.00	148.00	299.00	139.00	170.00	210.00	230.00	62.00	240.00	100.00	150.00	100.00	165.42	
	FAST	mg/L	3.26	7.75	8.02	6.00	4.30	9.00	5.70	2.60	14.00	4.80	1.00	1.00	5.62	96.6
	FAST-ABF	mg/L	NO DATA	NO DATA	10.00	10.00	2.20	1.40	1.70	2.70	1.00	1.40	1.00	1.00	3.24	98.0
BOD (Carbonaceous)																
	INFLUENT	mg/L	176.00	136.00	215.00	183.00	150.00	200.00	220.00	59.00	130.00	67.00	130.00	71.00	144.75	
	FAST	mg/L	2.48	8.85	9.01	6.00	1.20	1.40	1.00	1.00	1.00	1.00	1.00	1.00	2.91	98.0
	FAST-ABF	mg/L	NO DATA	NO DATA	16.10	10.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.41	97.6
Ammonia Nitrogen																
	INFLUENT	mg/L N	18.90	34.90	50.80	26.80	23.00	37.00	29.00	26.00	36.00	30.00	27.00	27.00	30.53	
	FAST	mg/L N	0.32	1.24	1.73	0.58	0.75	1.40	0.10	0.07	1.90	0.30	0.15	0.04	0.72	97.7
	FAST-ABF	mg/L N	NO DATA	NO DATA	2.50	0.34	0.61	0.37	0.29	0.67	0.63	0.04	NO DATA	NO DATA	0.68	97.8
Nitrate-Nitrite Nitrogen																
	INFLUENT	mg/L N	0.05	0.05	0.05	0.05	0.04	0.02	0.02	0.01	0.01	0.04	NO DATA	NO DATA	0.03	
	FAST	mg/L N	9.23	9.39	8.47	19.70	9.20	7.00	3.90	12.00	11.00	9.40	9.80	4.00	9.42	NA
	FAST-ABF	mg/L N	NO DATA	NO DATA	18.81	19.00	8.60	6.40	2.40	7.40	11.00	10.00	10.00	2.40	9.60	NA
Total Kjeldahl Nitrogen																
	INFLUENT	mg/L N	19.20	46.90	62.50	37.40	32.00	46.00	39.00	33.00	44.00	36.00	33.00	32.00	38.42	
	FAST	mg/L N	1.23	1.77	1.82	0.49	1.90	2.50	1.10	1.00	3.40	1.30	1.50	0.55	1.55	96.0
	FAST-ABF	mg/L N	NO DATA	NO DATA	2.39	0.64	1.60	1.10	1.10	1.60	1.60	0.83	1.10	0.81	1.28	96.7
Total Nitrogen(TKN+Nitrates)																
	INFLUENT	mg/L N	19.25	46.95	62.55	37.45	32.04	46.02	39.02	33.01	44.01	36.04	NO DATA	NO DATA	39.63	
	FAST	mg/L N	10.46	11.16	10.29	20.19	11.10	9.50	5.00	13.00	14.40	10.70	11.30	4.55	10.97	72.3
	FAST-ABF	mg/L N	NO DATA	NO DATA	21.20	19.64	10.20	7.50	3.50	9.00	12.60	10.83	11.10	3.21	10.88	72.6
Total Phosphorus																
	INFLUENT	mg/L P	4.32	7.09	11.00	7.07	6.60	7.80	7.10	5.80	26.00	5.80	7.10	5.00	8.39	
	FAST	mg/L P	3.22	4.21	5.19	5.64	5.80	6.40	6.10	5.30	8.70	5.90	3.70	4.40	5.38	35.9
	FAST-ABF	mg/L P	NO DATA	NO DATA	4.52	5.22	5.60	5.60	5.40	5.30	5.80	7.10	4.50	4.20	5.32	36.5
Total Suspended Solids																
	INFLUENT	mg/L	60.00	86.00	345.00	70.00	17.00	203.00	170.00	162.00	80.00	123.00	74.00	20.00	117.50	
	FAST	mg/L	4.00	14.00	10.00	4.00	1.00	3.00	5.50	1.00	2.00	4.00	6.00	1.00	4.63	96.1
	FAST-ABF	mg/L	NO DATA	NO DATA	4.00	4.00	1.00	1.00	2.50	1.00	1.00	1.00	3.00	1.00	1.95	98.3

1 - sample collected following simulated vacation stress

2 - sample collected following simulated wash day stress

FLORIDA OWNRS PROJECT PHASE 2 - TEST DATA

PARAMETER		UNITS	SAMPLE DATES												AVG	% RED
			8/19/98	9/22/98	1/18/99	2/16/99	3/23/99	4/22/99	MAY	6/22/99	7/27/99	8/31/99	9/28/99	10/21/99		
BOD (5-Day@20°C)																
	INFLUENT	mg/L	160.00	120.00	NO DATA	120.00	140.00	56.00	N	160.00	160.00	160.00	110.00	150.00	133.60	
	FAST	mg/L	NO DATA	3.40	NO DATA	4.50	NO DATA	2.50	O	NO DATA	4.20	3.70	1.80	5.60	3.67	97.3
	FAST-ABF	mg/L	NO DATA	13.00	NO DATA	NO DATA	NO DATA	NO DATA		NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	13.00	90.3
BOD (Carbonaceous)									D							
	INFLUENT	mg/L	150.00	91.00	190.00	90.00	88.00	39.00	A	100.00	120.00	120.00	90.00	140.00	110.73	
	FAST	mg/L	1.00	1.70	1.00	2.00	1.00	1.00	T	1.00	1.00	1.10	1.00	1.00	1.16	98.9
	FAST-ABF	mg/L	NO DATA	NO DATA	3.80	1.50	1.00	1.00	A	1.00	1.00	6.70	36.00	1.00	5.89	94.7
Ammonia Nitrogen																
	INFLUENT	mg/L N	NO DATA	26.00	NO DATA	37.00	NO DATA	22.00	F	53.00	35.00	47.00	30.00	40.00	36.25	
	FAST	mg/L N	NO DATA	0.11	NO DATA	0.28	NO DATA	0.28	O	0.35	0.34	0.34	0.40	0.08	0.27	99.2
	FAST-ABF	mg/L N	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	R	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Nitrate-Nitrite Nitrogen																
	INFLUENT	mg/L N	0.02	0.01	0.01	0.26	0.28	0.01	M	0.01	0.01	0.05	0.12	0.01	0.07	
	FAST	mg/L N	15.00	8.20	13.00	12.00	12.00	9.70	O	12.00	9.50	5.90	4.70	2.40	9.49	N.A.
	FAST-ABF	mg/L N	NO DATA	7.20	3.90	9.60	11.00	6.10	N	8.10	10.00	0.01	0.01	2.00	5.79	N.A.
Total Kjeldahl Nitrogen									T							
	INFLUENT	mg/L N	38.00	32.00	62.00	44.00	37.00	29.00	H	56.00	48.00	65.00	46.00	46.00	45.73	
	FAST	mg/L N	1.20	0.89	1.20	1.20	0.99	1.20		0.77	1.20	1.50	1.20	0.35	1.06	97.7
	FAST-ABF	mg/L N	NO DATA	0.96	1.30	0.90	0.60	1.30	O	0.99	0.82	2.30	2.90	1.20	1.33	97.1
Total Nitrogen(TKN+Nitrates)									F							
	INFLUENT	mg/L N	38.02	32.01	62.01	44.26	37.28	29.01		56.01	48.01	65.05	46.12	46.01	45.80	
	FAST	mg/L N	16.20	9.09	14.20	13.20	12.99	10.90	M	12.77	10.70	7.40	5.90	2.75	10.55	77.0
	FAST-ABF	mg/L N	NO DATA	8.16	5.20	10.50	11.60	7.40	A	9.09	10.82	2.31	2.91	3.20	7.12	84.5
Total Phosphorus									Y							
	INFLUENT	mg/L P	6.50	7.80	8.00	12.00	9.40	5.80		9.50	5.70	11.00	8.70	7.90	8.39	
	FAST	mg/L P	6.40	7.00	6.20	6.10	6.00	7.20		5.70	5.70	7.70	6.90	6.00	6.45	23.2
	FAST-ABF	mg/L P	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA		NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Total Suspended Solids																
	INFLUENT	mg/L	68.00	48.00	68.00	90.00	108.00	66.00		70.00	114.00	100.00	133.00	92.00	87.00	
	FAST	mg/L	1.00	3.00	5.00	3.00	6.00	6.00		16.00	1.00	1.00	1.00	3.00	4.18	95.2
	FAST-ABF	mg/L	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA		NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Fecal Coliforms																
	INFLUENT	cts/100 ml	NO DATA	600,000 Q,Z	600,000 V	600,000 Z	600,000	630,000		600,000	21,000	600,000	600,000	600,000	604,375	
	FAST	cts/100 ml	NO DATA	460.00	200.00	450.00	63.00	140.00		1500.00	200.00	>600	270.00	3600.00	764.78	99.9
	FAST-ABF	cts/100 ml	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA		NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA

Q - Sample analyzed beyond the accepted holding limit. (Analyzed at client's request)

V - Greater than 6,000. Fecal coliforms exceeded 60 counts on lowest filtration volume (1ml).

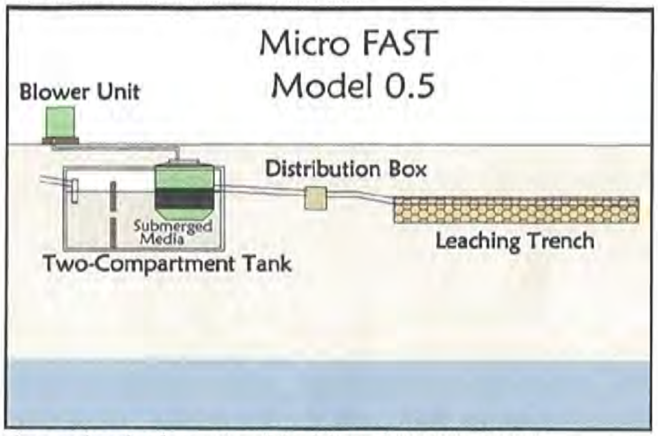
Z - Greater than 60,000. Fecal coliforms exceeded 60 counts on lowest filtration volume (0.1ml).

Massachusetts Alternative Septic System Test Center
Technology Fact Sheet -*Interim Findings*

MicroFAST®
Model 0.5

The Massachusetts Alternative Septic System Test Center is a collaborative project of the Buzzards Bay Project National Estuary Program, Massachusetts Office of Coastal Zone Management, Massachusetts Department of Environmental Protection, Barnstable County Department of Health and the Environment, and UMass Dartmouth School for Marine Science and Technology. The Test Center was established in recognition of the need in Massachusetts for cost-effective wastewater disposal systems suitable for sites with limited space, poor soils, high groundwater elevations, or where advanced pollutant removal is required. Its mission is twofold. First, to evaluate the performance and operation costs of new and innovative wastewater disposal technologies in a carefully controlled and unbiased manner, and provide this information to regulators and consumers. Second, to assist vendors in getting their technologies more quickly approved for use in Massachusetts, and at a lesser cost.

Technology Name:	MicroFAST®- residential unit, Model 0.5
Technology Type:	Fixed Activated Sludge Treatment System
Manufacturer:	Bio-Microbics Inc. 8450 Cole Parkway Shawnee, KS 66227 913-422-0707 or 1-800-753-3278 (FAST)
Contact:	Robert J. Rebori, President
Company Website:	www.biomicrobics.com
Performance & Permitting info at MA DEP and BCHED Websites:	www.state.ma.us/dep/brp/wwm/t5pubs.htm#it www.barnstablecountyhealth.org/AlternativeWebpage/
Testing Objectives:	Demonstrate N removal for use in N-sensitive watersheds. Obtain approval for reductions in SAS size or high groundwater elevation separation distance.
Testing Period:	Testing began 5/99 and is ongoing. Results shown for 7/99 to 7/00.
Test Loadings:	System loading was 330 gpd, (in 15 doses AM/PM), SAS was 0.74 gallons per sq. ft per day.



Generalized schematic of the MicroFAST Model 0.5.

MicroFAST during construction.

MicroFAST after installation.

Siting Considerations and Installation Notes

MicroFAST system component installation is similar to a standard Title 5 system. Installers should have training and oversight from the manufacturer. Above ground components include a blower with housing (approximately 2'x 2' x 2'), and an electrical control panel with an audio and visual alarm. Designer should consider situating the blower to minimize possibility for noise disturbance. Alternately, the blower can be installed in a belowground vault. Alarm and panel box should be accessible for inspection and maintenance.

Actual and Manufacturer's Estimated Costs (3-bedroom home) and Labor

Non-Title 5 Components: $2,995 suggested retail, this model (claim). *Components + Installation*: $3,500 more than conventional (claim). *Electrical:* $337 per year actual (local rates, annual KWh= 3,273). *O&M:* Quarterly inspection of motors, air flow, effluent and sludge. A service contract is required in Massachusetts (Approximately $400 per year minimum, but varies). Septic tank pumping averages $60 per year. *Other Costs:* Quarterly effluent quality monitoring is required for some permits ($300 or more annually). Design and permitting costs vary. *Replacement:* Blowers ($300) have a 2-year warranty by Bio-Microbics, extended 10 year warranty available, UL-CE-CSA certified electrical parts. No corrodible parts claimed to be in the unit.

Theory of Operation

The MicroFAST consists of a modified two-compartment 1500-gallon septic tank, where the first compartment of 500-gallon capacity is used for primary settling of the household wastewater. The second compartment contains the submerged plastic media around which air, supplied by a blower, is diffused. This technology uses both attached and suspended growth in the second chamber to achieve the nitrification of wastewater (*i.e.*, conversion of ammonium to nitrate) entering from the primary settling chamber. The recycling of a portion of the nitrified effluent back to the anoxic settling chamber makes possible the denitrification step of the process (*i.e.*, conversion of nitrate to nitrogen gas).

Permitting and Use in Massachusetts (*as of June 2001*)

Certification for General Use: MicroFAST is Certified for General Use and can be installed wherever a conventional Title 5 system can be installed. Remedial Use Approval: MicroFAST has approval in remedial situations where a system is failed, failing or nonconforming where relief is sought to construct an SAS within two feet (or three feet for percolation rates exceeding two minutes per inch) of the high groundwater elevation, or to construct an SAS reduced in size by up to 50 percent or in areas where at least 2 feet of suitable material is available beneath the SAS. Model 0.5 is approved for up to 440 gpd or four bedrooms. Provisional Use Approval: MicroFAST is approved for use in nitrogen sensitive areas for new construction for systems designed for less than 2000 gpd. For residential systems up to 660 gpd per acre, for nonresidential systems up to 550 gpd per acre. Model 0.5 is only approved for up to 330 gpd or three bedrooms.

Note: In this study, the model tested employed a 1/3 hp blower that operated continuously. The manufacturer is currently testing a unit with the blower with an on-off cycle to reduce electrical consumption. These results will be reported in the 2-year performance summary. The manufacturer has other models available, and their performance may not be identical to the results reported here.

Operation and Maintenance Issues

[This information will be included in the final report findings.].

Explanation of the Graphs

The graphs to the right show the mean of three replicates for each parameter over the testing period, compared to Title 5 performance and influent measured in parallel samples during the same period. Fecal coliform results are expressed as geometric means. In the nitrogen graph, NH4 represents ammonia, NOx represents nitrate + nitrite, DON is dissolved organic nitrogen, and PON is particulate organic nitrogen. Total nitrogen is the sum of these four parameters.

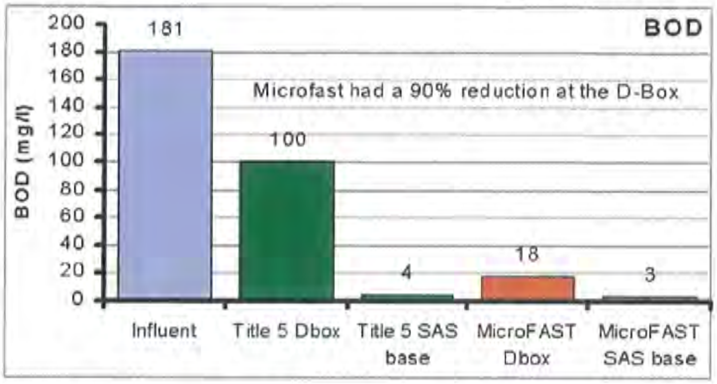
Soil absorption system samples include wastewater disposal system effluent and precipitation. The recharge of precipitation to groundwater is estimated to be between 8 and 16 percent of effluent discharge based on local rainfall, estimated groundwater recharge rates, SAS size and dosage rates. For all technologies, an interim dilution rate of 10 percent was employed based on precipitation and theoretical and measured dosage rates at the Test Center. The results for nitrogen removal include this estimated dilution factor (note bars labeled "SAS adj.") Results shown for biological oxygen demand (BOD), total suspended solids (TSS), and fecal coliforms were not adjusted for dilution by precipitation, because the adjustment was negligible in evaluating overall performance. This interim approach, is being compared to specific conductivity, chlorides, and bromide tracer to better refine this estimate, and develop system specific dilution factors. **Thus, the "SAS adjusted" values reported here for nitrogen discharge to groundwater should be considered preliminary.**

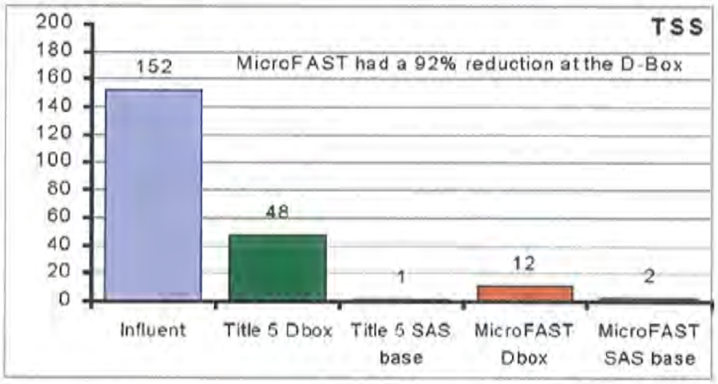
Summary of Interim Findings

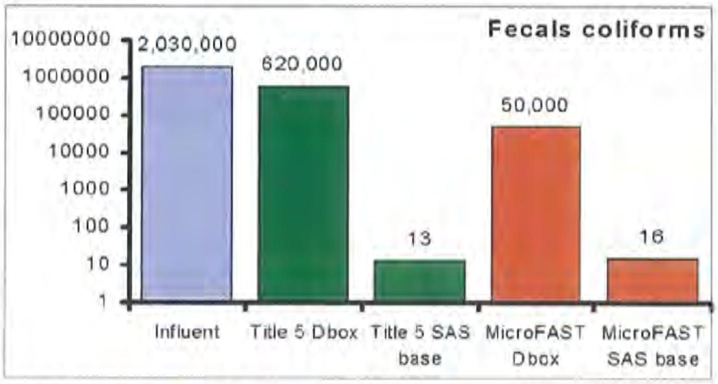
This technology exceeds secondary treatment (*i.e.*, TSS and BOD less than or equal to 30 mg per liter) to allow for the reduced separation to groundwater, or reduced soil absorption system size. BOD and TSS concentrations at the base of the SAS for this technology and the Title 5 system are similar. This technology discharged below the regulatory standard of 19 mg/l TN to allow for use in nitrogen sensitive areas. At the SAS base, this system was estimated to remove 60 percent of nitrogen inputs compared to 22 percent for a Title 5 system during the same period. This system was not tested at the Test Center for seasonal or intermittent use or for high hydraulic loading conditions.

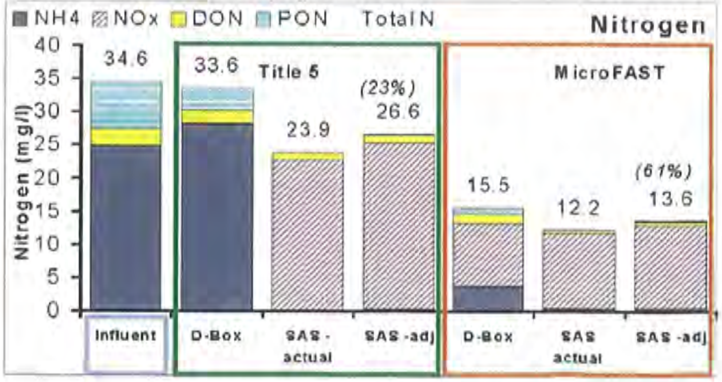
The Technical Review Committee does not recommend adoption of nitrogen loading ratings for this technology until the two-year testing period is complete. Differences in nitrogen removal among technologies tested are not necessarily significant. Nitrogen removal performance may vary with soil types and other site differences. The Buzzards Bay Project will recommend nitrogen loading rates for this technology for planning purposes and watershed loading evaluations at a later date.

Funding for the Massachusetts Septic System Test Center was provided by the US EPA, through Cooperative Agreements x991657 and x981007, the Massachusetts Department of Environmental Protection (319-99-01, 319-00-02), Massachusetts Office of Coastal Zone Management, Massachusetts Environmental Trust, Barnstable County Department of Health and Environment, UMass Dartmouth SMAST, and other organizations. Other information on this initiative can be found at www.buzzardsbay.org. These fact sheets were reviewed by a multi-agency work group. The views or opinions expressed are not necessarily those of the Commonwealth of Massachusetts, the US EPA, or any of the funding organizations and agencies. The information presented here represents the technical findings of the Massachusetts Septic System Test Center after at least one year of system testing. Manufacturer claims of cost and longevity, warranties, or stated costs have not been verified. Modifications to system designs from those tested, or installation under other soil or climate conditions may result in different system performance. This fact sheet was prepared and printed by the Buzzards Bay Project.









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Executive Office of Environmental Affairs
Bob Durand, Secretary
Buzzards Bay Project
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2870 Cranberry Highway East Wareham, MA 02538
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FAST® Wastewater Treatment Systems
Field Data Summary

Installation Location: Halifax, Massachusetts
Unit Type: ModularFAST®
Application: Multi-Unit Residential Complex
Design Flow:

Date	BOD		TSS		FOG		NO3		NH3		TKN		TN	
	Influent	Effluent	Influent	Effluent	Influent	Effluent								
4/22/1998		7.3		12				16.2		2.04		4		20.2
5/19/1998		20.8		12.4				9.24		2.5		8		17.24
7/23/1998		13.5		8.6				14.6		0.37		2.5		17.1
9/15/1998		2.3		6				20		0.82		3.8		23.8
12/9/1998		9.1		8				16.8		0.61		3.3		20.1
3/4/1999	209	9	402	13.6			0.5	6.47	35.3	1.52	40	3.9	40.5	10.37
9/7/1999		8.3		7.6				1		1.25		3.5		4.5
11/27/2001	170	12.6	78.3	40	38.3	<1.2	0.16	7.12			46.9	2.8	47.15	9.92

FAST® Wastewater Treatment Systems
Field Data Summary

Installation Location: Sandwich, Massachusetts
Unit Type & Size: ModularFAST®
Application: Health Center
Design Flow: 2385 GPD

StartDate	Sample Date	Influent pH	Effluent pH	Influent BOD	Effluent BOD	Influent TSS	Effluent TSS	Influent TKN	Effluent TKN
11/21/00	2/27/01	8.9	7.5	28.1	4.2	24.2	11	38	7.8
	3/29/01		8.1	15.8	19.1	47.7	10.8	51	4.88
	4/26/01		8.4	140	5.6	81	<2	69	3.05
	5/24/01	8.5	8.2	123	12.2	44	7.5	92.7	6.4
	6/28/01		8	86	4.2	75.8	<2	47.9	13.5
	7/31/01		7.7	46.4	10.6	40.5	3	22.6	2.02
	10/2/01			78.6	9.7	34	3	24.5	1.9
	10/26/01			21	5.6	27.5	<2	19.1	1.87
	11/28/01		6.8	69	10	20.5	<2	18.8	1.3
	2/28/02	8.2	7.1	142	7.9	120	4.5	42.3	6.42
	5/31/02		6.3		5		<10		1.8

FAST® Wastewater Treatment Systems
Field Data Summary

Installation Location: Sherborn, Massachusetts
Unit Type & Size: ModularFAST®
Application: Clustered Residential
Design Flow: 4600 GPD

StartDate	Sample Date	Influent pH	Effluent pH	Influent BOD	Effluent BOD	Influent TSS	Effluent TSS	Influent TKN	Effluent TKN
2/8/00	5/22/00	7.7	7.20	162	22.9	344	11.20	36.6	10.70
	6/28/00	8.1	7.50	146	8.4	38.8	8.40	39	5.10
	8/17/00	7.3	7.50	140	<4.0	55.5	6.40	37.8	5.60
	9/26/00	7.1	7.60	261	10.2	89	6.00	46.1	8.50
	10/25/00	7.1	7.80	170	7.3	32.7	3.60	49.3	10.60
	2/16/01	7.3	7.80	255	11.2	668	5.60	65.3	30.60
	5/31/01	7.3	7.70	161	<4	31.3	<2	39.3	7.60
	8/9/01	7.3	7.80	147	6.6	34.7	2.50	37.2	5.72
	10/1/01				11		<10		13.00
	2/27/02	7.3	7.80	134	<4	54	2.00	46.3	25.90
	5/28/02	7.6	7.6	139	5.5	530	6.9	64	9

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FAST® Wastewater Treatment Systems
Field Data Summary

Installation Location: Sudbury, Massachusetts
Unit Type & Size: ModularFAST®
Application: Clustered Residential
Design Flow: 6630 GPD

StartDate	Sample Date	Influent pH	Effluent pH	Influent BOD	Effluent BOD	Influent TSS	Effluent TSS	Influent TKN	Effluent TKN
12/3/01	12/27/01	7.3	7.8	160	9.2	40.7	4	47.4	35.7
	01/14/02	7.3	8.1	161	12	26	4.2	63.9	55
	02/28/02	7.4	7.3	234	31.6	280	21.3	44.3	10.8
	03/26/02	6.8	7.5	130	9	20	11	56	18
	04/23/02	7.5	7.5	210	8	67	<10	44	7
	05/22/02	7.1	7.1	28	3	16	<10	6.3	2.4
	06/26/02	7.2	7.5	29	27	27	18	11	8.4
	7/16/02	7.3	7.5	19	17	15	17	6.1	6

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FAST® Wastewater Treatment Systems
Field Data Summary

Installation Location: Coonemesett Inn, Massachusetts
Unit Type & Size: 2 HighStrengthFAST® 9.0s
Application: Hotel & Restaurant
Design Flow: 15,000 GPD

Date	FOG		BOD		TSS		NO3		NH3		TKN		TN	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
8/9/1996		5		5.4		32		0.7		2.31		5.6		6.3
9/5/1996		5		<3.0		9		0.95		0.42		3.01		3.96
10/8/1996		5		25.5		8.4		1.14		<0.1		1.47		2.88
11/7/1996		5		14		18.8		0.92		<0.1		6.65		7.57
1/7/1997		5		10.2		24.2		2.05		0.42		2.94		4.99
2/5/1997		5		23.7		20		1.7		<0.1		7.91		9.61
3/5/1997		5		21.8		17		2.97		0.7		8.05		11
6/10/1997		5		18.1		13		0.8		1.09		4.86		5.68
9/10/1997		5		8.1		8.7		2.4		<0.1		1.6		4
7/29/1998		5		72		39.3		0.01		23.8		29.4		29.4
10/6/1998		5		7.5		29.4		1.3		0.87		3.77		5.07
1/12/1999		5		33		27.8		1.3		<0.2		9.4		10.7
4/27/1999		5		42.6		22.2		0.52		0.87		9.64		10.2
7/15/1999		5		44.2		46.7		<0.05		0.98		22.8		22.8
10/6/1999		5		58		154.3		1.38		1.47		11.8		13.2
Averages			600	29.13		31.39								

FAST® Wastewater Treatment Systems
Field Data Summary

Installation Location: Fuego, Washington
Unit Type & Size: HighStrengthFAST® 1.5
Application: Restaurant
Design Flow: 500 GPD

Date	BOD		TSS		FOG		NH3		TKN		TN	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
9/17/2003	700	19	80	19								
10/29/2003	1000	15	138	12	43.1	2.5						
11/21/2003	970	49	230	43	87	6.1						
12/27/2003	910	73	300	110	170	11						
Averages	895.00	39.00	187.00	46.00	100.03	6.53						

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FAST® Wastewater Treatment Systems - Field Data Summary

Installation Location: Littleton, Massachusetts
Unit Type & Size: ModularFAST®
Application: Grocery Store

		INFLUENT			EFFLUENT					
DATE	FLOW	BOD	TSS	TN	BOD	TSS	NO3-N	NH4-N	TN	TKN
	gpd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
3/22/2000	12,570	433.0	550.0	92.0	6.0	5.0	1.0	0.8	1.6	0.6
4/19/2000	12,250	426.0	398.0	79.0	6.0	5.0	1.3	1.1	3.0	1.7
5/26/2000	11,150	345.0	474.0	114.0	6.0	5.0	1.4	1.0	1.4	0.0
6/29/2000	12,170	840.0	504.0	78.2	6.0	5.0	1.0	0.7	1.5	0.5
7/20/2000	10,740	555.0	592.0	93.2	6.0	5.0	1.0	0.8	1.5	0.5
8/24/2000	10,610	375	486	76.7	5.1	5.0	1	0.64	1.82	0.8
9/29/2000	9,920	450.0	650.0	104.0	6.0	5.0	1.0	<0.5	1.8	0.8
10/20/2000	9,570	540.0	568.0	108.5	6.0	5.0	1.9	0.6	4.2	2.3
11/21/2000	11,210	335	508	75.4	4.8	5.0	1	1.06	2.1	1.1
12/28/2000	12,210	401	400	83	6.0	5.0	1	1.2	1.92	0.9
1/30/2001	10,320	360	594	108	6.0	5.0	6.98	0.92	9.22	2.2
2/21/2001	10,100	198	584	104	6.0	5.0	1.13	1	3.26	2.1
3/23/2001	12,400	209	356	72.5	8.4	6.0	1	0.62	1.78	0.8
4/24/2001	9,190	237	520	96.3	6.2	5.0	1	0.72	2.14	1.1
5/18/2001	9,500	480	500	103	6.0	5.0	1	2.2	2.2	1.2
6/13/2001	9,510	215	524	101.8	6.6	5.0	1	0.92	3.1	2.1
7/12/2001	9,080	344	510	89	6.0	5.0	1	1.48	2	1.0
8/8/2001	7,770	372	376	95.8	11.3	5.0	1	1.32	2.55	1.6
9/5/2001	5,800	285	484	87.3	6.0	5.0	2.52	0.5	4.85	2.3
10/5/2001	6,900	390	582	122	6.0	5.0	1	1.8	2.3	1.3
11/7/2001	9,550	369	644	123	5.9	5.0	1	0.58	3.49	2.5
12/4/2001	9,820	452	539	90.4	6.0	5.0	1.14	1.06	2.2	1.1
1/9/2002	12,780	464	593	116	6.0	5.0	1	0.58	2.17	1.2
2/8/2002	12,550	273	496	104	6.0	5.0	1.71	1	3.94	2.2
3/7/2002	10,700	540	590	108	7.3	5.0	1	1.32	2.42	1.4
4/10/2002	11,570	353	592	116	9.9	5.0	1	1.4	2.32	1.3
5/8/2002	11,620	409	678	175	8.1	5.0	1	1	2.52	1.5
6/5/2002	11,840	216	448	103	6.0	5.0	1.28	1.04	4.23	3.0
7/17/2002	10,000	320	436	75.7	6.0	5.0	2.19	0.58	3.66	1.5
8/8/2002	10,030	327	514	66.8	6.0	5.0	1	0.5	2.15	1.2
9/11/2002	10,550	510	572	106.6	14.1	5.0	1	0.74	2	1.0
10/4/2002	8,160	434	474	81.4	6.0	5.0	2.21	0.66	4.18	2.0
11/8/2002	19,960	395	610	93.3	7.8	5.0	1	0.5	1.82	1.82
12/12/2002	8,250	342	506	101	6.0	5.0	1.41	1.47	3.33	
1/10/2003	15,190	401	572	123	6.0	8.0	1.11	0.5	2.86	1.75
2/5/2003	10,620	300	506	121	6.0	5.0	1	1.04	2.4	2.46
3/14/2003	11,390	352	704	135	7.2	5.0	1	0.5	1.85	1.85
4/9/2003	11,080	286	578	120	6.0	5.0	1	0.5	2.03	2.03
6/6/2003	12,670	358	442	105	6	5	1	1.58	2.01	2.01

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FAST® Wastewater Treatment Systems
Field Data Summary

Installation Location:	Mashpee, MA
Unit Type & Size:	2 HSF 9.0
Application:	Mashpee 99 Restaurant
Design Flow:	15,000 GPD

Date	BOD		TSS		NO3		NH3		TKN		TN	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
2/21/2003	890	55.8	800	18	<0.5	1.01			51.1	22.3	51.6	23.31
8/28/2001		19.4		6.5								
2/27/2001		91.5		15								
9/9/1999	11500	75	7820	87.5	1.46	1.04	71.3	26	132	40.8	133.46	41.84
2/12/1999	8010	41.7	9450	48	<0.5	<0.5	34.9	10.1	128	22.5	128.5	23
10/26/1998	2540	123	3320	256	0.5	<0.5	30.6	18.2	92.4	62	92.9	62.5
1/5/1998	5034	67.2	5470	104	<1.0	<1.0	33.3	14	188	28	189	29
3/18/1997	1500	68.3	667	18.5	2.74	11	56	8.25	90	24	92.74	35
Averages	4912	68	4588	69								

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FAST® Wastewater Treatment Systems - Field Data Summary

Installation Location: Plymouth, Massachusetts
Unit Type & Size: ModularFAST®
Application: Grocery Store
Design Flow: 4000 GPD

Date	BOD		TSS		FOG	
	Influent	Effluent	Influent	Effluent	Influent	Effluent
10/5/1999	510	20	260	29	62	10
11/2/1999	780	11	65	38	54	9
11/11/1999	521	23	362	21		
12/6/1999	570	3	460	8	68	12
1/4/2000	930	34	520	24	51	9

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FAST® Wastewater Treatment Systems - Field Data Summary

Installation Location: Richmond, Rhode Island
Unit Type & Size: ModularFAST®
Application: Grocery Store
Design Flow: 4000 GPD

Date	BOD		TSS		FOG	
	Influent	Effluent	Influent	Effluent	Influent	Effluent
11/11/1999	415	23	144	18		<0.1
11/17/1999	630	11	200	23	62	49
12/7/1999	590	32	180	56	55	29
1/3/2000	550	59	140	26	70	11

September 2003
03/08/WQPC-SWP

Environmental Technology Verification Report

Reduction of Nitrogen in Domestic Wastewater from Individual Residential Homes

Bio-Microbics, Inc.
RetroFAST® 0.375 System

Prepared by

NSF International

Under a Cooperative Agreement with
U.S. Environmental Protection Agency

THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**BIOLOGICAL WASTEWATER TREATMENT – NITRIFICATION AND DENITRIFICATION FOR NITROGEN REDUCTION**	
APPLICATION:	**REDUCTION OF NITROGEN IN DOMESTIC WASTEWATER FROM INDIVIDUAL RESIDENTIAL HOMES**	
TECHNOLOGY NAME:	**RETROFAST® 0.375 SYSTEM**	
COMPANY:	**BIO-MICROBICS**	
ADDRESS:	**8450 COLE PARKWAY** **SHAWNEE, KS 66227**	**PHONE: (913) 422-0707** **FAX: (913) 422 0808**
WEB SITE: EMAIL:	http://www.biomicrobics.com onsite@biomicrobics.com	

NSF International (NSF) operates the Water Quality Protection Center (WQPC) under the U.S. Environmental Protection Agency's (EPA) Environmental Technology Verification (ETV) Program. The WQPC evaluated the performance of a submerged attached-growth biological treatment system for nitrogen removal for residential applications. This verification statement provides a summary of the test results for the Bio-Microbics, Inc. RetroFAST® 0.375 System (RetroFAST®). NovaTec Consultants, Inc. (NovaTec) performed the verification testing.

EPA created the ETV Program to facilitate deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV program is to further environmental protection by accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high quality, peer reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations; stakeholder groups consisting of buyers, vendor organizations, and permitters; and the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and verifiable quality are generated, and that the results are defensible.

NSF International

Ann Arbor, MI · Sacramento, CA · Washington, D.C. · Brussels, Belgium

Data Summary for BioMicrobics, Inc. RetroFAST 0.375 Under the EPA ETV Water Quality Protection Center

The following is a preliminary summary of the test results obtained for the BioMicrobics, Inc. RetroFAST 0.375 system for nutrient reduction under the ETV Water Quality Protection Center. These results have been QA reviewed, but will not be considered final until all EPA reviews have been completed. The testing was completed at the Mamquam Wastewater Technology Test Facility (British Columbia) during the period of September 2001 through October 2002. The data summarized below does not include data for November 2001 because of errors in testing. A full report for this testing will be completed soon and posted on the EPA (www.epa.gov/etv) and NSF (www.nsf.org/etv) web sites.

Table 1. BOD$_5$/CBOD$_5$ and TSS Data Summary

	BOD$_5$	CBOD$_5$			TSS	
	Influent (mg/L)	Effluent (mg/L)	Removal Percent	Influent (mg/L)	Effluent (mg/L)	Removal Percent
No. Samples	61	61		61	61	
Average	150	12	92	190	28	84
Median	140	12	92	170	23	88
Max	210	28	98	440	170	98
Min	60	2.0	79	110	3	14
Std. Dev.	29	5.9	7.4	59	25	15

Table 2. Nitrogen Data Summary

	TKN (mg/L)		Ammonia (mg/L)		Total Nitrogen (mg/L)		Nitrate (mg/L)	Nitrite (mg/L)
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Effluent	Effluent
No. Samples	61	61	61	61	61	61	59	58
Average	39	11	28	6.0	39	19	7.9	< 0.002
Median	37	6.6	28	3.7	37	18	9.0	< 0.002
Maximum	64	44	42	30	64	44	18	0.006
Minimum	28	1.7	19	0.2	28	6.4	0.1	< 0.002
Std. Dev.	8.9	10	4.0	6.9	8.9	7.6	5.0	0.002

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stevenst@nsf.org

Clifton Associates Ltd.
engineering science technology

Appendix B

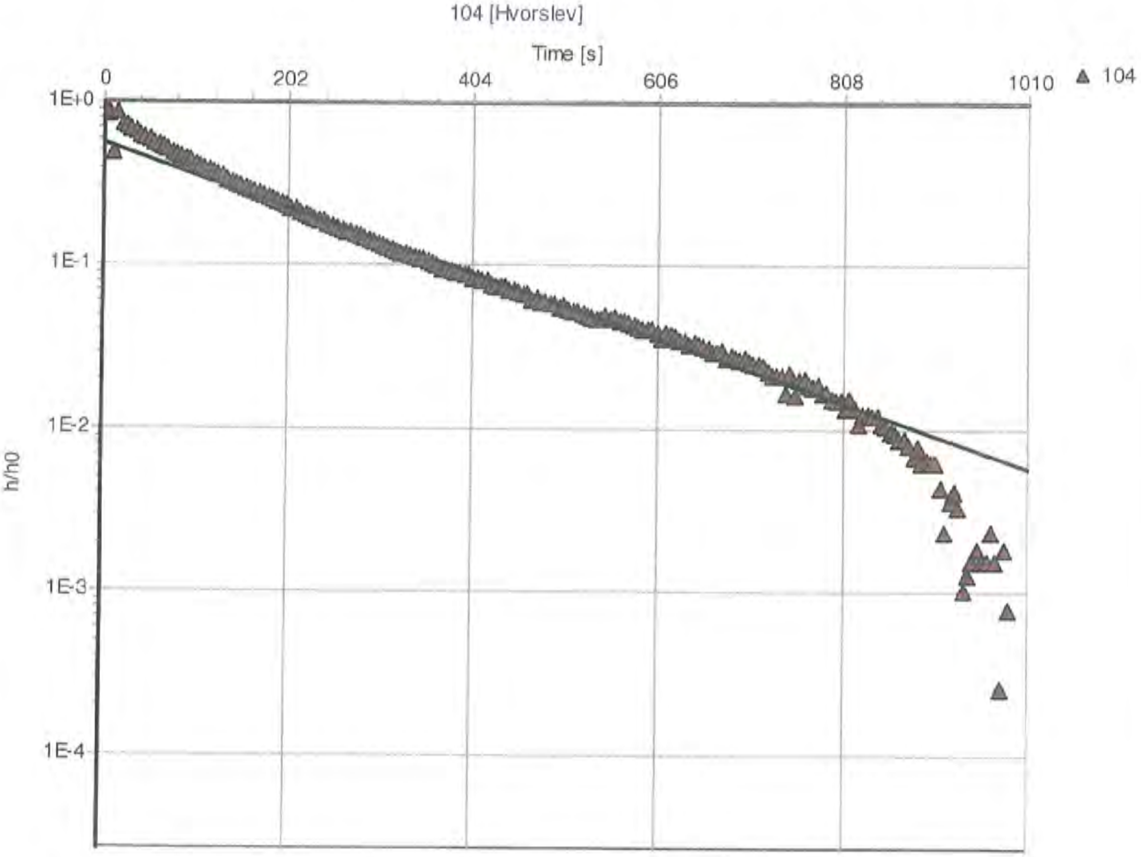
Clifton Associates Ltd.
4-1925 1st Avenue North
Saskatoon, SK
1 (306) 975-0401

Slug Test Analysis Report

Project: Grasswoods Estates

Number: S1607.7

Client: Urban Elements Developments Corp



Slug Test: **104**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 3.28E-6 [m/s]

Test parameters:

Test Well: 104

Casing radius: 0.0254 [m]

Screen length: 1.524 [m]

Boring radius: 0.0508 [m]

Aquifer Thickness:

Comments:

Evaluated by:

Evaluation Date: 16/07/2012

Clifton Associates Ltd.

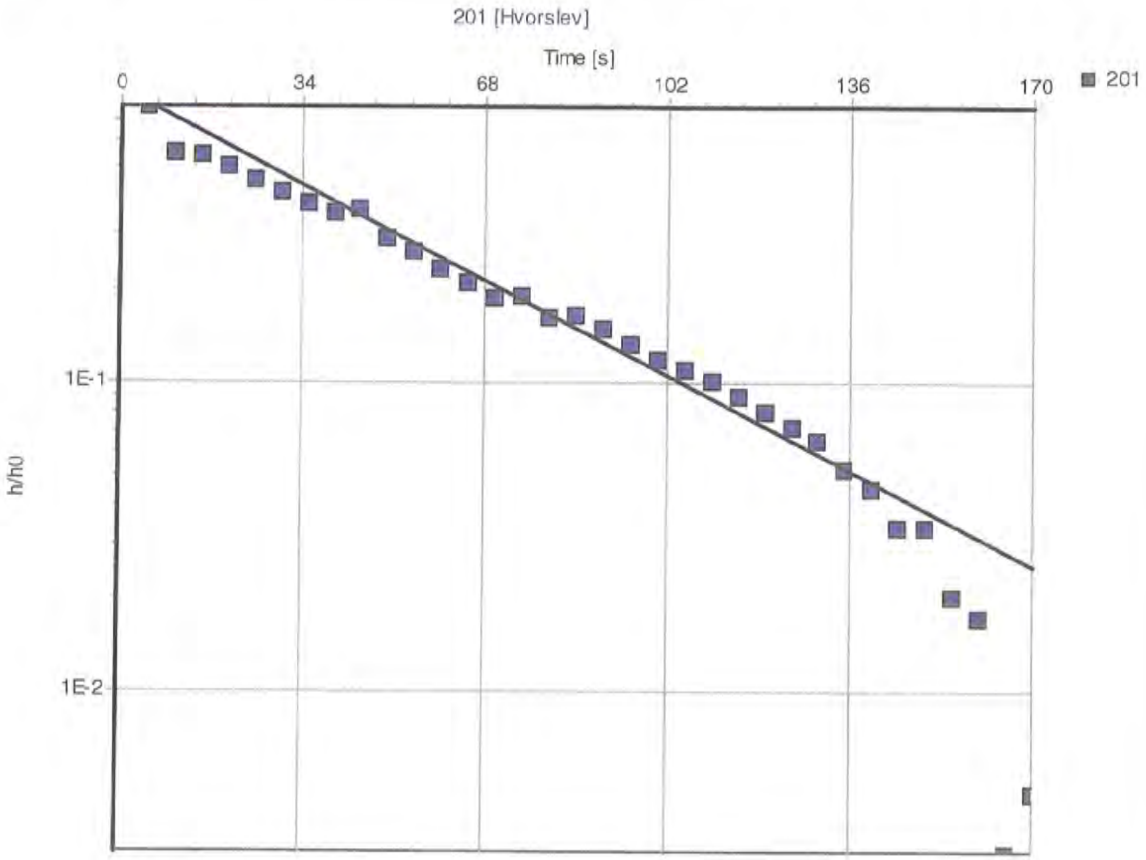
4-1925 1st Avenue North
Saskatoon, SK
1 (306) 975-0401

Slug Test Analysis Report

Project: Grasswoods Estates

Number: S1607.7

Client: Urban Elements Developments Corp



Slug Test: **201**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 1.12E-5 [m/s]

Test parameters:

Test Well: 201

Casing radius: 0.0254 [m]

Screen length: 2.3 [m]

Boring radius: 0.0508 [m]

Aquifer Thickness:

Comments:

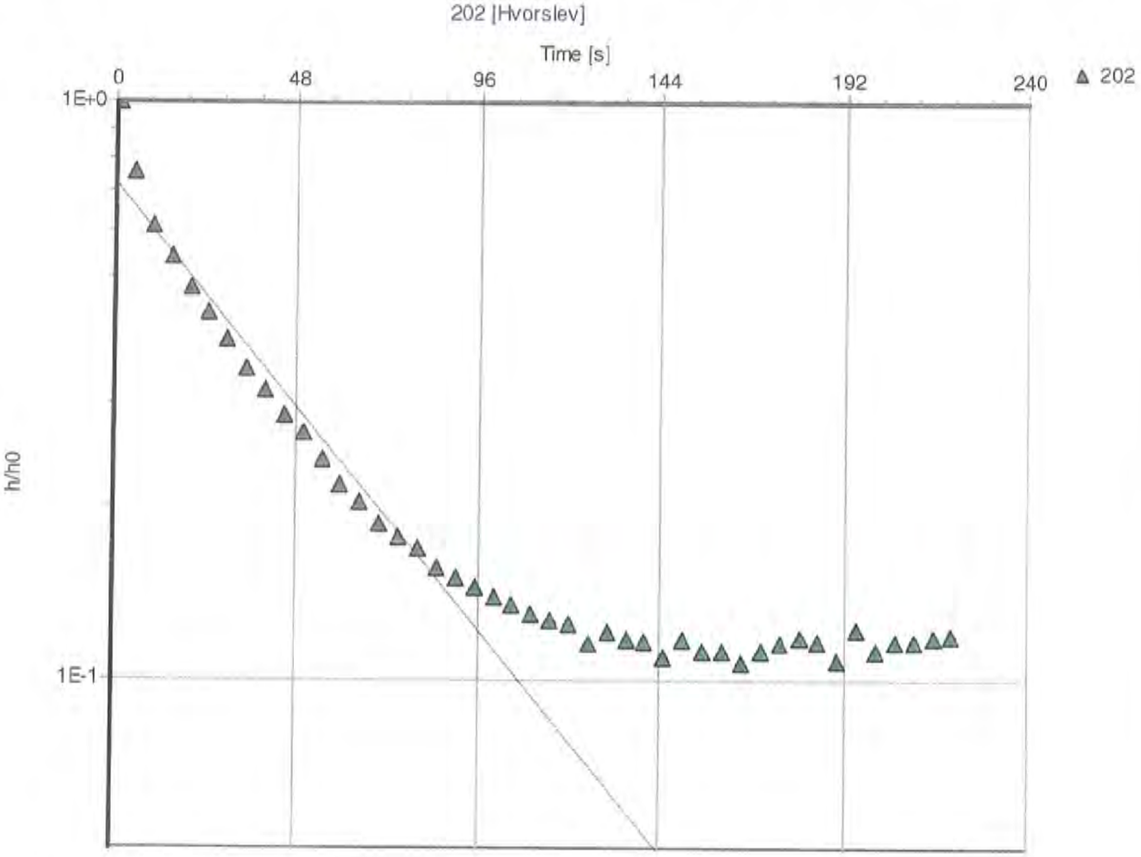
Evaluated by: MN

Evaluation Date: 06/07/2012

Clifton Associates Ltd.
4-1925 1st Avenue North
Saskatoon, SK
1 (306) 975-0401

Slug Test Analysis Report

Project: Grasswoods Estates
Number: S1607.7
Client: Urban Elements Developments Corp



Slug Test: **202**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 6.57E-6 [m/s]

Test parameters:

Test Well: 202

Casing radius: 0.0254 [m]

Screen length: 4 [m]

Boring radius: 0.0508 [m]

Aquifer Thickness:

Comments:

Evaluated by: MN

Evaluation Date: 16/07/2012

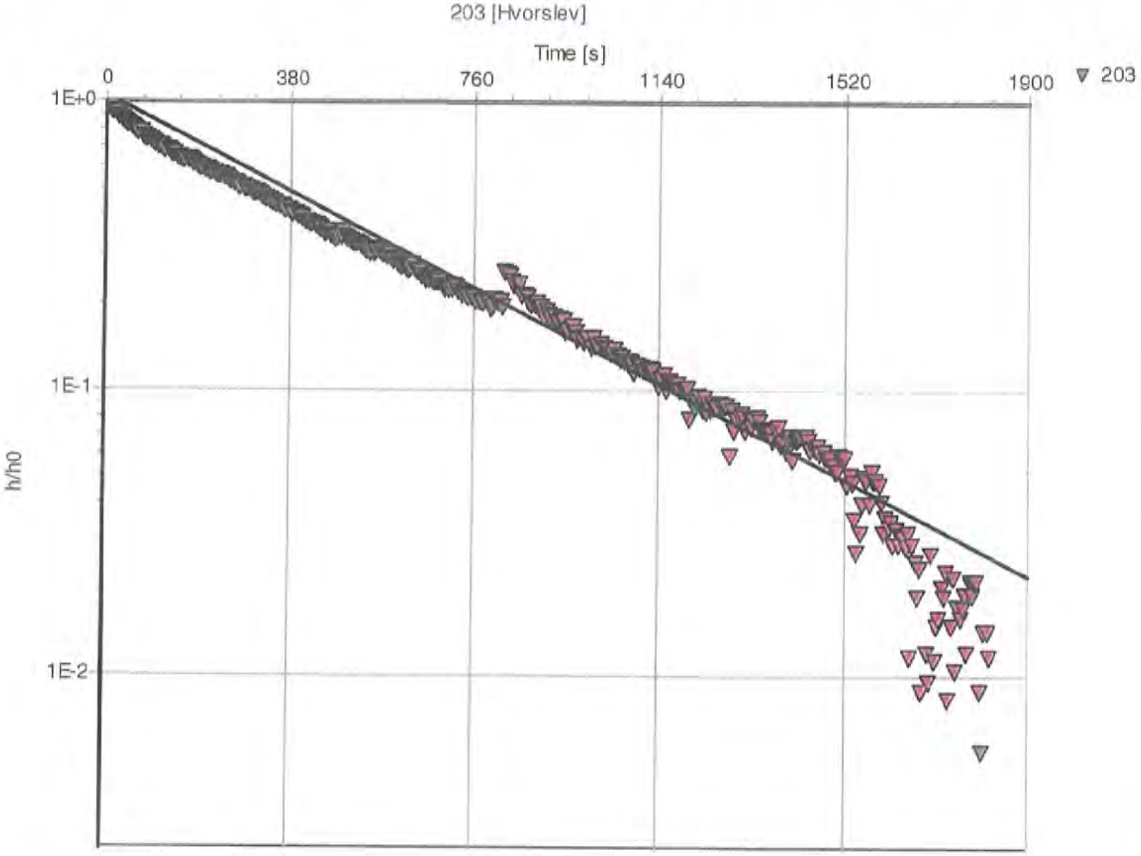
Clifton Associates Ltd.
4-1925 1st Avenue North
Saskatoon, SK
1 (306) 975-0401

Slug Test Analysis Report

Project: Grasswoods Estates

Number: S1607.7

Client: Urban Elements Developments Corp



Slug Test: **203**

Analysis Method: **Hvorslev**

Analysis Results: Conductivity: 1.21E-6 [m/s]

Test parameters:
Test Well: 203
Casing radius: 0.0254 [m]
Screen length: 2 [m]
Boring radius: 0.0508 [m]

Aquifer Thickness:

Comments:

Evaluated by: MN
Evaluation Date: 16/07/2012

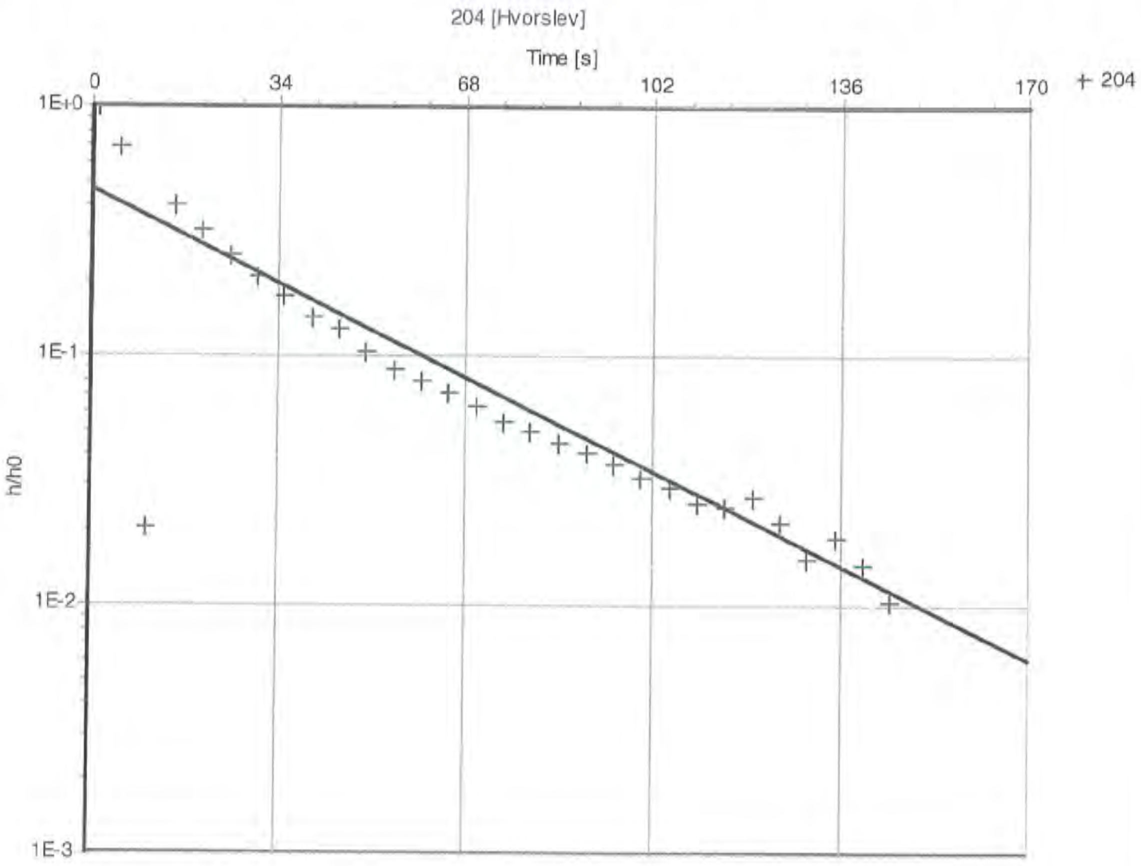
Clifton Associates Ltd.
4-1925 1st Avenue North
Saskatoon, SK
1 (306) 975-0401

Slug Test Analysis Report

Project: Grasswoods Estates

Number: S1607.7

Client: Urban Elements Developments Corp



Slug Test: **204**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 1.52E-5 [m/s]

Test parameters:

Test Well: 204

Casing radius: 0.0254 [m]

Screen length: 2 [m]

Boring radius: 0.0508 [m]

Aquifer Thickness:

Comments:

Evaluated by: MN

Evaluation Date: 16/07/2012

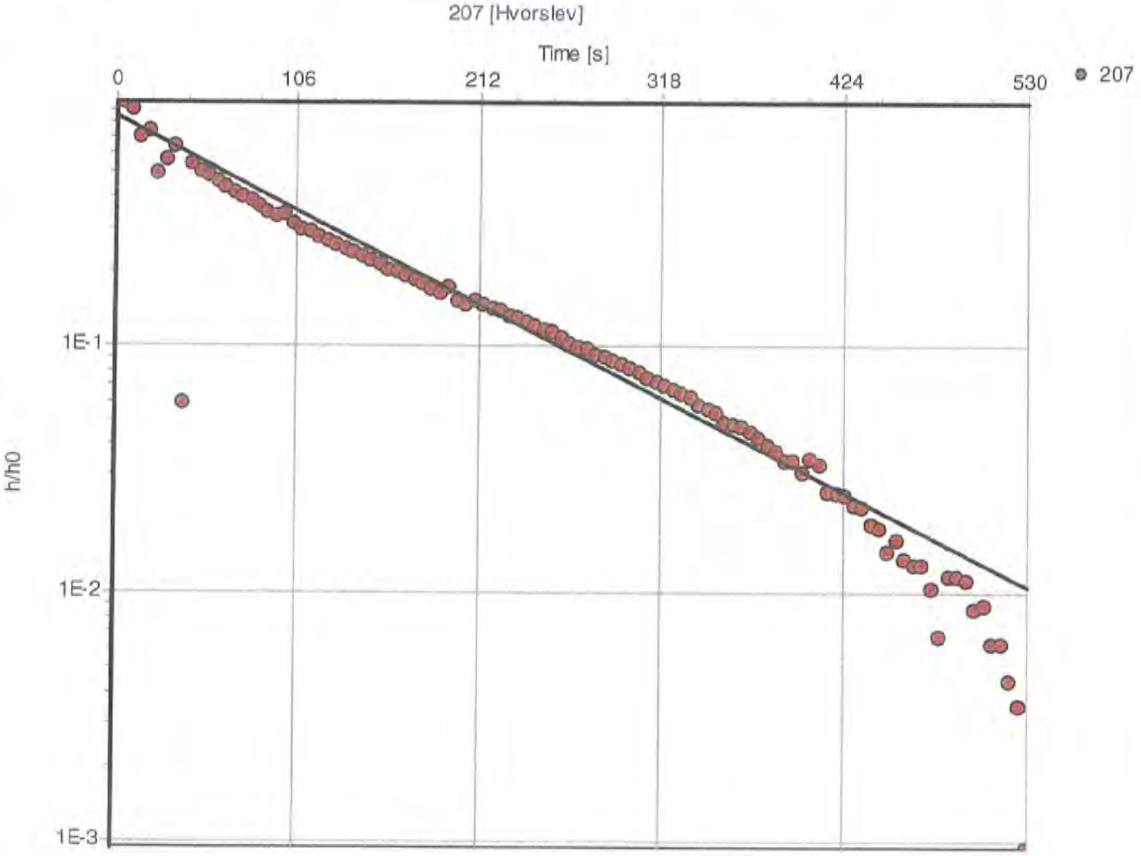
Clifton Associates Ltd.
4-1925 1st Avenue North
Saskatoon, SK
1 (306) 975-0401

Slug Test Analysis Report

Project: Grasswoods Estates

Number: S1607.7

Client: Urban Elements Developments Corp



Slug Test: 207

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 4.53E-6 [m/s]

Test parameters:

Test Well: 207

Casing radius: 0.0254 [m]

Screen length: 1.9 [m]

Boring radius: 0.0762 [m]

Aquifer Thickness:

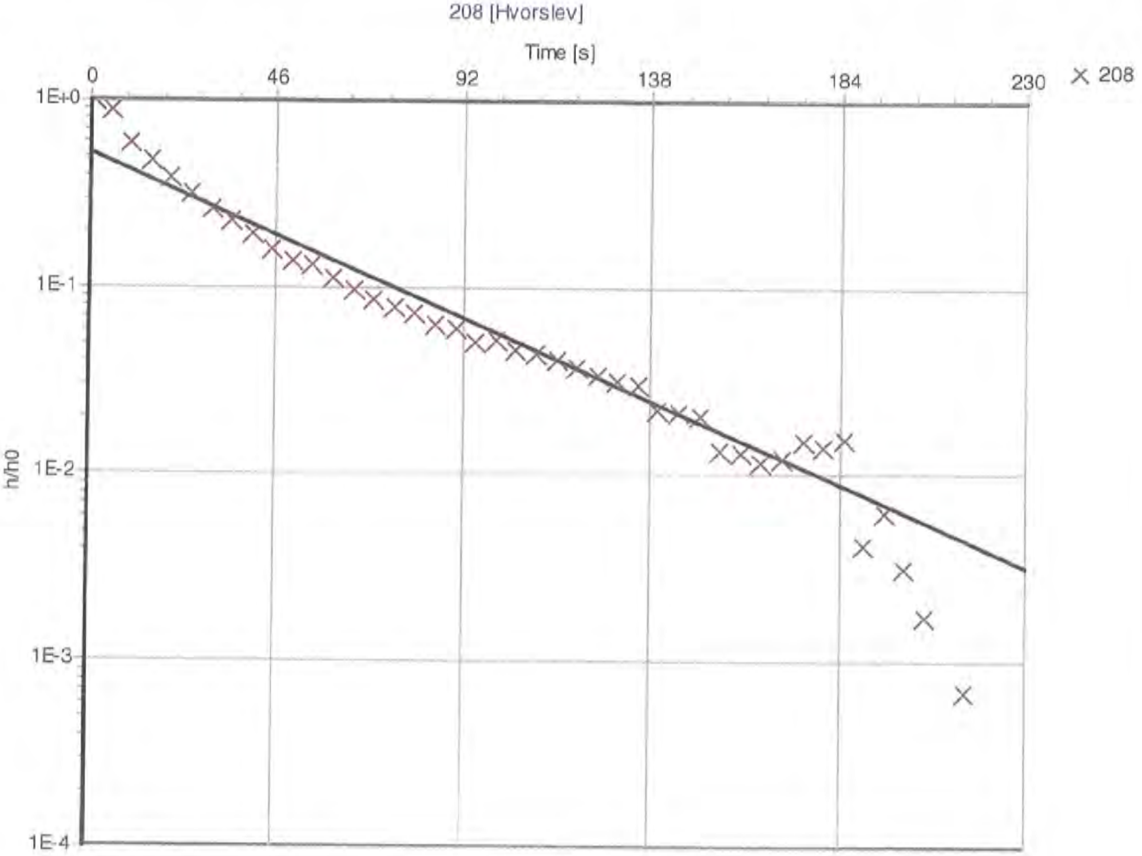
Comments:

Evaluated by: MN

Evaluation Date: 06/07/2012

Clifton Associates Ltd.
4-1925 1st Avenue North
Saskatoon, SK
1 (306) 975-0401

Slug Test Analysis Report
Project: Grasswoods Estates
Number: S1607.7
Client: Urban Elements Developments Corp



Slug Test: **208**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 1.32E-5 [m/s]

Test parameters:

Test Well: 208
Casing radius: 0.0254 [m]
Screen length: 2 [m]
Boring radius: 0.0508 [m]

Aquifer Thickness:

Comments:

Evaluated by: MN
Evaluation Date: 16/07/2012

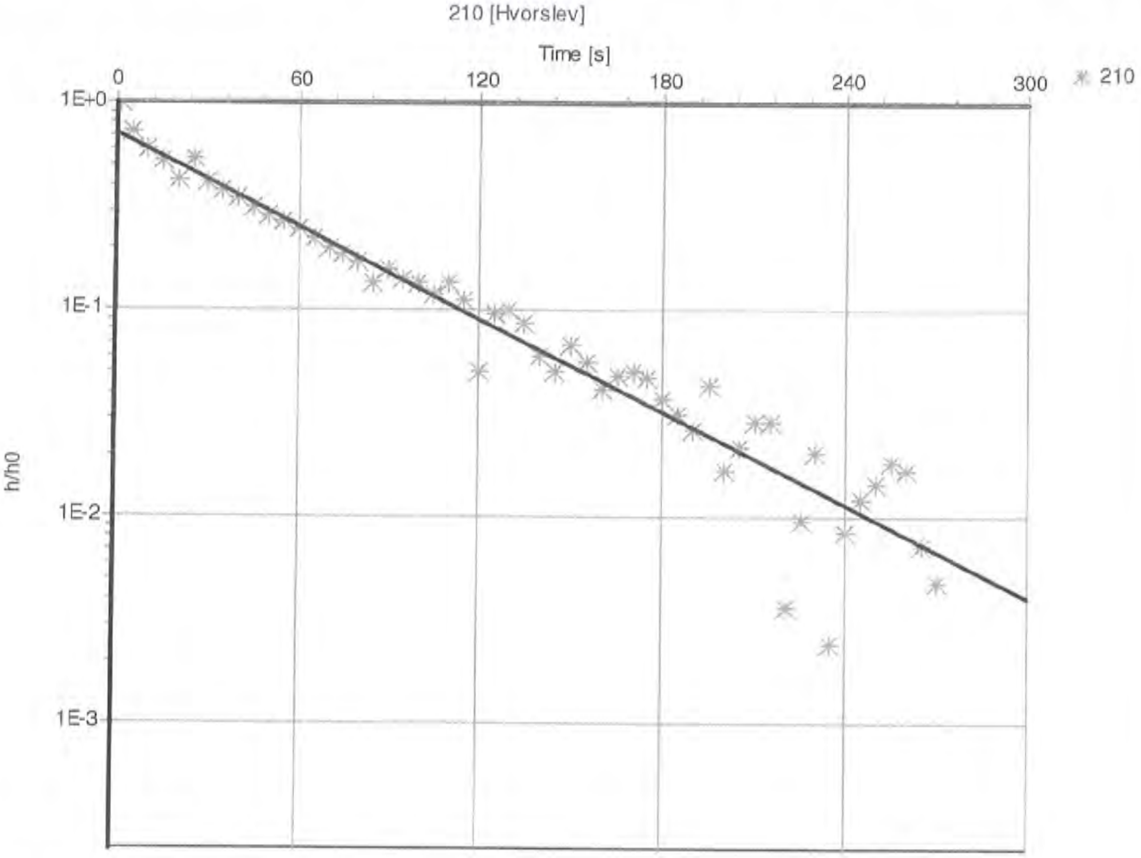
Clifton Associates Ltd.
4-1925 1st Avenue North
Saskatoon, SK
1 (306) 975-0401

Slug Test Analysis Report

Project: Grasswoods Estates

Number: S1607.7

Client: Urban Elements Developments Corp



Slug Test: **210**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 1.13E-5 [m/s]

Test parameters:

Test Well: 210

Casing radius: 0.0254 [m]

Screen length: 1.75 [m]

Boring radius: 0.0508 [m]

Aquifer Thickness:

Comments:

Evaluated by: MN

Evaluation Date: 16/07/2012

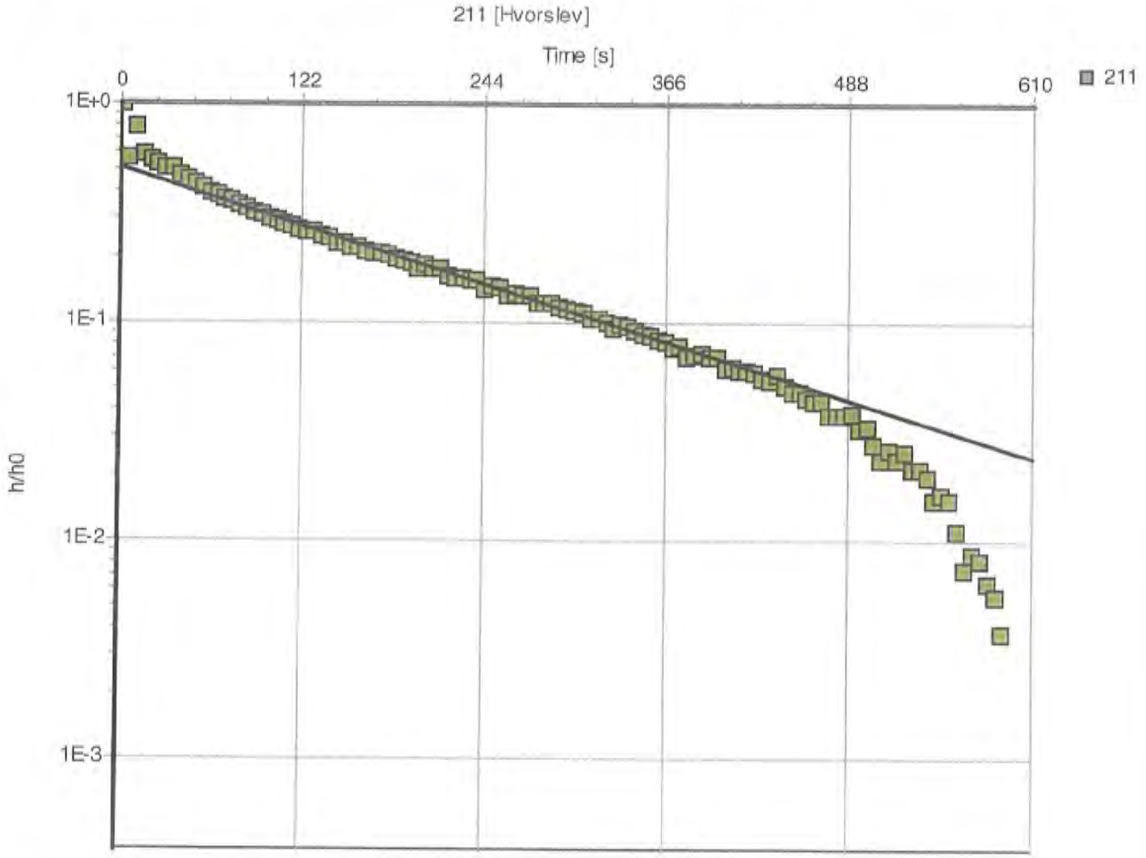
Clifton Associates Ltd.
4-1925 1st Avenue North
Saskatoon, SK
1 (306) 975-0401

Slug Test Analysis Report

Project: Grasswoods Estates

Number: S1607.7

Client: Urban Elements Developments Corp



Slug Test: **211**

Analysis Method: **Hvorslev**

Analysis Results:		Conductivity:	1.58E-6 [m/s]
Test parameters:	Test Well: 211	Aquifer Thickness:	
	Casing radius: 0.0254 [m]		
	Screen length: 4.65 [m]		
	Boring radius: 0.0508 [m]		

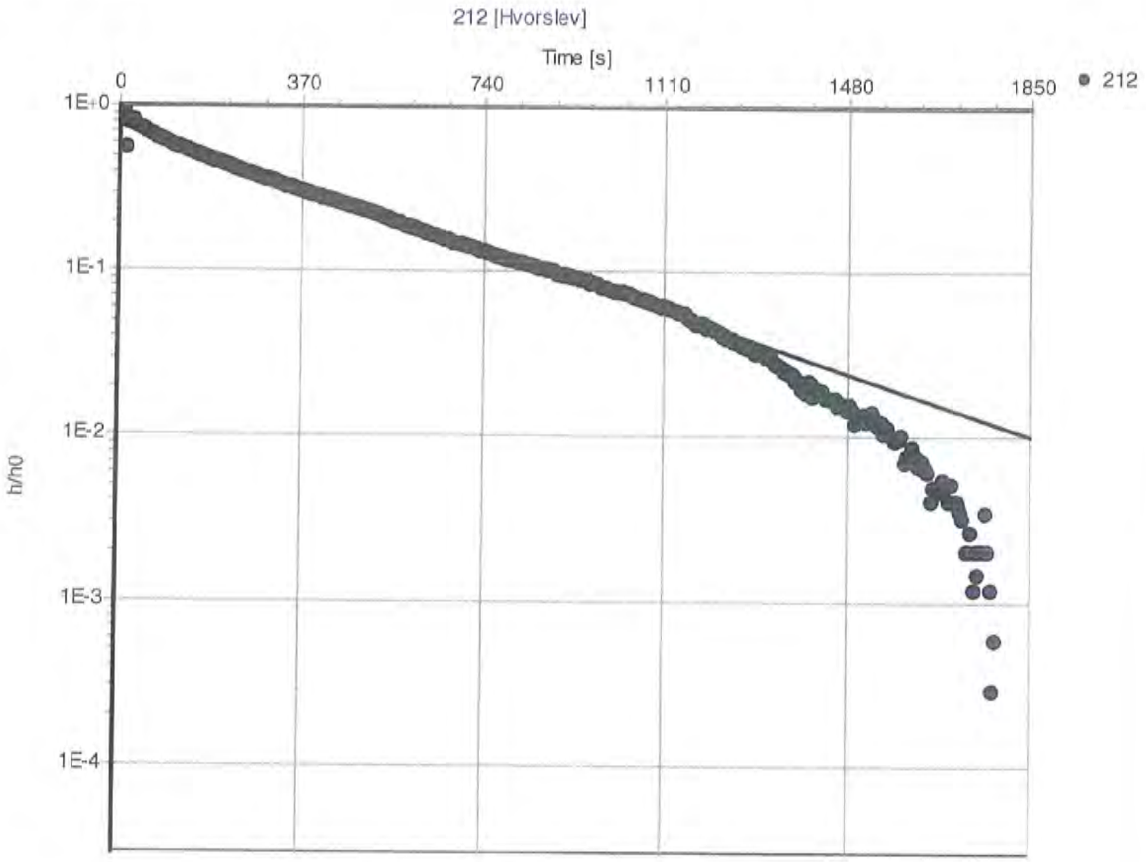
Comments:

Evaluated by:

Evaluation Date: 16/07/2012

Clifton Associates Ltd.
4-1925 1st Avenue North
Saskatoon, SK
1 (306) 975-0401

Slug Test Analysis Report
Project: Grasswoods Estates
Number: S1607.7
Client: Urban Elements Developments Corp



Slug Test: **212**

Analysis Method: **Hvorslev**

Analysis Results: Conductivity: 1.19E-6 [m/s]

Test parameters:
Test Well: 212
Casing radius: 0.0254 [m]
Screen length: 2.5 [m]
Boring radius: 0.0508 [m]
Aquifer Thickness:

Comments:

Evaluated by: MN
Evaluation Date: 16/07/2012

Clifton Associates Ltd.
engineering science technology

Appendix C

CLIFTON ASSOCIATES LTD
ATTN: CINDY / SUMITH
4 - 1925 1ST AVE. NORTH
SASKATOON SK S7K 6W1

Date Received:	04-JUL-12
Report Date:	10-JUL-12 08:27 (MT)
Version:	DRAFT REV. 3

Client Phone: 306-975-0401

Certificate of Analysis

Lab Work Order #:	**L1172891**
Project P.O. #:	NOT SUBMITTED
Job Reference:	S1607.7
C of C Numbers:	10-208196, 10-208197
Legal Site Desc:	

Comments:

10-JUL-12: BOD results forthcoming (11-July).

Brian Morgan
Account Manager

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-1 BH211							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	4.64	DLA	0.010	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.00444	DLA	0.00020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	0.352	DLA	0.00020	mg/L		09-JUL-12	R2395195
Boron (B)-Total	0.035	DLA	0.020	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.000332	DLA	0.000020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.00745	DLA	0.00020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.0060	DLA	0.0010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	6.69	DLA	0.020	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.00416	DLA	0.00010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	0.826	DLA	0.00060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	<0.00020	DLA	0.00020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.00520	DLA	0.000020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.0311	DLA	0.0060	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	372		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	294		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	359		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	1.9		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	0.30		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	84.2		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	2.5		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	26.1		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	7.2		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	30.2		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	<0.030		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.538		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	<0.050		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.37	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	588		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	OVERGROWN		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-2 BH202							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	1.24	DLA	0.010	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.00346	DLA	0.00020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	0.0686	DLA	0.00020	mg/L		09-JUL-12	R2395195
Boron (B)-Total	0.188	DLA	0.020	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.000081	DLA	0.000020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.00205	DLA	0.00020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.0032	DLA	0.0010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	2.45	DLA	0.020	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.00150	DLA	0.00010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	0.695	DLA	0.00060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	<0.00020	DLA	0.00020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.0270	DLA	0.000020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.0134	DLA	0.0060	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	55.8		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	383		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	467		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	5.0		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	0.22		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	127		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	6.9		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	54.2		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	66.0		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	263		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	0.082		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.574		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	<0.050		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.19	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	1150		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	OVERGROWN		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-3 BH201							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	10.5	DLA	0.010	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.0103	DLA	0.00020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	0.709	DLA	0.00020	mg/L		09-JUL-12	R2395195
Boron (B)-Total	0.060	DLA	0.020	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.000302	DLA	0.000020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.0155	DLA	0.00020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.0278	DLA	0.0010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	16.4	DLA	0.020	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.0257	DLA	0.00010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	0.998	DLA	0.00060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	0.00072	DLA	0.00020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.0276	DLA	0.000020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.0910	DLA	0.0060	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	424		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	296		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	361		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	6.7		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	0.20		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	88.8		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	3.4		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	25.7		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	15.8		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	35.9		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	<0.030		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.602		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	<0.050		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.28	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	639		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	890		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-4 BH208							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	8.33	DLA	0.010	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.0119	DLA	0.00020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	0.834	DLA	0.00020	mg/L		09-JUL-12	R2395195
Boron (B)-Total	0.025	DLA	0.020	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.000332	DLA	0.000020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.0125	DLA	0.00020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.0158	DLA	0.0010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	17.7	DLA	0.020	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.0134	DLA	0.00010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	1.89	DLA	0.00060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	0.00800	DLA	0.00020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.00397	DLA	0.000020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.0691	DLA	0.0060	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	1340		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	341		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	417		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	7.9		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	<0.10		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	140		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	4.7		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	32.5		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	16.5		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	139		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	<0.030		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.0057		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	7.10		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	<0.050		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	7.12		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.24	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	920		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-5 BH203							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	150	DLA	0.10	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.268	DLA	0.0020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	23.1	DLA	0.0050	mg/L		09-JUL-12	R2395195
Boron (B)-Total	0.23	DLA	0.20	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.0108	DLA	0.00020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.265	DLA	0.0020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.319	DLA	0.010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	430	DLA	0.20	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.383	DLA	0.0010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	29.6	DLA	0.0060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	0.0069	DLA	0.0020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.0256	DLA	0.00020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	1.78	DLA	0.060	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	>4000		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	314		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	383		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	40.6		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	0.20		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	173		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	7.2		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	53.7		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	44.7		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	186		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	<0.030		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.0895		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	51.0		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	0.276		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	51.3		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.51	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	1420		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-6 BH210							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	58.9	DLA	0.050	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.0779	DLA	0.0010	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	4.80	DLA	0.0010	mg/L		09-JUL-12	R2395195
Boron (B)-Total	<0.10	DLA	0.10	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.00282	DLA	0.00010	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.0978	DLA	0.0010	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.160	DLA	0.0050	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	175	DLA	0.10	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.162	DLA	0.00050	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	4.12	DLA	0.0030	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	0.0195	DLA	0.0010	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.00942	DLA	0.00010	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.631	DLA	0.030	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	>4000		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	224		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	274		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	5.2		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	<0.10		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	63.4		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	2.3		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	14.9		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	5.4		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	18.0		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	0.035		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.113		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	0.61		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	0.065		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	0.67		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.33	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	443		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
L1172891-7 BH204							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-7 BH204							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	8.21	DLA	0.010	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.0164	DLA	0.00020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	0.683	DLA	0.00020	mg/L		09-JUL-12	R2395195
Boron (B)-Total	0.052	DLA	0.020	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.000624	DLA	0.000020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.0131	DLA	0.00020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.0172	DLA	0.0010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	21.1	DLA	0.020	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.0190	DLA	0.00010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	1.12	DLA	0.00060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	0.00034	DLA	0.00020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.00163	DLA	0.000020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.0736	DLA	0.0060	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	>4000		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	282		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	344		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	3.4		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	<0.10		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	89.9		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	10.5		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	35.8		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	9.4		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	104		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	<0.030		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.297		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	<0.050		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.59	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	711		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	30		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
L1172891-8 CAL104							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-8 CAL104							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	37.4	DLA	0.050	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.0516	DLA	0.0010	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	2.75	DLA	0.0010	mg/L		09-JUL-12	R2395195
Boron (B)-Total	<0.10	DLA	0.10	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.00138	DLA	0.00010	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.0615	DLA	0.0010	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.0629	DLA	0.0050	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	89.0	DLA	0.10	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.0727	DLA	0.00050	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	1.29	DLA	0.0030	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	0.0023	DLA	0.0010	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.0134	DLA	0.00010	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.401	DLA	0.030	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	1740		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	227		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	277		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	7.4		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	0.23		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	73.4		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	4.0		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	28.8		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	29.2		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	112		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	<0.030		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.0309		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	<0.050		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.46	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	651		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	190		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-9 BH205							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	72.6	DLA	0.10	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.0629	DLA	0.0020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	3.20	DLA	0.0020	mg/L		09-JUL-12	R2395195
Boron (B)-Total	<0.20	DLA	0.20	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.00179	DLA	0.00020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.115	DLA	0.0020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.149	DLA	0.010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	160	DLA	0.20	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.118	DLA	0.0010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	2.78	DLA	0.0060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	0.0096	DLA	0.0020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.0265	DLA	0.00020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.667	DLA	0.060	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	613		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	294		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	359		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	5.2		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	0.22		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	106		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	2.9		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	30.9		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	7.7		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	95.3		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	<0.030		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.163		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	0.72		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	0.110		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	0.83		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.66	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	721		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	70		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-10 BH213							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	0.586	DLA	0.010	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.00213	DLA	0.00020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	0.136	DLA	0.00020	mg/L		09-JUL-12	R2395195
Boron (B)-Total	0.038	DLA	0.020	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.000025	DLA	0.000020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.00127	DLA	0.00020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.0021	DLA	0.0010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	1.25	DLA	0.020	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.00085	DLA	0.00010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	0.617	DLA	0.00060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	<0.00020	DLA	0.00020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.00284	DLA	0.000020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.0080	DLA	0.0060	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	13.5		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	190		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	231		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	2.3		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	0.20		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	76.2		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	3.1		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	21.3		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	8.6		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	95.5		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	<0.030		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.526		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	<0.050		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.52	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	550		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	OVERGROWN		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-11 BH206							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	88.0	DLA	0.10	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.0756	DLA	0.0020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	4.93	DLA	0.0020	mg/L		09-JUL-12	R2395195
Boron (B)-Total	<0.20	DLA	0.20	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.00491	DLA	0.00020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.147	DLA	0.0020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.200	DLA	0.010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	207	DLA	0.20	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.177	DLA	0.0010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	5.50	DLA	0.0060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	<0.0020	DLA	0.0020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.0300	DLA	0.00020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.974	DLA	0.060	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	>4000		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	423		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	516		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	1.8		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	0.14		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	110		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	3.4		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	41.7		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	7.6		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	18.3		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	<0.030		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.184		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	<0.050		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.49	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	786		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	40		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-12 BH207							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	0.76	DLA	0.10	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.0023	DLA	0.0020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	0.0412	DLA	0.0020	mg/L		09-JUL-12	R2395195
Boron (B)-Total	0.43	DLA	0.20	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	<0.00020	DLA	0.00020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	<0.0020	DLA	0.0020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	<0.010	DLA	0.010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	1.47	DLA	0.20	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.0013	DLA	0.0010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	0.247	DLA	0.0060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	<0.0020	DLA	0.0020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.195	DLA	0.00020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	<0.060	DLA	0.060	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	134		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	508		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	620		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	98	DLA	20	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	0.32		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	467	DLA	10	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	51	DLA	10	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	817	DLA	10	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	1180	DLA	20	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	6240	DLA	30	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	<0.030		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.254		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	0.058		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.39	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	8800		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	210		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-13 BH212							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	79.6	DLA	0.10	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.0811	DLA	0.0020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	2.64	DLA	0.0020	mg/L		09-JUL-12	R2395195
Boron (B)-Total	<0.20	DLA	0.20	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.00247	DLA	0.00020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.132	DLA	0.0020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.178	DLA	0.010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	178	DLA	0.20	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.115	DLA	0.0010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	4.37	DLA	0.0060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	0.0099	DLA	0.0020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.0159	DLA	0.00020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.685	DLA	0.060	mg/L		09-JUL-12	R2395195
Miscellaneous Parameters							
Turbidity	>4000		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	374		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	456		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	9.1		1.0	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	0.21		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	109		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	5.5		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	35.2		1.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	27.5		2.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	87.7		3.0	mg/L	05-JUL-12	05-JUL-12	R2393328
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	0.070		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.386		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	<0.050		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.58	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	834		10	uS/cm	05-JUL-12	05-JUL-12	R2392988
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	10		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	10		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-14 DUP 2							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Health and Toxicity Metals							
Total Mercury in Water by CRC ICPMS							
Mercury (Hg)-Total	<0.000050		0.000050	mg/L		06-JUL-12	R2393822
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	89.5	DLA	0.10	mg/L		09-JUL-12	R2395195
Arsenic (As)-Total	0.0881	DLA	0.0020	mg/L		09-JUL-12	R2395195
Barium (Ba)-Total	3.04	DLA	0.0020	mg/L		09-JUL-12	R2395195
Boron (B)-Total	<0.20	DLA	0.20	mg/L		09-JUL-12	R2395195
Cadmium (Cd)-Total	0.00273	DLA	0.00020	mg/L		09-JUL-12	R2395195
Chromium (Cr)-Total	0.147	DLA	0.0020	mg/L		09-JUL-12	R2395195
Copper (Cu)-Total	0.201	DLA	0.010	mg/L		09-JUL-12	R2395195
Iron (Fe)-Total	203	DLA	0.20	mg/L		09-JUL-12	R2395195
Lead (Pb)-Total	0.138	DLA	0.0010	mg/L		09-JUL-12	R2395195
Manganese (Mn)-Total	4.95	DLA	0.0060	mg/L		09-JUL-12	R2395195
Selenium (Se)-Total	0.0098	DLA	0.0020	mg/L		09-JUL-12	R2395195
Uranium (U)-Total	0.0181	DLA	0.00020	mg/L		09-JUL-12	R2395195
Zinc (Zn)-Total	0.771	DLA	0.060	mg/L		09-JUL-12	R2395195
L1172891-15 DUP 1							
Sampled By: CLIENT on 04-JUL-12							
Matrix: WATER							
Miscellaneous Parameters							
Turbidity	927		0.10	NTU		06-JUL-12	R2393860
Routine Potable Water							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	512		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Bicarbonate (HCO3)	625		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Hydroxide (OH)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Carbonate (CO3)	<5.0		5.0	mg/L	05-JUL-12	05-JUL-12	R2393108
Chloride (Cl)							
Chloride (Cl)	101	DLA	20	mg/L	05-JUL-12	05-JUL-12	R2393031
Fluoride (F)							
Fluoride (F)	0.31		0.10	mg/L	05-JUL-12	05-JUL-12	R2393297
ICP Cations							
Calcium (Ca)	459	DLA	10	mg/L	05-JUL-12	05-JUL-12	R2393328
Potassium (K)	51	DLA	10	mg/L	05-JUL-12	05-JUL-12	R2393328
Magnesium (Mg)	815	DLA	10	mg/L	05-JUL-12	05-JUL-12	R2393328
Sodium (Na)	1160	DLA	20	mg/L	05-JUL-12	05-JUL-12	R2393328
Sulfur (as SO4)	6400	DLA	30	mg/L	05-JUL-12	05-JUL-12	R2393328
Ion Balance Calculation							
Cation - Anion Balance	-1.6			%		05-JUL-12	
TDS (Calculated)	9290			mg/L		05-JUL-12	
Hardness (as CaCO3)	4500			mg/L		05-JUL-12	
Iron (Fe) & Manganese (Mn) -Dissolved							
Iron (Fe)-Dissolved	<0.030		0.030	mg/L	05-JUL-12	05-JUL-12	R2393310
Manganese (Mn)-Dissolved	0.244		0.0010	mg/L	05-JUL-12	05-JUL-12	R2393310
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrate-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrite-N	0.080		0.050	mg/L	05-JUL-12	05-JUL-12	R2393099
Nitrate+Nitrite-N	<0.50		0.50	mg/L	05-JUL-12	05-JUL-12	R2393099
pH and Conductivity							
pH	7.42	EHT	0.10	pH	05-JUL-12	05-JUL-12	R2392988
Conductivity (EC)	8800		10	uS/cm	05-JUL-12	05-JUL-12	R2392988

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1172891-15 DUP 1 Sampled By: CLIENT on 04-JUL-12 Matrix: WATER							
L1172891-16 DUP 3 Sampled By: CLIENT on 04-JUL-12 Matrix: WATER							
Total Coliform, EColi Mcoli Blue & HPC							
Escherichia Coli mcoli blue MF							
E. Coli	<1		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258
Heterotrophic Plate Count							
Heterotrophic Plate Count	>3000		10	CFU/mL	06-JUL-12	08-JUL-12	R2394461
Total Coliform mcoli blue MF							
Total Coliforms	OVERGROWN		1	CFU/100mL	06-JUL-12	07-JUL-12	R2394258

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
DLA	Detection Limit Adjusted For required dilution
EHT	Exceeded Recommended Holding Time Prior To Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TOT-SK	Water	Alkalinity, Total	APHA 2320 B-Auto-Pot. Titration

Alkalinity is determined by a titration of an aliquot with standardized acid solution to a pH of 4.5. Total alkalinity, bicarbonate, carbonate(if present) and hydroxide(if present) also reported.

Reference
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 2320B.

CL-SK	Water	Chloride (Cl)	APHA 4500-CL E

Chloride in aqueous matrices is determined colorimetrically by auto-analyzer.

EC-MCOLIMF-WP	Water	Escherichia Coli mcoli blue MF	APHA 9222B AND HACH 10029

This procedure is applicable to E. coli analysis for water samples. It is also used for Total Coliform analysis when only one 100 mL samples is submitted for both Total Coliforms and E. coli. If two sample bottles are submitted for these analyses, E. coli analysis is performed by this procedure, and Total Coliform analysis can be performed by A151.

A suitable sample volume is poured through a membrane filter and placed in a petri dish prepared with m-Coli Blue 24 broth. The inverted plates are incubated at 35C +/- 0.5C for 24hrs. Coliforms that are not E. coli turn red because they reduce TTC (2,3,5 triphenyltetrazolium chloride) in the medium. E. coli turn blue due to the reaction between the enzyme beta glucuronidase and BCIG (5-bromo-4 chloro-3 indolyl-beta-D-glucuronide) in the medium.

ETL-ROUTINE-ICP-SK	Water	ICP Cations	APHA 3120 B-ICP-OES-ROU

These ions are determined directly y ICP-OES.

Reference
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 3120B.

F-SK	Water	Fluoride (F)	APHA 4500-F C

The quantity of free fluoride is determined by inserting a fluoride ion selective electrode into solution and measuring the potential. Samples and standards are mixed beforehand at a 1:1 ratio with a low-level TICAB solution, which frees up any complexed fluoride ions.

Reference:
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 4500-F C

FE,MN-DIS-SK	Water	Iron (Fe) & Manganese (Mn) -Dissolved	APHA 3120 B-ICP-OES

Iron and Manganese are determined in a filtered and preserved sample by ICP-OES.

HG-T-CVAF-SK	Water	Total Mercury in Water by CRC ICPMS	APHA 3030E / EPA 245.7

This procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry

HPC-PP-WP	Water	Heterotrophic Plate Count	APHA 9215B, 2005

This is a procedure for estimating the number of live heterotrophic bacteria in water and measuring changes during water treatment and distribution or in swimming pools. In the pour plate method, samples are diluted and plated on to media. After incubation, the colonies are counted and reported as CFU/mL.

IONBALANCE-OP03-SK	Water	Ion Balance Calculation	APHA 1030-E
MET-T-CCMS-SK	Water	Total Metals in Water by CRC ICPMS	APHA 3030E / EPA 6020A

This procedure involves preliminary digestion with concentrated nitric acid followed by instrumental analysis using collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

N2/N3-SK	Water	Nitrate, Nitrite and Nitrate+Nitrite-N	APHA 4500 NO3F

Nitrate is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl)ethylenediamine dihydrochloride. The resulting

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

water-soluble dye has a magenta color, which is measured at 520nm. Original nitrite can also be determined by removing the cadmium column and following the same procedure. Nitrate-N, Nitrite-N and NO3+NO2-N are reported.

Reference
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 4500NO3-F.

PH/EC-SK	Water	pH and Conductivity	APHA 4500-H, 2510
TC-MCOLIMF-WP	Water	Total Coliform mcoli blue MF	APHA 9222B and HACH 10029

This procedure is applicable to E. coli analysis for water samples. It is also used for Total Coliform analysis when only one 100 mL samples is submitted for both Total Coliforms and E. coli. If two sample bottles are submitted for these analyses, E. coli analysis is performed by this procedure, and Total Coliform analysis is performed by A151.

A suitable sample volume is poured through a membrane filter and placed in a petri dish prepared with m-Coli Blue 24 broth. The inverted plates are incubated at 35C +/- 0.5C for 24hrs. Coliforms that are not E. coli turn red because they reduce TTC (2,3,5 triphenyltetrazolium chloride) in the medium. E. coli turn blue due to the reaction between the enzyme beta glucuronidase and BCIG (5-bromo-4 chloro-3 indolyl-beta-D-glucuronide) in the medium.

TURBIDITY-ED	Water	Turbidity	APHA 2130 B-Nephelometer

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
ED	ALS ENVIRONMENTAL - EDMONTON, ALBERTA, CANADA
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

10-208196 10-208197

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

10-208196

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Page ____ of ____

Report To
Company: Clifton Associates Ltd.
Contact: Sumith or Cindy.
Address: 4-1925 1st Avenue N
Saskatoon, SK, S7K 6W1
Phone: 975-0401 Fax: 975 1076

Invoice To Same as Report ? (circle) [✓ Yes] or No (if No, provide details)
Copy of Invoice with Report? (circle) [✓ Yes] or No
Company:
Contact:
Address:
Phone: Fax:

Lab Work Order # (lab use only)

Report Format / Distribution
Standard: ✓ Other (specify):
Select: PDF ✓ Excel Digital Fax
Email 1: Sumith_Kahanda@clifton.ca
Email 2: Cindy_Friesen@clifton.ca

Client / Project Information
Job #: S1607-7
PO / AFE:
LSD:
Quote #:

ALS Contact: **Sampler:**

Service Request:(Rush subject to availability - Contact ALS to confirm TAT)

	Regular (Standard Turnaround Times - Business Days)
	Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
✓	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
	Same Day or Weekend Emergency - Contact ALS to confirm TAT

Analysis Request
(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Routine - PortableH2O	TC, EC / Q51	HPC - mF	BOD	Metal-Health-Pak								Number of Containers
1	BH 211	July 04 2012		water	✓	✓	✓	✓	✓								4
2	BH 202	〃		〃	✓	✓	✓	✓	✓								4
3	BH 201	〃		〃	✓	✓	✓	✓	✓								4
4	BH 208	〃		〃	✓	✓	✓	✓	✓								4
5	BH 203	〃		〃	✓	✓	✓	✓	✓								4
6	BH 210	〃		〃	✓				✓								2
7	BH 204	〃		〃	✓	✓	✓	✓	✓								4
8	CAL 104	〃		〃	✓	✓	✓	✓	✓								4
9	BH 205	〃		〃	✓	✓	✓	✓	✓								4
10	BH 213	〃		〃	✓	✓	✓	✓	✓								4
11	BH 206	〃		〃	✓	✓	✓	✓	✓								4
12	BH 207	〃		〃	✓	✓	✓	✓	✓								4

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: KSmith	Date: July 04, 2012	Time:	Received by: A. Brown	Date: 04-Jul-12	Time: 18:25	Temperature: 8 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY GENF 18.01 Front

ALS Environmental

10- 208197

L1172891-COFC

Page ____ of ____

Report To		**Report Format / Distribution**	
Company:	Clifton Associates Ltd	Standard: ✓	Other (specify):
Contact:		Select: PDF ✓ Excel Digital Fax	
Address:		Email 1:	Symith_Bahanda@clifton.ca
		Email 2:	Cindy_friesen @ clifton.ca
Phone:	Fax:		
Invoice To	Same as Report ? (circle) [✓ Yes] or No (if No, provide details)	**Client / Project Information**	
	Copy of Invoice with Report? (circle) [✓ Yes] or No	Job #:	
Company:		PO / AFE:	
Contact:		LSD:	
Address:			
Phone:	Fax:	Quote #:	
Lab Work Order # (lab use only)		**ALS Contact:**	**Sampler:**

Service Request:(Rush subject to availability - Contact ALS to confirm TAT)

	Regular (Standard Turnaround Times - Business Days)
	Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
X	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
	Same Day or Weekend Emergency - Contact ALS to confirm TAT

Analysis Request

(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Routine - Potable	TC, EC/QSI	HPC-MF	BOD	metal + health + TOC								Number of Containers
13	BH 212	July04 201		Water	✓	✓	✓	✓	✓								4
14	Dup 2	"		"					✓								1.
15	Dup 1	"		"	✓												1
16	Dup 3	"		"		✓	✓										1
17	Dup 04	"		"				✓									1.

Special Instructions / Regulation with water or land use (CCME-Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

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SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
	July04 2012		A. Brown	04-Jul-12	18:25	8 °C				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY