OTTAWA SOUTH UNITED SOCCER ASSOCIATION

HYDROGEOLOGICAL STUDY AND TERRAIN ANALYSIS

OTTAWA SOCCER UNITED CLUBHOUSE, 5650 MITCH OWENS DRIVE, MANOTICK, ON

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1 INTRODUCTION

1.1 BACKGROUND

WSP Canada Inc. (WSP) was retained by Ottawa South United Soccer Association (the Client) to carry out a hydrogeological study and terrain analysis to support a Site Plan Approval (SPA) application for the proposed development of a field house and office at 5650 Mitch Owens Road, in Manotick, Ontario (Site).

These works have been completed in general accordance with the present City of Ottawa industry standard which seeks to utilize the following Ontario Ministry of Environment (MOE) guidance documents in the completion of hydrogeological assessments:

1. Guideline D-5: Planning for Sewage and Water Services (August 1996)
2. Procedure D-5-5:Technical Guideline for Private Wells: Water Supply Assessment (August 1996)
3. Procedure D-5-4:Technical Guideline for Individual Onsite Sewage System: Water Quality Impact Risk Assessment (August 1996)

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and recommendations pertaining to the private services for the subject development as it is understood at the time of preparation of this report.

1.2 DESCRIPTION OF PROPOSED DEVELOPMENT

The Site (also known as George Nelms Park) is currently occupied by six (6) soccer fields and paved parking areas. It is currently proposed by the Client to re-develop the Site with a two (2) storey field house, with an outdoor observation deck overlooking the soccer pitches on the mezzanine floor and office rooms. Water is planned to be supplied to the field house from the existing supply well on site. The proposed layout of the site is shown on Figure 1, Site Plan.

1.3 EXISTING SITE CONDITIONS

Based on available mapping from GeoOttawa, the existing Site area is approximately 129,531 m^2 and is situated on the south side of Mitch Owens Road, to the west of Dozois Road and St. Mark High School.

With respect to neighbouring development, there is a residential subdivision located to the south of the Site. To the west of the site exists vacant, undeveloped lands. To the north of the site, beyond Mitch Owen's Road, is a combination of strip lot residential dwellings and a small commercial operation (Burger and Shakes and Driving Range).

2 PHYSICAL SETTING

2.1 REGIONAL PHYSIOGRAPHY

Based on Ontario Geological Survey (OGS) mapping, the Site is located within the North Gower Drumlin Field physiographic region, just south of the Ottawa Valley Clay Plains. According to Chapman and Putnam (1984 and 2007), this physiographic region is described as having the majority of the area covered by clay or silt deposited between the drumlins by the Champlain Sea.

2.2 TOPOGRAHY AND DRAINAGE

The site topography is generally flat, with a gradual increase in elevation just east and south of the site. Runoff from the site is currently being directed to a surficial drainage swale style system with a discharge point to the west of the property and into the adjacent watercourse.

2.3 REGIONAL SURFICIAL GEOLOGY

The surficial geology of the site has been evaluated based on OGS Earth data and boreholes from previous geotechnical studies completed by others. The Ontario Ministry of the Environment, Conservation and Parks (MECP) published Water Well Records (WWR) for wells within 500 m of the site were also reviewed for surficial geology, primarily to confirm overburden thickness in the general vicinity of the Site. A summary of the review of surficial geology is discussed below.

Based OGS Earth data, the soils at the Site underlain by fine-textured glaciomarine deposits described as silt and clay with minor sand and gravel inclusions. Immediately northwest and east and southeast of the Site, Till deposits described as stone-poor, sandy silt to silty sand-textured till on Paleozoic terrain are present. Based on available MECP WWRs, topsoil was generally encountered at the surface, underlain by overburden soil consisting of 1m to 2m of a non-cohesive silty sand a modestly thick layer of stiff to very stiff silty clay. Underlying the silty clay, a compact to hard glacial till layer is present overlying the limestone bedrock of the Oxford Formation.

2.3.1 SITE SPECIFIC GEOLOGY

Paterson Group (Paterson) conducted a geotechnical investigation on June 25, 2015, for the Northeast field area on site where the proposed soccer fields and fieldhouse would be constructed. As part of the work program, eleven (11) boreholes were completed to a maximum depth of 6.1 m. Borehole logs are included in **Appendix A** along with the site plan from the Paterson Report.

Topsoil:

A thin layer of topsoil was encountered in all boreholes. Topsoil is thickest at the center of the site at 0.66m

and varies from 0.1m to 0.25m for the rest of the site. Based on the borehole logs, the moisture content is about 18%.

Silty Sand/ Sandy Silt:

All eleven (11) boreholes encountered a silty sand/sandy silt fill with some clay below the topsoil. This fill extended to depths ranging from 0.10 m to 1.90 m below the existing ground surface.

The SPT "N" values within the fill ranged from 1 blow to 12 blows per 305 mm of penetration indicating a loose to compact state of packing. This layer reported moisture content of 20%-25%

Silty Clay

A layer of sensitive silty clay was encountered underlying the fill in both boreholes drilled in this area. This deposit generally consists of interlayered clay and silty clay. This layer extended to depth of 1.3 m and 6.1 m in boreholes

This layer is classified as a soft to firm grey silty clay with some sand and has an increasing moisture content with depth that ranges between 25% to 60 %.

Additionally, in January 2022, WSP placed two (2) boreholes to confirm the soil content. Both test pits, located on the southwest portion of the site showed a 0.2m layer of topsoil underlain by 1.3m of a sandy clay to clayey sand (with a T-time of 35min/cm).

The site is not considered to be hydrogeologically sensitive and, as such, no special precautions need to be considered with respect to sewage system design, well construction, and minimum Ontario Building Code horizontal/vertical clearance distances for sewage system design.

Hydrogeologic sensitivity, as it applies in this instance, relates to the thickness, composition and consistency of the overburden soils. Thin, permeable soils overlying bedrock are considered to be hydrogeologically sensitive in most cases unless it can be demonstrated that the underlying bedrock aquifer system is isolated via the composition and consistency of the bedrock itself.

Percolation rates of native soils at the Site are estimated to be 35 min/cm based on the soil conditions observed during WSP's tactile examination of soils at the Site, and based on the guidance in MMAH Supplementary Standard SB-6. The northeast portion of the grass field area was identified to be the most suitable location for a new subsurface disposal system (see Figures 1 and 2).

2.4 REGIONAL BEDROCK GEOLOGY

Based on the available OGS bedrock mapping (1991), WSP's extensive local knowledge of the aquifer systems in the Ottawa area, and combined with the findings of a preliminary hydrogeological study completed by Golder Associates Ltd. (Golder) in 2013, the Site is situated over limestone belonging to the Oxford Formation which, in turn, is underlain by alternating limestone and sandstone layers of the March Formation and then the readily identifiable white sandstone of the Nepean Formation.

There are no faults located within 4.5km of the Site. Furthermore, the Site is situated approximately eight to 10 km west of the Gloucester Fault.

2.5 REGIONAL HYDROGEOLOGY

A review of the available MECP WWRs related to aquifer data generally reveals the following trends:

1. The wells located to the immediate northwest and west of the site have intercepted a shallow aquifer located within the upper 5 to 15 m of the Oxford Formation. Conversely, few, if any wells located further east from the western limits of the Site, based on the WWR's reviewed, intercepted this upper Oxford Formation;
2. Wells constructed on, and east (also north and south) of the site reveal the presence of two (2) deeper aquifer intercept ranges between 30 m and 50 m below ground surface (bgs) which corresponds to the likely basement of the Oxford Formation and upper limits of the March Formation;
3. Well yields in all aquifer intercepts exceeded the order of 5 USgpm; and
4. No dry holes were reported.

2.5.1 SITE SPECIFIC HYDROGEOLOGY

An existing water well (MECP WWR A199999, provided in **Appendix B**) has been previously constructed at the Site in 2017 by Capital Water Supply Ltd (the "Well Contractor"). A review of this WWR reveals that the casing was advanced through the overburden (14.93m bgs) and seated approximately 1.5 m into the underlying limestone bedrock using mud drilling. The annular space around the casing was sealed with a bentonite grout slurry. The open borehole was noted to intercept water bearing zones at approximately 41.1 m bgs and 50.8 m bgs in "grey & white sandstone" which is most probably the March Formation. The well was originally noted to be flowing at a rate of the order of 45.5 L/min (10 IGPM). The March Formation has been extensively documented to have significant confining pressures with artesian conditions often resulting in free-flowing artesian wells in several areas within the City of Ottawa, ON. At the time of the pumping test, the well had a sealed well cap suitable for flowing conditions.

The one-hour pumping test, completed by the Well Contractor, was conducted at 54.6 L/min (12 IGM). Drawdown after 60 minutes of continuous pumping was measured at 4.76m below top of casing (water level was at 0.00 m below casing at start of test). Full recovery was noted within approximately 20 minutes of termination of pumping.

Based on the pumping test information, the specific capacity of the well appears to be of the order of 11.5 L/min/m of drawdown.

2.5.2 REGIONAL AQUIFER WATER QUALITY

Water quality data was collected from a neighbouring property located at 5765 Longhearth Way (Well Tag A059485) on November 24th, 2022. This well was used as an observation well during the pump test conducted on December 1st, 2022. A copy of the WWR can be found in **Appendix B** (MECP WWR No. A059485). The laboratory Certificates of Analyses are compiled in **Appendix C.**

The water quality results are summarized in the **Table 2.1** below.

Table 2-1 Summary of Aquifer Analysis of Neighbouring Water Supply Well – 5765 Longhearth Way

PARAMETER	UNITS	MDL	GROUNDWATER ANALYTICAL RESULTS LAB ID: 1664952	ONTARIO DRINKING WATER STANDARDS TYPE	 LIMIT	REASONABLE TREATABLE LIMIT AS PER PROCEDURE D5-5
MICROBIOLOGICAL						
Total Coliforms	CFU/100mL	0	0	MAC	0	-
E.coli	CFU/100mL	0	0	MAC	0	-
Chloride	mg/L	1	160	AO	250	250
Fluoride	mg/L	0.10	<0.10	MAC	2.4	-
Nitrite	mg/L	0.1	<0.10	MAC	1.0	-
Nitrate	mg/L	0.1	<0.10	MAC	10.0	-
Total Kjeldahl Nitrogen	mg/L	0.05	0.304	-	-	-
Turbidity (Lab)	mg/L	0.1	10.0	MAC/AO	1.0/5.0	5
Alkalinity	mg/L	5	368	OG	500	-
Colour	TCU	2	42	AO	5	7
DOC	mg/L	0.5	4.0	AO	5	10
Sulfide	mg/L	0.02	<0.01	AO	0.05	
pH	unitless	1	7.42	AO	6.5-8.5	-

PARAMETER	UNITS	MDL	GROUNDWATER ANALYTICAL RESULTS LAB ID: 1664952	ONTARIO DRINKING WATER STANDARDS TYPE	ONTARIO DRINKING WATER STANDARDS LIMIT	REASONABLE TREATABLE LIMIT AS PER PROCEDURE D5-5
Sulphate	mg/L	3	140	AO	500	500
Hardness	mg/L	1	568	OG	100	-
Sodium	mg/L	2	72	AO	20(200)	200
Iron	mg/L	0.03	1.08	AO	0.3	10
Manganese	mg/L	0.01	0.05	AO	0.05	1
Total Dissolved Solids	mg/L	1	832	AO	500	-
Ammonia	mg/L	0.010	0.092	-	-	-
Calcium	mg/L	1	135	-	-	-
Conductivity	uS/cm	5	1280	-	-	-
Ion Balance	Unitless	0.01	0.99	-	-	-
Magnesium	mg/L	1	56	-	-	-
Phenols	mg/L	0.001	<0.001	-	-	-
Potassium	mg/L	1	4	-	-	-
Tannin & Lignin	mg/L	0.1	1.1	-	-	-

Note: Parameters highlighted in blue represent Ontario Drinking Water Standards aesthetic/operational exceedances. Parameters highlighted in orange represent ODWS health warning (for Sodium only).

The groundwater geochemistry obtained from the neighbouring water supply well at 5765 Longhearth Way represents the intercepted aquifer system at that property, as it relates to health and aesthetic water quality parameters. A review of the water quality data indicates that it meets the heath related parameter requirements specified by the Ontario Drinking Water Standards (ODWS) for the parameters tested.

With respect to aesthetic related water quality parameters results of colour, hardness and total dissolved solids, turbidity, were reported at concentrations higher than the ODWS values.

3 STUDY METHODOLOGY

3.1 HYDROGEOLOGICAL ASSESSMENT

3.1.1 WATER WELL ASSESSMENT - EXISTING WELL

As mentioned above, an existing water supply well (WSW), has been previously constructed at the Site in 2017 by Capital Water Supply Ltd of Stittsville Ontario. A copy of the published WWR for the existing well is provided in **Appendix B** (MECP WWR No. A199999).

A review of this WWR reveals that the casing was advanced through the overburden (14.93m bgs) and seated approximately 1.5 m into the underlying limestone bedrock using mud drilling. The annular space around the casing was sealed with a bentonite grout slurry. The open borehole was noted to intercept water bearing zones at approximately 41.1 m bgs and 50.8 m bgs in "grey & white sandstone" which is most probably the March Formation. The well record originally noted the well was flowing at a rate of approximately 45.5 L/min (10 IGPM). The existing grade elevation at the drilled well was recorded to be 93.78m with the top of casing extending 0.63m above existing grade for a measured elevation of 94.41m. There are no site changes being proposed within the vicinity of the drilled well and as a result, no changes to the existing grade are expected.

3.1.2 AQUIFER ANALYSIS

To evaluate the yield and collect data on the aquifer system intercepted by the existing water well on site, WSP carried out a constant rate pumping test on December 1st, 2022. The results of the pumping test were used to determine the relevant aquifer characteristics to assess long term well yield, etc.

3.1.3 PUMPING TEST SUMMARY

To facilitate the pumping test, given that the pump size and diameter of the discharge line (i.e. 50 mm dia.), WSP coordinated with Air Rock Drilling Company Ltd. to install a diverter on the existing discharge piping assembly which was connected to the existing irrigation system for the soccer fields rather than bring in a crane to lift the piping off the pitless adapter and connect to separate discharge pipes. The discharge piping was connected to the diverter and the piping was extended upwards of 30 m away from the well. The discharge water was conveyed away from the well area via an existing grassed swale sloping westward.

Initially, WSP had intended to complete a step test on the well, but given that the drawdown response was minimal when the pump was turned on and allowed to operate at full, unadjusted rates, it was decided to proceed with a full rate test until 50,000 L had been pumped. The existing infrastructure did not allow for the flow rate to be reduced and the project timeline was not sufficient to register on the Environmental Activity and Sector Registry (EASR) for the pumping test. Instead, a constant rate pumping test was carried out on the existing water supply well at a rate of approximately 202 L/min for approximately 245 minutes before the pump was shut off. A total of approximately 49,500 L of water was withdrawn from the pumping well with a corresponding total net drawdown of approximately 1.96 m. This approach was considered suitable for this site since the pumping test approximated the highest use of the well during irrigation activities. Following pump shutoff, the water level recovered to 0.02 m below the top of the well casing in less than one minute.

Drawdown and recovery were monitored using a pressure transducer installed in the well and a barometric logger installed nearby. Two observation wells were used during this test. One observation well is located approximately 525 m north of the site at Burger and' Shakes at 5510 Limebank Road, and one observation well is located at a nearby residence at 5765 Longhearth Way (approximately 800 m east of the pumping well) (Figure 1). Drawdown data was gathered prior to the start of pumping and beyond the termination of pumping to assess aquifer drift characteristics where drawdown and recovery values differ.

Upon return to the Site on December 14, 2022, WSP was unable to retrieve the pressure transducer installed at the WSW during the pumping test. WSP suspects that the pressure transducer may have encountered wiring from the pump components in the well, which is preventing staff from pulling the logger out of the well. Manual measurements recorded during the constant rate pumping rate were therefore used to provide an assessment of aquifer properties intercepted by the WSW. The pressure transducer will be retrieved at a later date by a licensed well technician.

4 AQUIFER ANALYSIS

4.1 WATER QUANTITY

The results of the pumping test are provided in **Appendix D** and the aquifer characteristics determined from the constant rate pumping test carried out on the existing WSW, which are indicative of the underlying aquifer system are summarized in **Table 3-1** below:

Table 4-1 SUMMARY OF AQUIFER ANALYSIS OF EXISTING WATER SUPPLY WELL

AQUIFER PARAMETER

Pumping Rate (L/min)	202.8
Static Water Level (m) (below top of casing)	Overflowing
Depth of Well (m)	53.33

AQUIFER PARAMETER

Available Drawdown (m) (inferred based on recommended depth from the well driller at time of initial pumping test)	30.47
Total Drawdown During Pumping of Well (m)	1.96
Specific Capacity (L/min./m of drawdown)	103.5
Time to 95% Recovery from Drawdown Test (minutes)	<1

Note: 1. Available drawdown estimated based on recommended pump depth available in MECP WWR.

The manual water level measurements from the pumping well were used to estimate the aquifer transmissivity with the Aqtesolv software package. The estimated transmissivity is approximately 830 m^2/day (refer to **Appendix D**).

4.2 GROUNDWATER GEOCHEMISTRY ASSESSMENT

4.2.1 LABORATORY WATER QUALITY ANALYSIS

A raw groundwater sample was collected from the site well on December 1st , 2022, in conjunction with the constant rate pump test. The analytical results from raw groundwater chemistry obtained are provided in **Table 4-2**. The laboratory Certificates of Analyses are compiled in **Appendix C.**

Table 4-2 SUMMARY OF GROUNDWATER GEOCHEMISTRY OBTAINED THROUGH PUMPING OF EXISITNG DRILLED WELL

			GROUNDWATER ANAYLTICAL RESULTS	ONTARIO DRINKING WATER STANDARDS		REASONABLE TREATABLE LIMIT AS PER PROCEDURE D5-5
PARAMETER	UNITS	MDL	LAB ID: 1666217	TYPE	LIMIT	
MICROBIOLOGICAL						
Total Coliforms	CFU/100mL	0	0	MAC	0	-
E.coli	CFU/100mL	0	0	MAC	0	-

PARAMETER	UNITS	MDL	GROUNDWATER ANAYLTICAL RESULTS LAB ID: 1666217	ONTARIO DRINKING WATER STANDARDS TYPE	 LIMIT	REASONABLE TREATABLE LIMIT AS PER PROCEDURE D5-5
Chloride	mg/L	1	91	AO	250	250
Fluoride	mg/L	0.10	0.19	MAC	2.4	-
Nitrite	mg/L	0.1	<0.10	MAC	1.0	-
Nitrate	mg/L	0.1	<0.10	MAC	10.0	-
Total Kjeldahl Nitrogen	mg/L	0.05	0.116	-	-	-
Turbidity (Lab)	mg/L	0.1	1.7	MAC/AO	1.0/5.0	5
Alkalinity	mg/L	5	255	OG	500	-
Colour	TCU	2	13	AO	5	7
DOC	mg/L	0.5	1.9	AO	5	10
Sulfide	mg/L	0.02	<0.01	AO	0.05	
pH	unitless	1	7.41	AO	6.5-8.5	-
Sulphate	mg/L	3	58	AO	500	500
Hardness	mg/L	1	351	OG	100	-
Sodium	mg/L	2	48	AO	20(200)	200
Iron	mg/L	0.03	0.20	AO	0.3	10
Manganese	mg/L	0.01	0.05	AO	0.05	1

PARAMETER	UNITS	MDL	GROUNDWATER ANAYLTICAL RESULTS LAB ID: 1666217	ONTARIO DRINKING WATER STANDARDS TYPE	 LIMIT	REASONABLE TREATABLE LIMIT AS PER PROCEDURE D5-5
Total Dissolved Solids	mg/L	1	535	AO	500	-
Ammonia	mg/L	0.010	0.084	-	-	-
Calcium	mg/L	1	81	-	-	-
Conductivity	uS/cm	5	823	-	-	-
Ion Balance	Unitless	0.01	1.04	-	-	-
Magnesium	mg/L	1	36	-	-	-
Phenols	mg/L	0.001	<0.001	-	-	-
Potassium	mg/L	1	4	-	-	-
Tannin & Lignin	mg/L	0.1	0.8	-	-	-

Note: Parameters highlighted in blue represent Ontario Drinking Water Standards aesthetic/operational exceedances. Parameters highlighted in orange represent ODWS health warning (for Sodium only).

4.3 WATER SUPPLY AQUIFER SUMMARY

4.3.1 WATER QUANTITY

Based on the information summarized in **Table 3-1,** it is apparent that the water supply aquifer located beneath the subject lands has considerable yield. Based on the calculated specific capacity, the minimum long term well yield of the existing WSW is at least 202 L/min. It is possible that a pumping test conducted at a higher rate could identify a higher sustainable pumping rate. This is significantly higher than the minimum yield necessary for the intended use (i.e., average of 4,800 L/day (3.3 L/min); refer to Section 5.2). Using the data from the pumping well, the estimated

transmissivity of the aquifer is approximately 830 m^2/day (refer to **Appendix D**). Insufficient drawdown was measured at the nearby observation wells to be able to estimate the aquifer storativity (refer to Section 4.5).

Based on the minimum long term yield, and considering the rapid rate of recovery after the termination of pumping after minimal drawdown during pumping, it is our opinion that there is ample yield within the intercepted aquifer system to accommodate the proposed re-development and addition of a field house and office building.

4.3.2 WATER QUALITY

The groundwater geochemistry obtained from the existing WSW, representative of the intercepted aquifer system on the subject property, as it relates to health and aesthetic water quality parameters, is presented in **Table 4-2**. A review of the water quality data indicates that it meets the heath related parameter requirements specified by the Ontario Drinking Water Standards (ODWS) for the parameters tested.

With respect to aesthetic related water quality parameters, the levels of colour, hardness and total dissolved solids were reported at concentrations higher than the ODWS values. A discussion of these aesthetic parameters, as it relates to water treatment options, is provided in Section 4.4, below.

4.4 TREATABILITY OF RAW WATER

The following aesthetic parameters were noted to be present in concentrations exceeding the Ontario Drinking Water Standards:

- Colour;
- Hardness;
- Sodium; (special statement) and
- Total Dissolved Solids

The measured concentration of colour (13 TCU) exceeds the Table 3 of Procedure D-5-5 maximum concentration considered reasonably treatable (7 TCU). Activated carbon filters have been shown to effectively reduce the concentration of colour by 60-90% by adsorbing organic and inorganic water components on the surfaces of the activate carbon. The designer of the drinking water treatment system should consider a commercial-grade backwashing activated carbon filter to reduce the colour concentration, and reduce the natural organic matter (NOM) content in the raw water. The reduction of NOM will also reduce the production of disinfection byproducts should chlorination or chloramination be selected as a disinfection mechanism employed in the treatment train at the development. Additionally, based on visual observations of the raw water samples, iron oxidation is thought to be contributing to the elevated colour measurements. Although the iron concentration in the water sample collected at the time of the pumping tests did not yield significant quantities of iron, this phenomenon is known to occur in the area. The iron, tannin and lignin, and DOC concentrations in the sample collected at the neighbouring water supply well located at 5765 Longhearth Way (results summarized in Table 2-1) were significantly higher than that observed in the raw water sample collected at 5650 Mitch Owens Road at the time of the constant-rate pumping test, and are may be generally representative of the raw water quality that will be available for use at the proposed development under typical demand conditions. As such, in addition to the backwashing activated carbon filtration equipment, the designer of the drinking water treatment system should consider a commercial-grade backwashing iron filter. Iron filtration apparatus should be installed upstream of softening and activated carbon filtration equipment.

The hardness was measured to be of the order of 351 mg/L and is considered to be very hard. While this value is above the operational guideline of 100 mg/L, Table 3 of Procedure D-5-5 does not specify a maximum treatable limit for hardness. The designer of the drinking water treatment system should consider a commercial-grade water softener to condition the water. Due to the reported hardness concentration, a water conditioning professional should be retained to select the necessary grain value to effectively condition the water. Backwash water should not be directed to nearby roadside ditches.

It is recommended that either potassium salts be used as the regeneration salt for the softener resin, or otherwise fixtures used to supply drinking water be equipped with a point of use reverse osmosis device to remove the sodium content. .

In the event that sodium salts are preferred for softener regeneration purposes, the designer of the drinking water treatment system should consider a partial bypass of the softener to temper the hardness of the softened water to within the recommended operational guideline range of 80 to 100 mg/L. This will ultimately reduce the resin regeneration frequency, and help control the sodium content of the softened water because use of sodium salts for the purpose of softener resin regeneration will exacerbate the elevated sodium content in the raw water, potentially to the point of exceeding the aesthetic limit of 200 mg/L in the treated water.

In addition to the above discussion regarding sodium, the measured concentration in the raw water exceeds the cautionary limit of 20 mg/L. As such, it is required to notify the Medical Officer of Health for the City of Ottawa to allow for the dissemination of this information for persons with dietary restrictions for sodium. The sodium concentration in the raw water is below the aesthetic limit of 200 mg/L identified in Procedure D-5-5.

With respect to total dissolved solids (TDS), the laboratory results showed a concentration of the order of 535 mg/L. The Langelier Saturation Index was calculated for the raw water at temperatures at 8°C and 56°C to evaluate the stability of the water over the cold and hot water environments. At 8°C, the water is expected to be slightly corrosive but non-scale forming in its raw form. Above 56°C, the water is expected to be slightly scale forming and non-corrosive. A copy of the calculations appear in **Appendix E**. Raw water at the temperature of 8C is anticipated to be undersaturated with respect to calcium carbonate and has a tendency to remove existing calcium carbonate protective coatings in pipelines and equipment. The designer of the drinking water treatment system should consider the configuration and material of the piping in the distribution system, and consider provisions for adjustment of the pH and alkalinity for corrosion control immediately prior to water distribution at the lower temperature ranges, to minimize corrosion effects on piping and equipment.

The design and operation of the drinking water treatment system should also include provisions for primary disinfection (and secondary disinfection if necessary) designed in accordance with the MECP publication *Procedure for Disinfection of Drinking Water in Ontario*, and include provisions for any other level of treatment or operational requirements prescribed by O. Reg. 170/03, or otherwise O. Reg. 319/08 as appropriate. Additionally, a suitably-licensed well contractor should disinfect and develop the well prior to commissioning of the drinking water treatment system.

4.5 POTENTIAL OFFSITE WELL INTERFERENCE

To assess the potential for off-site well interference, pressure transducers were installed at two observation wells on November 25, 2022 and removed on December 14, 2022. The wells were located north of the site at Burger and' Shakes at 5510 Limebank Road, and at a nearby residence at 5765 Longhearth Way. Drawdown data was gathered

prior to the start of pumping and beyond the termination of pumping to assess long-term regional groundwater trends.

The data collected by the pressure transducers is shown in Figure 2 along with daily precipitation data recorded at the Ottawa Airport climate station. Figure 2 illustrates the significant, periodic drops in groundwater levels that occur when the well pumps turn on during water usage at the observation wells. On November 30, 2022, 21 mm of rain was recorded to have fallen. The water levels at the observation wells increased following this precipitation event, and subsequently declined slightly over the next day. This period of decline overlapped with the date of the pumping test.

Figure 3 shows the drawdown measured at the observation wells on the day of the pumping test. Based on the water levels measured when the well pumps in the observation wells were not operating, maximum water level declines of approximately 0.04 m and 0.05 m were measured at 5510 Limebank Road and at 5765 Longhearth Way, respectively. Given that the pumping test occurred during a period of groundwater level decline following a precipitation event, it is likely that much of the apparent drawdown at the observation wells is due to this regional water level decline and not to the influence of the pumping well. As an example, the water level at 5510 Limebank Road remained steady for several hours following pump shutdown; if the water level had been impacted during the pumping test, it would be expected to exhibit some recovery after pump shutdown.

Given the minimal drawdown observed at the pumping well at a pumping rate of 202 L/min, combined with the rapid recovery of the water level to 100% within one minute of the termination of pumping, and in direct consideration of the density of surrounding development, the potential for adverse offsite impacts to nearby wells is anticipated to be minimal.

5 GROUNDWATER IMPACT ASSESSMENT

5.1 CONCEPTUAL HYDROGEOLOGICAL MODEL

The Site is present within the southern portions of the Ottawa Valley Clay Plains. The general overburden stratigraphy, below the topsoil layer, consists of a 1m to 2 m of a non-cohesive silty sand a modestly thick layer of stiff to very stiff silty clay. Underlying the silty clay is, as evidenced in the available WWR's and based on WSP's local experience, a compact to hard glacial till layer is present overlying the limestone bedrock of the Oxford Formation.

It is likely that infiltrating surface precipitation will pass through the topsoil and silty sand transition layer with relative ease. Vertical infiltration will be significantly retarded/reduced once the infiltrate reaches the surface of the silty clay. Looking at the deeper borehole data from the 2015 Paterson report, the silty clay was noted to have a soft to firm consistency in the upper few metres of the layer, becoming stiff to hard towards the base of the layer. This suggests that the overburden groundwater is present generally at the interface between the silty sand and the silty clay layer, and has, over a long period of time, vertically percolated into the clay layer by several metres. The lower moisture content and stiffer consistency/increase in shear strength deeper into the silty clay layer supports our supposition that the overburden groundwater is generally perched in this area.

As such, overburden groundwater is believed to generally migrate laterally along the surface of the silty clay layer, at the Site, significantly influenced by surficial topography and nearby drainage networks. Given the general topographic relief of the site, surface drainage appears to be directed westward towards the watercourse which meanders along the western limits of the property.

With respect to additional overburden aquifers, it is WSP's general experience, that an overburden aquifer generally exists near the basal contact area between the glacial till and the limestone bedrock.

In consideration of the above, it is WSP's opinion that the site is not considered hydrogeologically sensitive to receiving sewage system effluent. There is a lack of existing geotechnical information that would allow a confirmation of hydraulic isolation, and, as such, a groundwater impact assessment for nitrate-nitrogen will be required.

5.2 SEWAGE SYSTEM CAPACITY ASSESSMENT

The potential for impacts to occur within the local groundwater regime is dependent upon the local hydrogeologic setting, as well as the volume of sewage effluent being discharged and concentration of nutrients contained within the effluent. MECP Procedure D-5-4 - Technical Guideline for Individual On-Site Sewage Systems: Water Quality Impact Risk Assessment (August, 1996) (Procedure D-5-4) describes a three-step process for the assessment of potential groundwater impact(s) associated with development proposals outside of areas designated for reasonable use assessments under B-7.

The purpose of this assessment is to "…ensure that the combined effluent discharges from all the individual on-site sewage systems in a development will have a minimal effect on the groundwater and the present or potential use of the adjacent property". In this regard, Procedure D-5-4 utilizes the 10 mg/L (as N) Ontario Drinking-Water Quality Standard (MECP, 2006) for nitrate-nitrogen as the primary indicator for groundwater impact potential where surface waters are not located directly downgradient of the subject property being evaluated.

To determine the representative existing background nitrate nitrogen levels in the receiving groundwater, WSP collected groundwater samples from water supply wells located on and adjacent lands to the site. Water samples were collected at the Site on December 1, 2022 during the 4-hour constant rate pumping test and at the nearby property located at 5765 Longhearth Way on November 24, 2022. Based on the analytical results, the concentration of nitrate reported for both samples were below laboratory method detection limits of 0.10 mg/L and existing background nitrate nitrogen levels in the intercepted aquifer are considered non-detectable.

To assess the potential groundwater impacts of the proposed on-site sewage system at the boundary of the Site, WSP has completed the groundwater quality impact risk assessment by first completing a site-specific water budget analysis for the Site. Climate data was obtained from the Ottawa McDonald Cartier Airport Station for the period from 1981 until 2010. Mean monthly temperatures were calculated by averaging mean monthly minimum and maximum temperatures. Temperature data were derived from the 30-year (1981-2010) climate data summaries. The Thornthwaite-Mather method was used to estimate potential and actual evapotranspiration on a monthly basis. The Thornthwaite-Mather method is based on an empirical relationship between potential evapotranspiration and mean air temperature and was used to estimate the potential water surplus at the Site. The water budget analysis is summarized in **Appendix F**.

Based on the location of the Site and the parent soil stratum present within the footprint of the proposed sewage system described at sandy clay to clayey sand, a water surplus of 351 mm per year was calculated to be available for infiltration. This infiltrate, for the purposes of the Procedure D-5-4 Impact Risk Assessment, is expected to dilute

the sewage system effluent that is discharged through the leaching beds and into the natural environment beyond the property.

Using the surplus water value obtained from the site-specific water budget, WSP has completed a predictive groundwater impact risk analysis for the underlying groundwater aquifer system using the following critical assumptions:

- The Ontario Drinking Water Standard value for Nitrates in groundwater of 10 mg/L will be used as the maximum allowable downgradient concentration.
- Infiltration factor derivation will be reflective of conservative post-development conditions as follows:
    - Topography = 0.2 (Rolling Land)
    - Soil = 0.1 (Clay)
    - Cover = 0.05 (Grassed Areas)
- Percentage of impervious surfaces in the post-development scenario is assumed to be 10% (associated with building rooftops, driveways and parking areas)
- Concentration of nitrate in effluent is 40 mg/L
- No additional infiltration from landscaping is occurring

Based on the groundwater quality impact risk assessment results with the conservative assumptions outlined above, the sewage system nitrate attenuative capacity of the Site is estimated to be 14,800 L/day. Since the proposed sewage site is located near the eastern property boundary and the inferred shallow groundwater flow direction is westwards, the entire property area was used in the dilution calculations. At this estimated daily sewage flow, the concentration of nitrates in the infiltrate at the downstream receiving water supply aquifer system at the property boundary beneath the site is 9.9 mg/L. The groundwater quality impact risk assessment results are provided in **Appendix G.**

The current theoretical total daily design sanitary sewage flow (TDDSSF) for the subject property has been based on the Ontario Building Code 2012, as amended with consideration of the Manual Policy, Procedures and Guidelines for Onsite Sewage Systems, MECP (1982). The TDDSSF has been based on the combined theoretical sewage flows, of the players per team, the portion of players who use the facility to shower, and the number of office staff. The breakdown of the estimated flows, and the averaged balanced flow considered for design are outlined below:

On weeknights:

- Fieldhouse: 15 players and 3 spectators per team, with 6 teams =114 people total. 114x8L/day= 912L/day
- Office: 5 staff per day x 75L/day= 375L/day
- Meeting room: Meeting of 20 people x 8L/day= 160L/day
- Fitness facility: 20 people x 30L/day= 600
- Showering facilities: 1 in 4 players uses the shower. Therefore 23 players x 22L/day = 506L/day comes from the showers
- Weeknight total average of **2,553L/day**

On weekends:

- Fieldhouse: 19 players and 4 spectators per team, with 40 teams= 760 people total. 760x 8L/day= 6080L/day
- Office: 5 staff per day x 75L/day= 375L/day
- Fitness facility: 20 people x 30L/day= 600
- Showering facilities: 1 in 4 players uses the shower. Therefore, 150 players x 22L/day= 600L/day
- Weekend total average of 10,355L/day

Considering the flows, the TDDSSF for the proposed facility load is:

TDDSSF= [(5 x 2, 553L.day) + (2x 10,355L/day)]/7

= 4, 782L/day ~ **4,800** L/day (balanced flow)

Based on the TDDSSF currently being considered at the Site, the groundwater quality impact assessment estimated the long-term nitrate concentration in the infiltrate at the downstream receiving water supply aquifer system at the property boundary beneath the site is 3.8 mg/L. This resulting value is below the maximum acceptable concentration (MAC) for nitrate-nitrogen of 10 mg/L as noted by the ODWQS. As such, impacts to the groundwater quality down-gradient in the long-term resulting from the construction of the proposed sewage system is anticipated to be acceptable. The groundwater quality impact risk assessment results are provided in **Appendix G.**

Based on information provided in the Paterson Geotechnical Investigation Report (June 2015) and the shallow soil investigations completed by WSP in January 2022, the surficial geology at the site is generally underlain by topsoil cover ranging in thickness between 0.10 m to 0.66 m, overlying silty sand to sandy silt fill to depths ranging between 0.10 m to 1.90 m below the existing ground surface and silty clay deposits extending to depths of 1.3 and 6.1 m in the boreholes advanced at the site. Based on the soil conditions observed, the site is not considered to be hydrogeologically sensitive and, as such, no special precautions need to be considered with respect to sewage system design, well construction, and minimum Ontario Building Code horizontal/vertical clearance distances for sewage system design.

5.2.1 SEWAGE SYSTEM DESIGN PARAMETERS

As the theoretical daily design sewage flow for the Site is less than 10,000 L/day, the Ontario Building code is the regulatory guideline for the proposed sewage disposal system.

6 CONCLUSION

Based on the information contained within the body of this assessment, the following conclusions can be drawn:

1. The Site is underlain by silty sand to sandy silt fill, extending to depths ranging from 0.10 m to 1.90 m below the existing ground surface. A layer of sensitive silty clay was encountered underlying the fill in boreholes drilled in this area, extending to depths of 1.3 and 6.1 m. This layer is classified as a soft to firm grey silty clay with some sand and has an increasing moisture content with depth that ranges between 25% to 60 %. The existing water supply well at the Site encountered up to 14.9 m of overburden, underlain by limestone and sandstone bedrock, likely of the Oxford and March Formations, respectively.

2. As required under Ontario Regulation 903, the supply well must be equipped with a well packer system suitable for flowing groundwater conditions.
3. The water supply aquifer intercepted by the existing water supply well is strong and capable of significant well yields. Given the rapid recovery of the water level to 100% upon termination of pumping, combined with the surrounding low-density development, drawdown in neighbouring offsite wells is anticipated to be negligible.
4. The water supply aquifer intercepted by the existing water supply well contains a water supply that shows concentrations of colour, hardness and total dissolved solids at concentrations higher than the ODWS aesthetic limits. Additionally, elevated concentrations of dissolved organic carbon and iron are known to be common in the area, As such, the designer of the drinking water treatment system should consider provisions for iron filtration, water softening, and activated carbon filtration to reduce the concentrations of the colour and hardness, as well as the anticipated iron and organic matter content.. A suitably-licensed well contractor should disinfect and develop the well prior to commissioning of the drinking water treatment system.
5. The site is underlain by a silty sand to sandy silt transition soil to a soft to firm silty clay layer. Bedrock was not encountered within the depths of the boreholes advanced at the site, to a maximum depth of 6.1 m. As such, the subject land are not considered to be hydrogeologically sensitive to receiving sewage system effluent and require no special engineering design recommendations. Hydraulic isolation could not be confirmed with the available geotechnical information, as such a groundwater impact assessment for nitrate-nitrogen was completed.
6. Based on the groundwater quality impact risk assessment results, the sewage system nitrate attenuative capacity of the Site is estimated to be 14,800 L/day. At this estimated daily sewage flow, the concentration of nitrates in the infiltrate at the downstream receiving water supply aquifer system at the property boundary beneath the site is 9.9 mg/L.
7. Using a theoretical total daily design sanitary sewage flow (TDDSSF) for the subject property for 4,800 L/day, the concentration of nitrates in the infiltrate at the downstream receiving water supply aquifer system at the property boundary beneath the site is 3.8 mg/L. This resulting value is below the maximum acceptable concentration (MAC) for nitrate-nitrogen of 10 mg/L as noted by the ODWQS. As such, impacts to the groundwater quality down-gradient in the long term resulting from the construction of the proposed sewage system is anticipated to be minimal.

7 REFERENCES

- Chapman, L.J., & Putnam, D. F. (1984). Physiography of Southern Ontario. Miscellaneous Release, Data 228 ISBN 0-7743-9422-6. Ontario Geological Survey.
- Chapman, L.J., & Putnam, D. F. (2007). Physiography of Southern Ontario. Miscellaneous Release, Data 228 ISBN 978-1-4249-5158-1. Ontario Geological Survey
- Ontario Geological Survey (1991). Bedrock Geology of Ontario, Southern Sheet; Ontario Geological Survey, Map 2544, scale 1: 1,000,000

- Ontario Geological Survey 2010. Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128-REV

FIGURES

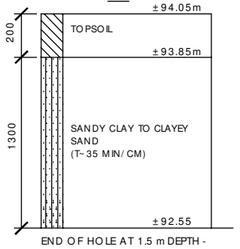
LEGEND:

- TEST HOLE LOCATION
- 93.94 EXISTING GROUND SURFACE ELEVATION (m)
- PROPERTY LINE

SOILS INFORMATION

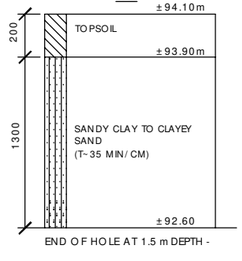
NOTE: T-TIME ESTIMATES SHOWN IN THIS SECTION REFLECT PROFESSIONAL TACTILE EXAMINATION BY A QUALIFIED ENGINEER

TEST HOLE LOG SUMMARY FOR TH1



END OF HOLE AT 1.5 m DEPTH -

TEST HOLE LOG SUMMARY FOR TH2



END OF HOLE AT 1.5 m DEPTH -

WSP
2611 QUEENSVIEW DR #300
OTTAWA, ONTARIO
CANADA K2B 8K2
PHONE: 613-829-2900
WWW.WSP.COM

CLIENT:

OTTAWA SOUTH UNITED

CLIENT REF. #:

PROJECT:

PROPOSED FIELD HOUSE

5650 MITCHOWENS ROAD, OTTAWA

IS	RE	DATE	DESCRIPTION

PROJECT NO: 211-13935-00

DATE: MAY 2023

ORIGINAL SCALE: N.T.S

IF THIS BAR IS NOT 25mm LONG, ADJUST YOUR PLOTTING SCALE.

25mm

DESIGNED BY: CC

DRAWN BY: BA

CHECKED BY: CC

DISCIPLINE: RURAL DEVELOPMENT

TITLE:

SITE PLAN

SHEET NUMBER:

SHEET #: 1 OF 1

ISSUE:

DATE OF:

FIGURE 1

REV # 0

Figure 2: OSU Pumping Test
Observation Well Data

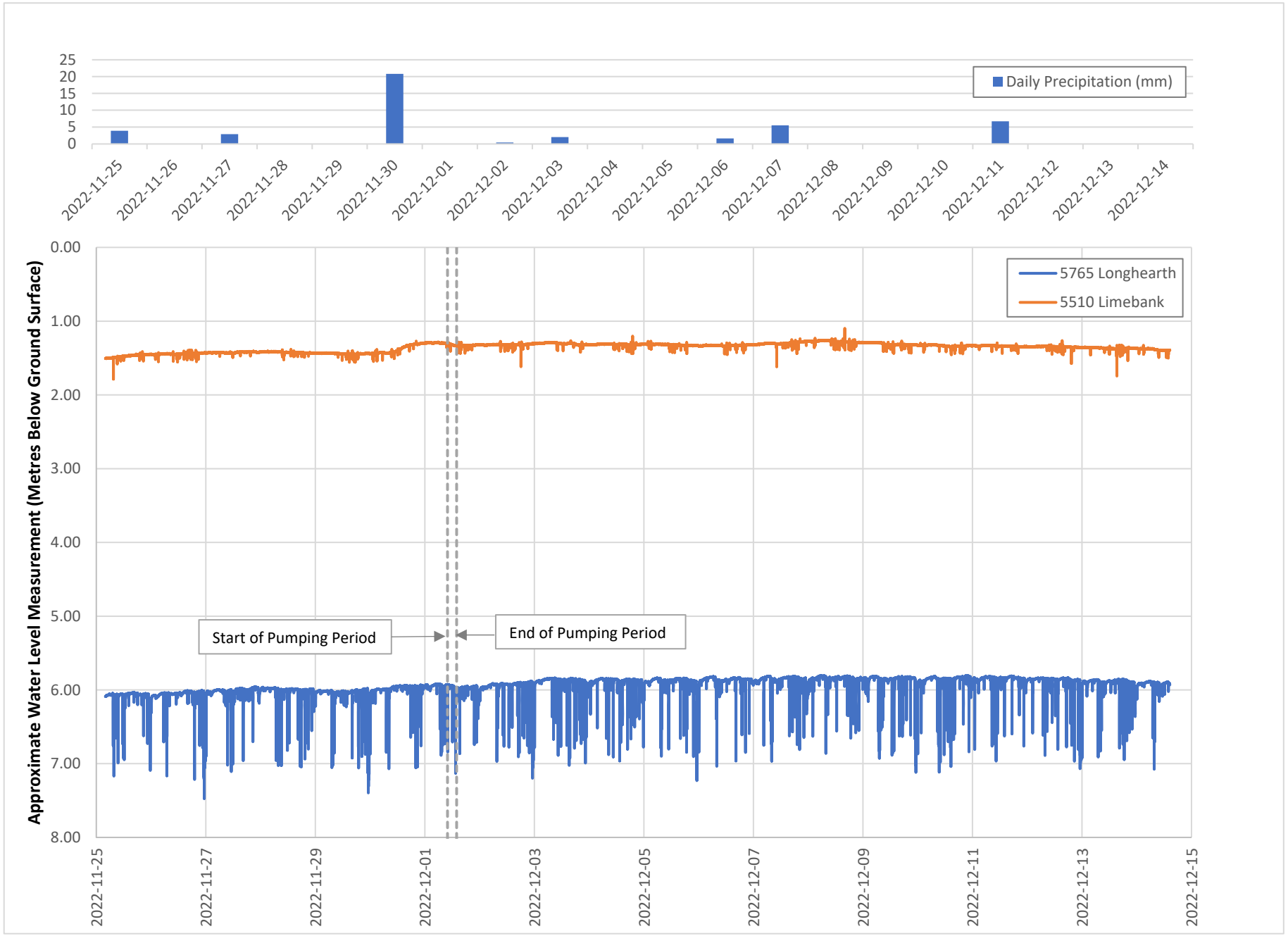
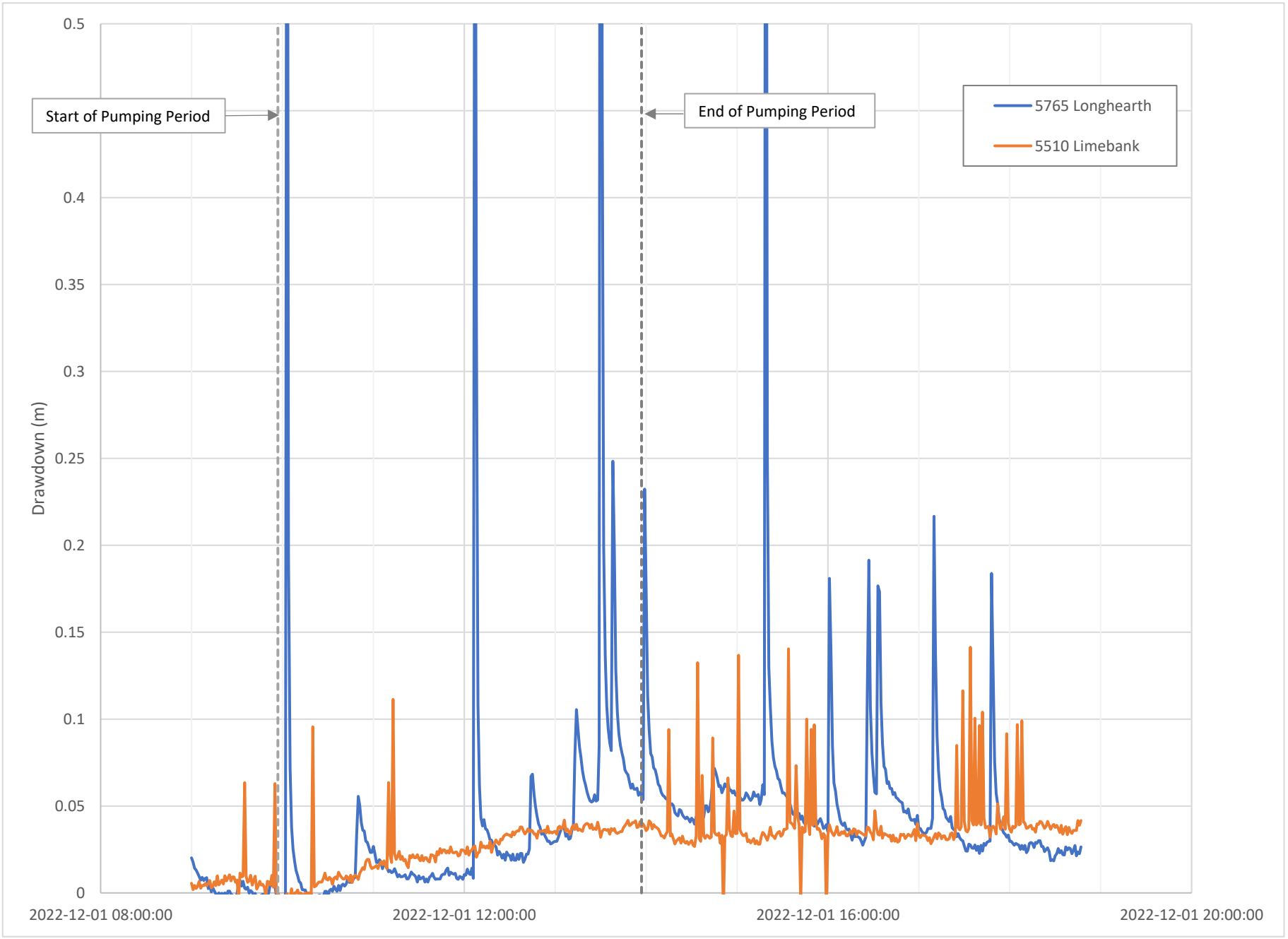


Figure 3: OSU Pumping Test
Observation Well Drawdown Data



APPENDIX

A PATERSON BOREHOLE LOGS

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Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Turf Field & Soccer Dome - 5650 Mitch Owens Dr.
Ottawa, Ontario

DATUM TBM consists of existing ground surface at eat property boundary. Geodetic elevation = 94.02m.

REMARKS

FILE NO. PG3545

HOLE NO. BH 1

BORINGS BY Geoprobe **DATE** June 25, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.77
TOPSOIL		SS	1	33	4		
0.66							
		SS	2	42	5	1	92.77
Loose to very loose, grey **SILTY SAND,** some clay		SS	3	33	5		
1.95						2	91.77
		SS	4	50	W		
Soft to firm, grey **SILTY CLAY,** some sand						3	90.77
						4	89.77
						5	88.77
5.94							
End of Borehole							
(GWL @ 2.0m depth based on field observations)							

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**
○ **Water Content %**

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Turf Field & Soccer Dome - 5650 Mitch Owens Dr.
Ottawa, Ontario

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REMARKS

FILE NO. PG3545

HOLE NO. BH 2

BORINGS BY Geoprobe **DATE** June 25, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE									
TOPSOIL 0.10		SS	1	67	8	0	93.43		
Loose to very loose, grey **SILTY SAND,** some clay		SS	2	75	4	1	92.43		
		SS	3	100	2				
1.83 End of Borehole									
(BH dry upon completion)									

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Turf Field & Soccer Dome - 5650 Mitch Owens Dr.
Ottawa, Ontario

DATUM TBM consists of existing ground surface at eat property boundary. Geodetic elevation = 94.02m.

REMARKS

FILE NO. PG3545

HOLE NO. BH 3

BORINGS BY Geoprobe **DATE** June 25, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	93.82		
TOPSOIL 0.25		SS	1	50	3				
FILL: Brown silty sand, some clay 0.60		SS	2	100	10	1	92.82		
Very loose to loose, brown to grey **SILTY SAND,** some clay		SS	3	100	8				
1.83									
End of Borehole									
(BH dry upon completion)									

Pen. Resist. Blows/0.3m: 20 40 60 80

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Turf Field & Soccer Dome - 5650 Mitch Owens Dr.
Ottawa, Ontario

DATUM TBM consists of existing ground surface at eat property boundary. Geodetic elevation = 94.02m.

REMARKS

FILE NO. PG3545

HOLE NO. BH 4

BORINGS BY Geoprobe **DATE** June 25, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE									
TOPSOIL 0.20		SS	1	75	8	0	93.56		
Loose, grey **SILTY SAND,** some clay		SS	2	100	9	1	92.56		
1.57		SS	3	100	1				
Soft, grey **SILTY CLAY,** some sand 1.83									
End of Borehole									
(BH dry upon completion)									

Pen. Resist. Blows/0.3m: 20 40 60 80

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Turf Field & Soccer Dome - 5650 Mitch Owens Dr.
Ottawa, Ontario

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REMARKS

FILE NO. PG3545

HOLE NO. BH 5

BORINGS BY Geoprobe **DATE** June 25, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE									
TOPSOIL 0.10		SS	1	67	6	0	93.63		
Loose, brown **SILTY SAND,** some clay		SS	2	100	6	1	92.63		
1.37									
Soft, grey **SILTY CLAY**		SS	3	100	W				
1.83									
End of Borehole									
(BH dry upon completion)									

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Turf Field & Soccer Dome - 5650 Mitch Owens Dr.
Ottawa, Ontario

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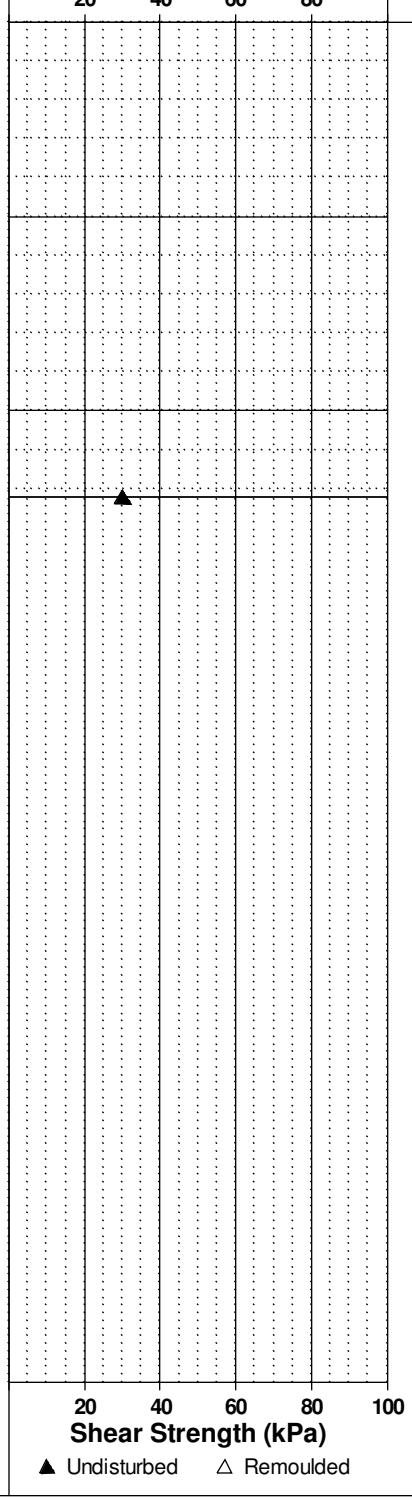
FILE NO. PG3545

REMARKS

HOLE NO. BH 6

BORINGS BY Geoprobe **DATE** June 25, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	93.65		
TOPSOIL 0.10		SS	1	75	10				
Loose, brown **SILTY SAND,** some clay		SS	2	58	8	1	92.65		
1.50		SS	3	100	W				
Firm, grey **SILTY CLAY**						2	91.65		
2.44 End of Borehole									
(BH dry upon completion)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Turf Field & Soccer Dome - 5650 Mitch Owens Dr.
Ottawa, Ontario

DATUM TBM consists of existing ground surface at eat property boundary. Geodetic elevation = 94.02m.

FILE NO. PG3545

REMARKS

HOLE NO. BH 7

BORINGS BY Geoprobe **DATE** June 25, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE									
TOPSOIL 0.15						0	94.02		
FILL: Brown silty sand, some clay 0.60		SS	1	75	5				
Loose, brown **SILTY SAND**, some clay		SS	2	100	8	1	93.02		
- grey by 1.2m depth		SS	3	100	6				
1.83 End of Borehole									
(BH dry upon completion)									

Pen. Resist. Blows/0.3m: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Turf Field & Soccer Dome - 5650 Mitch Owens Dr.
Ottawa, Ontario

DATUM TBM consists of existing ground surface at eat property boundary. Geodetic elevation = 94.02m.

FILE NO. PG3545

REMARKS

HOLE NO. BH 8

BORINGS BY Geoprobe **DATE** June 25, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.73
TOPSOIL 0.20							
FILL: Brown silty sand		SS	1	67	8		
0.60							
		SS	2	100	8	1	92.73
Loose to very loose, brown **SILTY SAND**							
		SS	3	100	2		
1.68							
Firm, grey **SILTY CLAY** 1.83							
End of Borehole							
(BH dry upon completion)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Turf Field & Soccer Dome - 5650 Mitch Owens Dr.
Ottawa, Ontario

DATUM TBM consists of existing ground surface at eat property boundary. Geodetic elevation = 94.02m.

REMARKS

FILE NO. PG3545

HOLE NO. BH 9

BORINGS BY Geoprobe **DATE** June 25, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	93.59		
TOPSOIL 0.13									
FILL: Brown silty sand, some clay		SS	1	62	8				
0.60									
Loose to very loose, brown **SILTY SAND,** some clay		SS	2	75	7	1	92.59		
		SS	3	100	2				
1.68 Firm, grey **SILTY CLAY,** some sand 1.83									
End of Borehole									
(BH dry upon completion)									

Pen. Resist. Blows/0.3m: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Turf Field & Soccer Dome - 5650 Mitch Owens Dr.
Ottawa, Ontario

DATUM TBM consists of existing ground surface at eat property boundary. Geodetic elevation = 94.02m.

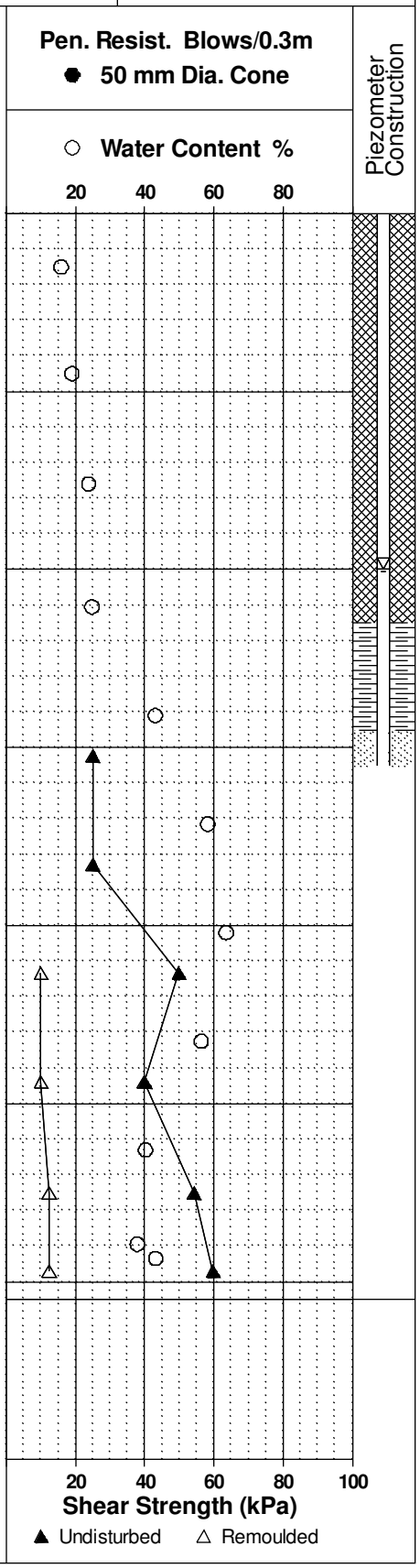
REMARKS

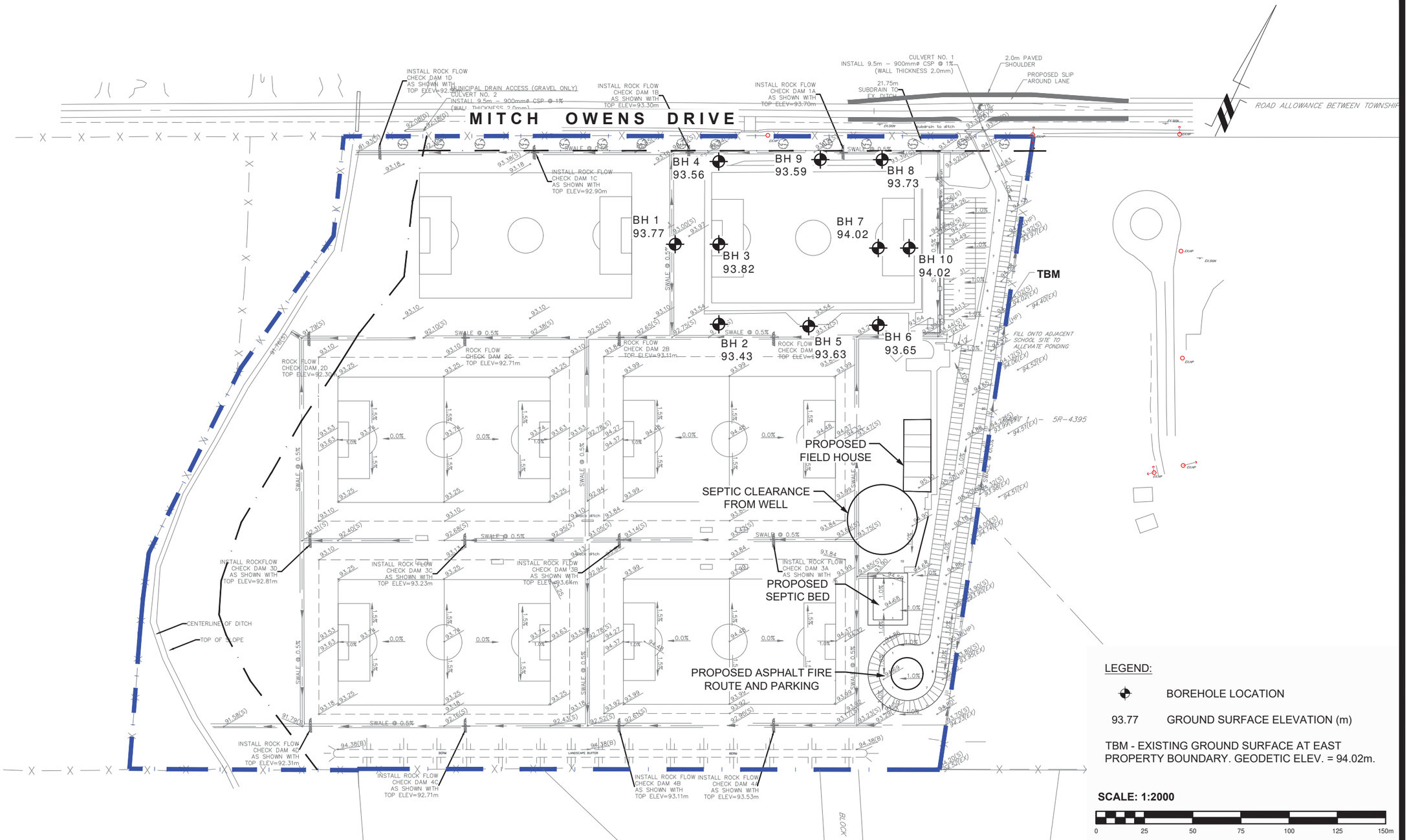
BORINGS BY Geoprobe **DATE** June 25, 2015

FILE NO. PG3545

HOLE NO. BH10

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	94.02
TOPSOIL 0.10							
FILL: Brown silty sand, some clay		SS	1	83	7		
0.60							
Compact to very loose, brown **SILTY SAND,** some clay		SS	2	100	12	1	93.02
		SS	3	100	2		
1.83							
Loose, grey **SANDY SILT** with clay						2	92.02
2.44							
Soft to firm, grey **SILTY CLAY**						3	91.02
						4	90.02
- stiff by 5.0m depth						5	89.02
		SS	4	100	24		
6.10						6	88.02
End of Borehole							
(GWL @ 2.0m depth based on field observations)							





LEGEND:

- BOREHOLE LOCATION
- 93.77 GROUND SURFACE ELEVATION (m)

TBM - EXISTING GROUND SURFACE AT EAST PROPERTY BOUNDARY. GEODETIC ELEV. = 94.02m.

SCALE: 1:2000

0 25 50 75 100 125 150m

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7Z9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
1.	UPDATED TO NEW BASE PLAN	28/07/2022	YZ

OTTAWA SOUTH UNITED

GEOTECHNICAL INVESTIGATION
PROPOSED TURF FIELD, SOCCER DOME AND FIELD HOUSE
5650 MITCH OWENS DRIVE
OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:2000	Date: 07/2015
Drawn by: MPG	Report No.: PG3545-1
Checked by: NP	Drawing No.: PG3545-1
Approved by: FA	Revision No.: 1

p:\autocad drawings\geotechnical\pg35xx\pg3545\150605_osu_base plan.dwg

APPENDIX

B MECP WATER WELL RECORDS

Ontario Ministry of the Environment

Well Tag No A 059485 ow)
A059465

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

[redacted]

Address of Well Location (Street Number/Name, RR)	Township	Lot	Concession
#5765 Longhearth Way	Osgoode	PL 1	2

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa-Carleton	Greely	Ontario	

UTM Coordinates NAD 8 3	Zone	Easting	Northing	GPS Unit Make	Model	Mode of Operation
	18	449587	5041 6	Magellan	200	☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Overburden and Bedrock Materials *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (Metres) From	To
	Sand Boulders Gravel			0	8.53
	Grey limestone			8.53	21.33
	Grey sandstone			21.33	36.57

* Plan 4M-1254 S/L 2 *

Annular Space/Abandonment Sealing Record

Depth Set at (Metres) From	To	Type of Sealant Used (Material and Type)	Volume Placed (Cubic Metres)
10.36	7.31	Neat cement slurry	.2724
7.31	0	Bentonite slurry	.490

Method of Construction

☐ Cable Tool ☐ Diamond
☐ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Rotary (Air) ☐ Digging
☒ Air percussion ☐ Boring
☐ Other, *specify* ____

Water Use

☐ Public ☐ Commercial ☐ Not used
☒ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☐ Test Hole ☐ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, *specify* ____

Status of Well

☒ Water Supply ☐ Dewatering Well ☐ Observation and/or Monitoring Hole
☐ Replacement Well ☐ Abandoned, Insufficient Supply ☐ Alteration (Construction)
☐ Test Hole ☐ Abandoned, Poor Water Quality ☐ Other, *specify* ____
☐ Recharge Well ☐ Abandoned, other, *specify* ____

Results of Well Yield Testing

Check box if after test of well yield, water was:
☐ Clear and sand free ☐ Cannot develop to sand-free state

If pumping discontinued, give reason: ____

Pumping test method: Submp

Pump intake set at *(Metres)*: 30.47

Pumping rate *(Litres/min)*: 91.00

Duration of pumping: 1 hrs + 0 min

Final water level end of pumping *(Metres)*: 28.1

Recommended pump type: ☐ Shallow ☒ Deep

Recommended pump depth: 30.47 Metres

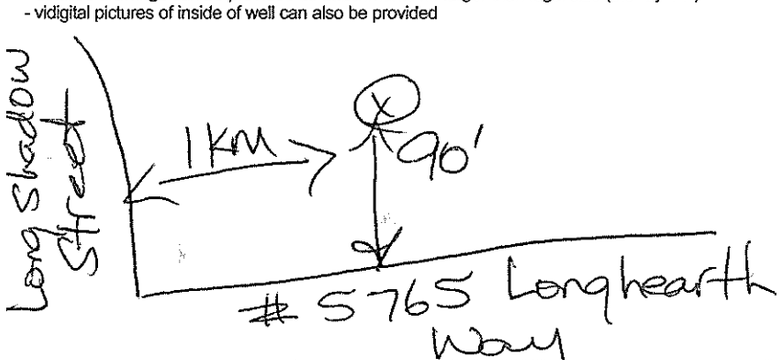
Recommended pump rate *(Litres/min)*: 91.00

If flowing give rate *(Litres/min)*: ____

Draw Down Time (Min)	Water Level (Metres)	Recovery Time (Min)	Water Level (Metres)
Static Level	6.30	Static Level	28.1
1	9.64	1	21.0
2	10.78	2	15.20
3	12.40	3	10.13
4	13.59	4	8.90
5	14.68	5	6.60
10	18.25	10	6.30
15	20.90	15	
20	23.40	20	
25	24.35	25	
30	25.55	30	
40	27.18	40	
50	27.64	50	
60	28.1	60	

Location of Well

Please provide a map below showing:
- all property boundaries, and measurements sufficient to locate the well in relation to fixed points,
- an arrow indicating the North direction
- detailed drawings can be provided as attachments no larger than legal size (8.5" by 14")
- vidigital pictures of inside of well can also be provided



Water Details

Water found at Depth	Kind of Water
32 91 Metres ☐ Gas	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals
Metres ☐ Gas	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals
Metres ☐ Gas	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals

Not tested

Date Well Completed (yyyy/mm/dd)	Was the well owner's information package delivered?	Date the Well Record and Package Delivered to Well Owner (yyyy/mm/dd)
2007-10-25	☒ Yes ☐ No	2007-10-30

Casing Used

☐ Galvanized
☒ Steel
☐ Fibreglass
☐ Plastic
☐ Concrete

Screen Used

☐ Galvanized
☐ Steel
☐ Fibreglass
☐ Plastic
☐ Concrete

Casing and Well Details

Diameter of the Hole *(Centimetres)*: 15.55

Depth of the Hole *(Metres)*: 36.57

Wall Thickness *(Metres)*: .48 cm

Inside Diameter of the Casing *(Metres)*: .1588

Depth of the Casing *(Metres)*: 10.97

No Casing and Screen Used

☒ Open Hole 10.36 36.57

Disinfected? ☒ Yes ☐ No

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Air Rock Drilling Co LTD	1119

Business Address (Street No./Name, number, RR)	Municipality
RR#1	Richmond

Province	Postal Code	Business E-mail Address
Ont	K0A2Z0	

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6138382170	Desaulniers, Ken

Well Technician's Licence No.	Signature of Technician	Date Submitted (yyyy/mm/dd)
14		2007-12-03

Ministry Use Only

Audit No.	Well Contractor No.
z69705	
Date Received (yyyy/mm/dd) DEC 14 2007	**Date of Inspection (yyyy/mm/dd)**
Remarks	

Ontario

Ministry of the Environment and Climate Change

Measurements recorded in: [X] Metric [ ] Imperial

Well Tag No. *(Place Sticker and/or Print Below)*

A199999

Tag#: A199999

Well Record

Regulation 903 Ontario Water Resources Act

Page _____ of _____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	[ ] Well Constructed by Well Owner
	Ottawa South United		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
1128 Clapp Lane	Manotick	Ontario	K4M 1A4	613 266 1224

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5650 Mitch Owens Road	Osgoode		

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa Carleton	Manotick	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	448902	5010081		

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brown	Sandy Soil			0	1.82
Grey	Clay		Loose	1.82	7.31
Grey	Till	Large Boulders		7.31	14.93
Grey	Limestone		Hard	14.93	35.05
Grey & White	Sandstone		Hard	35.05	53.33

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
16.45	0	Grouted Bentonite Slurry	.49m^3

Method of Construction

[ ] Cable Tool [ ] Diamond
[X] Rotary (Conventional) Mud [ ] Jetting
[ ] Rotary (Reverse) [ ] Driving
[ ] Boring [ ] Digging
[X] Air percussion
[ ] Other, *specify* _____

Well Use

[ ] Public [ ] Commercial [ ] Not used
[ ] Domestic [ ] Municipal [ ] Dewatering
[ ] Livestock [ ] Test Hole [ ] Monitoring
[X] Irrigation [ ] Cooling & Air Conditioning
[ ] Industrial
[ ] Other, *specify* _____

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
27.13	Open		0	16.45
15.86	Steel	.48	+.45	16.45

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To

Status of Well

[X] Water Supply
[ ] Replacement Well
[ ] Test Hole
[ ] Recharge Well
[ ] Dewatering Well
[ ] Observation and/or Monitoring Hole
[ ] Alteration (Construction)
[ ] Abandoned, Insufficient Supply
[ ] Abandoned, Poor Water Quality
[ ] Abandoned, other, *specify*
[ ] Other, *specify*

Water Details

Water found at Depth	Kind of Water	
41.14 (m/ft) [ ] Gas	[ ] Fresh [X] Untested [ ] Other, *specify*	
50.28 (m/ft) [ ] Gas	[ ] Fresh [X] Untested [ ] Other, *specify*	
(m/ft) [ ] Gas	[ ] Fresh [ ] Untested [ ] Other, *specify*	

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	16.45	15.86
16.45	53.33	15.55

Results of Well Yield Testing

After test of well yield, water was:
[X] Clear and sand free
[ ] Other, *specify* _____

If pumping discontinued, give reason:

Pump intake set at (m/ft): 30.47

Pumping rate (l/min / GPM): 54.6

Duration of pumping: 1 hrs + _____ min

Final water level end of pumping (m/ft): 4.76

If flowing give rate (l/min / GPM): 45.5

Recommended pump depth (m/ft): 30.47

Recommended pump rate (l/min / GPM): 45.5

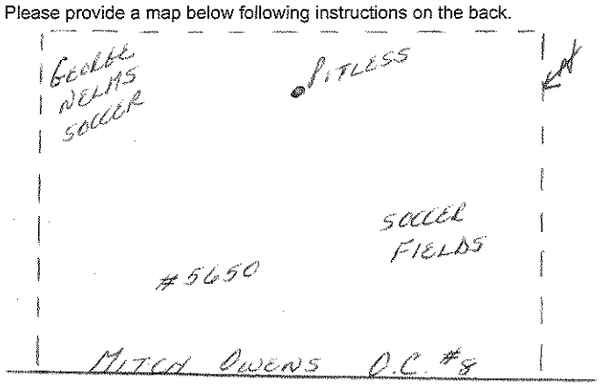
Well production (l/min / GPM):

Disinfected? [X] Yes [ ] No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level	+0		
1	.27	1	3.91
2	.54	2	3.02
3	.82	3	2.49
4	1.09	4	1.97
5	1.35	5	1.23
10	1.95	10	.76
15	2.45	15	.21
20	3.00	20	.03
25	3.54	25	+0
30	4.02	30	+0
40	4.76	40	
50	4.76	50	
60	4.76	60	

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Capital Water Supply Ltd.	1558

Business Address (Street Number/Name)	Municipality
Box 490	Stittsville

Province	Postal Code	Business E-mail Address
Ontario	K2S1A6	office@capitalwater.ca

Bus. Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
6138361766	Miller, Stephen

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
0097		2017 10 16

Well owner's information package delivered	Date Package Delivered	Date Work Completed
[X] Yes [ ] No	2017 10 12	2017 10 01

Ministry Use Only

Audit No. Z256772

Received MAR 12 2018

0506E (2014/11)

Ministry's Copy

APPENDIX

C LABORATORY CERTIFICATES OF ANALYSES

Certificate of Analysis

Client: WSP (Ottawa)
2611 Queensview Drive
Ottawa, ON
K2B 8K2
Attention: Mr. Robert Passmore
PO#:
Invoice to: WSP Canada Inc.

Report Number: 1990867
Date Submitted: 2022-12-01
Date Reported: 2022-12-08
Project: 211-13935-00
COC #: 219741

Dear Robert Passmore:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL: _____
Emma-Dawn Ferguson, Chemist

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: https://directory.cala.ca/.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is licensed by the Ontario Ministry of the Environment, Conservation, and Parks (MECP) for specific tests in drinking water (license #2318). A copy of the license is available upon request.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Certificate of Analysis

eurofins | Environment Testing

Client: WSP (Ottawa)
2611 Queensview Drive
Ottawa, ON
K2B 8K2
Attention: Mr. Robert Passmore
PO#:
Invoice to: WSP Canada Inc.

Report Number: 1990867
Date Submitted: 2022-12-01
Date Reported: 2022-12-08
Project: 211-13935-00
COC #: 219741

				Lab I.D.	1666217
				Sample Matrix	Water
				Sample Type	
				Sampling Date	2022-12-01
				Sample I.D.	221201LW
Group	**Analyte**	**MRL**	**Units**	**Guideline**	
Anions	Cl	1	mg/L	AO 250	91
	F	0.10	mg/L	MAC 1.5	0.19
	N-NO2	0.10	mg/L	MAC 1.0	<0.10
	N-NO3	0.10	mg/L	MAC 10.0	<0.10
	SO4	1	mg/L	AO 500	58
General Chemistry	Alkalinity as CaCO3	5	mg/L	OG 30-500	255
	Colour (Apparent)	2	TCU	AO 5	13*
	Conductivity	5	uS/cm		823
	DOC	0.5	mg/L	AO 5	1.9
	pH	1.00		6.5-8.5	7.41
	Phenols	0.001	mg/L		<0.001
	S2-	0.01	mg/L	AO 0.05	<0.01
	TDS (COND - CALC)	1	mg/L	AO 500	535*
	Turbidity	0.1	NTU	AO 5	1.7
Hardness	Hardness as CaCO3	1	mg/L	OG 80-100	351*
Indices/Calc	Ion Balance	0.01			1.04
Metals	Al	0.01	mg/L	OG 0.1	<0.01
	As	0.001	mg/L	IMAC 0.01	<0.001
	B	0.01	mg/L	IMAC 5.0	0.09
	Ba	0.01	mg/L	MAC 1.0	0.16
	Ca	1	mg/L		81
	Cd	0.0001	mg/L	MAC 0.005	<0.0001
	Cr	0.001	mg/L	MAC 0.05	<0.001
	Cu	0.001	mg/L	AO 1	<0.001
	Fe	0.03	mg/L	AO 0.3	0.20

Guideline = ODWSOG *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

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COC #: 219741

				Lab I.D.	1666217
				Sample Matrix	Water
				Sample Type	
				Sampling Date	2022-12-01
				Sample I.D.	221201LW
Group	**Analyte**	**MRL**	**Units**	**Guideline**	
Metals	Hg	0.0001	mg/L	MAC 0.001	<0.0001
	K	1	mg/L		4
	Mg	1	mg/L		36
	Mn	0.01	mg/L	AO 0.05	0.05
	Na	1	mg/L	AO 200	48
	Pb	0.001	mg/L	MAC 0.010	<0.001
	Sb	0.0005	mg/L	IMAC 0.006	<0.0005
	Se	0.001	mg/L	MAC 0.05	<0.001
	Sr	0.001	mg/L		1.38
	U	0.001	mg/L	MAC 0.02	0.001
	Zn	0.01	mg/L	AO 5	<0.01
Microbiology	Escherichia Coli	0	ct/100mL	MAC 0	0
	Total Coliforms	0	ct/100mL	MAC 0	0
Nutrients	N-NH3	0.020	mg/L		0.084
	Total Kjeldahl Nitrogen	0.100	mg/L		0.116
Subcontract	Tannin & Lignin	0.1	mg/L		0.8

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Report Number: 1990867
Date Submitted: 2022-12-01
Date Reported: 2022-12-08
Project: 211-13935-00
COC #: 219741

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 434334 **Analysis/Extraction Date** 2022-12-02 **Analyst** DRA **Method** AMBCOLM1			
Escherichia Coli			
Total Coliforms			
Run No 434359 **Analysis/Extraction Date** 2022-12-02 **Analyst** ACG **Method** C SM4500-S2-D			
S2-	<0.01 mg/L	98	80-120
Run No 434386 **Analysis/Extraction Date** 2022-12-02 **Analyst** ACG **Method** C SM2130B			
Turbidity	<0.1 NTU	100	70-130
Run No 434465 **Analysis/Extraction Date** 2022-12-02 **Analyst** ACG **Method** SM2320,2510,4500H/F			
Alkalinity (CaCO3)	<5 mg/L	98	90-110
Conductivity	<5 uS/cm	101	90-110
F	<0.10 mg/L	103	90-110
pH		99	90-110
Run No 434566 **Analysis/Extraction Date** 2022-12-06 **Analyst** ACG **Method** C SM5310C			
DOC	<0.5 mg/L	87	84-116

Guideline = ODWSOG *** = Guideline Exceedence**

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MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

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Attention: Mr. Robert Passmore
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Report Number: 1990867
Date Submitted: 2022-12-01
Date Reported: 2022-12-08
Project: 211-13935-00
COC #: 219741

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 434614 **Analysis/Extraction Date** 2022-12-07 **Analyst** AaN **Method** SM 4110			
Chloride	<1 mg/L	100	90-110
N-NO2	<0.10 mg/L	107	90-110
N-NO3	<0.10 mg/L	102	90-110
SO4	<1 mg/L	100	90-110
Run No 434634 **Analysis/Extraction Date** 2022-12-06 **Analyst** SD **Method** EPA 200.8			
Aluminum	<0.01 mg/L	112	80-120
Arsenic	<0.001 mg/L	86	80-120
Boron (total)	<0.01 mg/L	111	80-120
Barium	<0.01 mg/L	87	80-120
Cadmium	<0.0001 mg/L	97	80-120
Chromium Total	<0.001 mg/L	99	80-120
Copper	<0.001 mg/L	98	80-120
Iron	<0.03 mg/L	108	80-120
Mercury	<0.0001 mg/L	118	80-120
Manganese	<0.01 mg/L	105	80-120

Guideline = ODWSOG *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Certificate of Analysis

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2611 Queensview Drive
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K2B 8K2
Attention: Mr. Robert Passmore
PO#:
Invoice to: WSP Canada Inc.

Report Number: 1990867
Date Submitted: 2022-12-01
Date Reported: 2022-12-08
Project: 211-13935-00
COC #: 219741

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Lead	<0.001 mg/L	99	80-120
Antimony	<0.0005 mg/L	84	80-120
Selenium	<0.001 mg/L	95	80-120
Strontium	<0.001 mg/L	94	80-120
Uranium	<0.001 mg/L	93	80-120
Zinc	<0.01 mg/L	96	80-120
Run No 434644 **Analysis/Extraction Date** 2022-12-06 **Analyst** SKH **Method** EPA 351.2			
Total Kjeldahl Nitrogen	<0.100 mg/L	115	70-130
Run No 434657 **Analysis/Extraction Date** 2022-12-07 **Analyst** ACG **Method** C SM2120C			
Colour (Apparent)	<2 TCU	95	90-110
Run No 434683 **Analysis/Extraction Date** 2022-12-06 **Analyst** AET **Method** SUBCONTRACT-A			
Tannin & Lignin	<0.10 mg/L	95	
Run No 434693 **Analysis/Extraction Date** 2022-12-07 **Analyst** ML **Method** EPA 350.1			
N-NH3	<0.020 mg/L	101	80-120

Guideline = ODWSOG *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

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Ottawa, ON
K2B 8K2
Attention: Mr. Robert Passmore
PO#:
Invoice to: WSP Canada Inc.

Report Number: 1990867
Date Submitted: 2022-12-01
Date Reported: 2022-12-08
Project: 211-13935-00
COC #: 219741

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 434700 **Analysis/Extraction Date** 2022-12-07 **Analyst** IP **Method** SM5530D/EPA420.2			
Phenols	<0.001 mg/L	109	50-120
Run No 434701 **Analysis/Extraction Date** 2022-12-07 **Analyst** Z S **Method** M SM3120B-3500C			
Calcium	<1 mg/L	101	90-110
Potassium	<1 mg/L	105	87-113
Magnesium	<1 mg/L	100	76-124
Sodium	<1 mg/L	103	82-118
Run No 434706 **Analysis/Extraction Date** 2022-12-07 **Analyst** AET **Method** C SM2340B			
Hardness as CaCO3			
Ion Balance			
TDS (COND - CALC)			

Guideline = ODWSOG *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Certificate of Analysis

Client: WSP (Ottawa)
2611 Queensview Drive
Ottawa, ON
K2B 8K2
Attention: Mr. Robert Passmore
PO#:
Invoice to: WSP Canada Inc.

Report Number: 1990549
Date Submitted: 2022-11-25
Date Reported: 2022-12-05
Project: 211-13935-00
COC #: 219755

Dear Robert Passmore:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL: _____
Emma-Dawn Ferguson, Chemist

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: https://directory.cala.ca/.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is licensed by the Ontario Ministry of the Environment, Conservation, and Parks (MECP) for specific tests in drinking water (license #2318). A copy of the license is available upon request.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Certificate of Analysis

eurofins | Environment Testing

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Report Number: 1990549
Date Submitted: 2022-11-25
Date Reported: 2022-12-05
Project: 211-13935-00
COC #: 219755

				Lab I.D.	1664952
				Sample Matrix	Water
				Sample Type	
				Sampling Date	2022-11-24
				Sample I.D.	WS - 5765 LW
Group	**Analyte**	**MRL**	**Units**	**Guideline**	
Anions	Cl	1	mg/L	AO 250	160
	F	0.10	mg/L	MAC 1.5	<0.10
	N-NO2	0.10	mg/L	MAC 1.0	<0.10
	N-NO3	0.10	mg/L	MAC 10.0	<0.10
	SO4	1	mg/L	AO 500	140
General Chemistry	Alkalinity as CaCO3	5	mg/L	OG 30-500	368
	Colour (Apparent)	2	TCU	AO 5	42*
	Conductivity	5	uS/cm		1280
	DOC	0.5	mg/L	AO 5	4.0
	pH	1.00		6.5-8.5	7.42
	Phenols	0.001	mg/L		<0.001
	S2-	0.01	mg/L	AO 0.05	<0.01
	TDS (COND - CALC)	1	mg/L	AO 500	832*
	Turbidity	0.1	NTU	AO 5	10.0*
Hardness	Hardness as CaCO3	1	mg/L	OG 80-100	568*
Indices/Calc	Ion Balance	0.01			0.99
Metals	Al	0.01	mg/L	OG 0.1	<0.01
	As	0.001	mg/L	IMAC 0.01	0.001
	B	0.01	mg/L	IMAC 5.0	0.07
	Ba	0.01	mg/L	MAC 1.0	0.12
	Ca	1	mg/L		135
	Cd	0.0001	mg/L	MAC 0.005	<0.0001
	Cr	0.001	mg/L	MAC 0.05	<0.001
	Cu	0.001	mg/L	AO 1	<0.001
	Fe	0.03	mg/L	AO 0.3	1.08*

Guideline = ODWSOG *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
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MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

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Date Reported: 2022-12-05
Project: 211-13935-00
COC #: 219755

Group	Analyte	MRL	Units	Guideline	Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D. 1664952 Water 2022-11-24 WS - 5765 LW
Metals	Hg	0.0001	mg/L	MAC 0.001	<0.0001
	K	1	mg/L		4
	Mg	1	mg/L		56
	Mn	0.01	mg/L	AO 0.05	0.05
	Na	1	mg/L	AO 200	72
	Pb	0.001	mg/L	MAC 0.010	<0.001
	Sb	0.0005	mg/L	IMAC 0.006	<0.0005
	Se	0.001	mg/L	MAC 0.05	<0.001
	Sr	0.001	mg/L		0.963
	U	0.001	mg/L	MAC 0.02	0.004
	Zn	0.01	mg/L	AO 5	0.02
Microbiology	Escherichia Coli	0	ct/100mL	MAC 0	0
	Total Coliforms	0	ct/100mL	MAC 0	0
Nutrients	N-NH3	0.020	mg/L		0.092
	Total Kjeldahl Nitrogen	0.100	mg/L		0.304
Subcontract	Tannin & Lignin	0.1	mg/L		1.1

Guideline = ODWSOG *** = Guideline Exceedence**

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QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 433924 **Analysis/Extraction Date** 2022-11-26 **Analyst** DRA **Method** AMBCOLM1			
Escherichia Coli			
Total Coliforms			
Run No 433950 **Analysis/Extraction Date** 2022-11-26 **Analyst** CK **Method** C SM2130B			
Turbidity	<0.1 NTU	101	70-130
Run No 433968 **Analysis/Extraction Date** 2022-11-28 **Analyst** ACG **Method** C SM2120C			
Colour (Apparent)	<2 TCU	105	90-110
Run No 434011 **Analysis/Extraction Date** 2022-11-28 **Analyst** SD **Method** EPA 200.8			
Aluminum	<0.01 mg/L	107	80-120
Arsenic	<0.001 mg/L	90	80-120
Boron (total)	<0.01 mg/L	99	80-120
Barium	<0.01 mg/L	91	80-120
Cadmium	<0.0001 mg/L	95	80-120
Chromium Total	<0.001 mg/L	97	80-120
Copper	<0.001 mg/L	96	80-120

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QC Summary

Analyte	Blank	QC % Rec	QC Limits
Iron	<0.03 mg/L	104	80-120
Mercury	<0.0001 mg/L	111	80-120
Manganese	<0.01 mg/L	107	80-120
Lead	<0.001 mg/L	99	80-120
Antimony	<0.0005 mg/L	87	80-120
Selenium	<0.001 mg/L	96	80-120
Strontium	<0.001 mg/L	91	80-120
Uranium	<0.001 mg/L	93	80-120
Zinc	<0.01 mg/L	96	80-120
Run No 434152 **Analysis/Extraction Date** 2022-11-29 **Analyst** ML **Method** EPA 350.1			
N-NH3	<0.020 mg/L	90	80-120
Run No 434154 **Analysis/Extraction Date** 2022-11-29 **Analyst** ACG **Method** SM2320,2510,4500H/F			
Alkalinity (CaCO3)	<5 mg/L	98	90-110
Conductivity	<5 uS/cm	101	90-110
F	<0.10 mg/L	100	90-110
pH		99	90-110

Guideline = ODWSOG *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

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Report Number: 1990549
Date Submitted: 2022-11-25
Date Reported: 2022-12-05
Project: 211-13935-00
COC #: 219755

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 434254 **Analysis/Extraction Date** 2022-11-30 **Analyst** SKH **Method** EPA 351.2			
Total Kjeldahl Nitrogen	<0.100 mg/L	113	70-130
Run No 434257 **Analysis/Extraction Date** 2022-11-30 **Analyst** AaN **Method** SM 4110			
N-NO2	<0.10 mg/L	107	90-110
N-NO3	<0.10 mg/L	103	90-110
Run No 434269 **Analysis/Extraction Date** 2022-12-01 **Analyst** AaN **Method** SM 4110			
Chloride	<5 mg/L		90-110
SO4	<5 mg/L	105	90-110
Run No 434278 **Analysis/Extraction Date** 2022-12-01 **Analyst** Z S **Method** M SM3120B-3500C			
Calcium	<1 mg/L	100	90-110
Potassium	<1 mg/L	100	87-113
Magnesium	<1 mg/L	97	76-124
Sodium	<1 mg/L	100	82-118
Run No 434287 **Analysis/Extraction Date** 2022-12-01 **Analyst** ACG **Method** C SM5310C			

Guideline = ODWSOG *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

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Report Number: 1990549
Date Submitted: 2022-11-25
Date Reported: 2022-12-05
Project: 211-13935-00
COC #: 219755

QC Summary

Analyte	Blank	QC % Rec	QC Limits
DOC	<0.5 mg/L	85	84-116
Run No 434359 **Analysis/Extraction Date** 2022-12-02 **Analyst** ACG **Method** C SM4500-S2-D			
S2-	<0.01 mg/L	98	80-120
Run No 434360 **Analysis/Extraction Date** 2022-12-02 **Analyst** SKH **Method** C SM2340B			
Hardness as CaCO3			
Ion Balance			
TDS (COND - CALC)			
Run No 434388 **Analysis/Extraction Date** 2022-12-02 **Analyst** IP **Method** SM5530D/EPA420.2			
Phenols	<0.001 mg/L	107	50-120
Run No 434466 **Analysis/Extraction Date** 2022-12-01 **Analyst** AET **Method** SUBCONTRACT-A			
Tannin & Lignin	<0.10 mg/L	94	

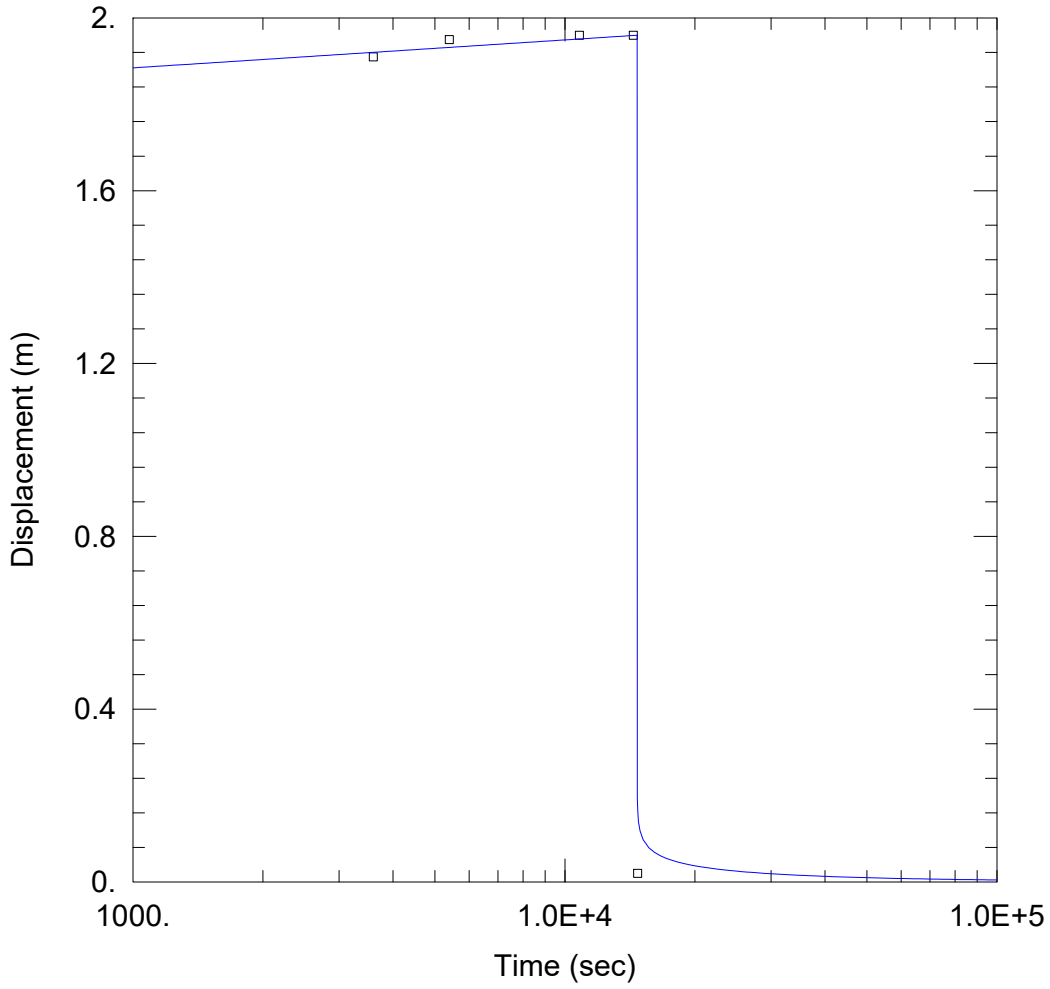
Guideline = ODWSOG *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

APPENDIX

D PUMPING TEST DATA FOR TEST WELL



WELL TEST ANALYSIS

Data Set: C:\Users\CCooke\OneDrive - WSP O365\Desktop\OSU\OSU pumping test.aqt
Date: 05/18/23 Time: 09:25:25

PROJECT INFORMATION

Company: WSP
Client: OSU
Project: 211-13935-00
Test Date: 2022-12-01

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Supply Well	0	0

Observation Wells

Well Name	X (m)	Y (m)
▫ Supply Well	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 826.8 m^2/day
S = 2.908E-24
Kz/Kr = 1.
b = 55. m

APPENDIX

E LANGELIER SATURATION INDEX CALCULATIONS

Langelier Saturation Index Calculator

This calculator helps you determine the scaling potential of the water by using the Langelier Saturation Index.

Give the values of your water analysis. All the fields with * are required.

Table 1: Input table

pH	7.41	*	
Conductivity / TDS	535	*	mg/L
$[Ca^{2+}]$	81	*	mg/L
$[HCO3^-]$	255	*	mg/L
Water temperature	8	*	degree C

Calculate the Langlier Saturation Index

Erase input values

If you do not have a water analysis you can use the values in table 2. Click on a button at the bottom of table 2

Table 2 : Additional data

pH =	7.7	8	8.6	
TDS =	20	34483	273	mg/l
$[Ca^{2+}]$ =	5	400	49	mg/l
$[HCO_3^-]$ =	10	140	121	mg/l
T =	20	20	20	degree C
	Example	Seawater	Tap water	

Table 3: Results Langelier Saturation Index

pH_s	7.7
LSI	-0.31
Indication based on Langelier (1936)	Water is undersaturated with respect to calcium carbonate. Undersaturated water has a tendency to remove existing calcium carbonate protective coatings in pipelines and equipment.
Indication based on improved Langelier by Carrier (1965)	Slightly corrosive but non-scale forming.

The Langelier Saturation Index formula is

$$LSI = pH - pH_s$$

For an explanation of the formula click here.

The indications for the LSI and the improved LSI by Carrier are based on the following values:

LSI	Indication
LSI<0	Water is undersaturated with respect to calcium carbonate. Undersaturated water has a tendency to remove existing calcium carbonate protective coatings in pipelines and equipment.
LSI=0	Water is considered to be neutral. Neither scale-forming nor scale removing.
LSI>0	Water is supersaturated with respect to calcium carbonate ($CaCO_3$) and scale forming may occur.

LSI (Carrier)	Indication
-2,0<-0,5	Serious corrosion
-0,5<0	Slightly corrosion but non-scale forming
LSI = 0,0	Balanced but pitting corrosion possible
0,0<0,5	Sligthly scale forming and corrosive
0,5<2	Scale forming but non corrosive

References:
[1] : Kevin Rafferty, Scaling in geothermal heat pump systems, U.S. Department of Energy (july 1999)
[2] : Metcalf and Eddy, Wastewater Engineering Treatment and Reuse 2003

Explanation of the Langelier Saturation formula.

Other calculators

Warning: Lenntech BV cannot be held responsible for errors in the calculation, the program itself or the explanation. For questions or remarks please contact us.

More from 'Calculators'

< to top

Langelier Saturation Index Calculator

This calculator helps you determine the scaling potential of the water by using the Langelier Saturation Index.

Give the values of your water analysis. All the fields with * are required.

Table 1: Input table

pH	7.41	*	
Conductivity / TDS	535	*	mg/L
$[Ca^{2+}]$	81	*	mg/L
$[HCO3^-]$	255	*	mg/L
Water temperature	21	*	degree C

Calculate the Langlier Saturation Index

Erase input values

If you do not have a water analysis you can use the values in table 2. Click on a button at the bottom of table 2

Table 2 : Additional data

pH =	7.7	8	8.6	
TDS =	20	34483	273	mg/l
$[Ca^{2+}]$ =	5	400	49	mg/l
$[HCO_3^-]$ =	10	140	121	mg/l
T =	20	20	20	degree C
	Example	Seawater	Tap water	

Table 3: Results Langelier Saturation Index

pH_s	7.4
LSI	-0.011
Indication based on Langelier (1936)	Water is undersaturated with respect to calcium carbonate. Undersaturated water has a tendency to remove existing calcium carbonate protective coatings in pipelines and equipment.
Indication based on improved Langelier by Carrier (1965)	Slightly corrosive but non-scale forming.

The Langelier Saturation Index formula is

$$LSI = pH - pH_s$$

For an explanation of the formula click here.

The indications for the LSI and the improved LSI by Carrier are based on the following values:

LSI	Indication
LSI<0	Water is undersaturated with respect to calcium carbonate. Undersaturated water has a tendency to remove existing calcium carbonate protective coatings in pipelines and equipment.
LSI=0	Water is considered to be neutral. Neither scale-forming nor scale removing.
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Langelier Saturation Index Calculator

This calculator helps you determine the scaling potential of the water by using the Langelier Saturation Index.

Give the values of your water analysis. All the fields with * are required.

Table 1: Input table

pH	7.41	*	
Conductivity / TDS	535	*	mg/L
$[Ca^{2+}]$	81	*	mg/L
$[HCO3^-]$	255	*	mg/L
Water temperature	22	*	degree C

Calculate the Langlier Saturation Index

Erase input values

If you do not have a water analysis you can use the values in table 2. Click on a button at the bottom of table 2

Table 2 : Additional data

pH =	7.7	8	8.6	
TDS =	20	34483	273	mg/l
$[Ca^{2+}]$ =	5	400	49	mg/l
$[HCO_3^-]$ =	10	140	121	mg/l
T =	20	20	20	degree C
	Example	Seawater	Tap water	

Table 3: Results Langelier Saturation Index

pH_s	7.4
LSI	0.011
Indication based on Langelier (1936)	Water is supersaturated with respect to calcium carbonate (CaCO3) and scale forming may occur.
Indication based on improved Langelier by Carrier (1965)	Slightly scale forming and corrosive.

The Langelier Saturation Index formula is

$$LSI = pH - pH_s$$

For an explanation of the formula click here.

The indications for the LSI and the improved LSI by Carrier are based on the following values:

LSI	Indication
LSI<0	Water is undersaturated with respect to calcium carbonate. Undersaturated water has a tendency to remove existing calcium carbonate protective coatings in pipelines and equipment.
LSI=0	Water is considered to be neutral. Neither scale-forming nor scale removing.
LSI>0	Water is supersaturated with respect to calcium carbonate ($CaCO_3$) and scale forming may occur.

LSI (Carrier)	Indication
-2,0<-0,5	Serious corrosion
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Explanation of the Langelier Saturation formula.

Other calculators

More from 'Calculators'

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Langelier Saturation Index Calculator

This calculator helps you determine the scaling potential of the water by using the Langelier Saturation Index.

Give the values of your water analysis. All the fields with * are required.

Table 1: Input table

pH	7.41	*	
Conductivity / TDS	535	*	mg/L
$[Ca^{2+}]$	81	*	mg/L
$[HCO3^-]$	255	*	mg/L
Water temperature	56	*	degree C

Calculate the Langlier Saturation Index

Erase input values

If you do not have a water analysis you can use the values in table 2. Click on a button at the bottom of table 2

Table 2 : Additional data

pH =	7.7	8	8.6	
TDS =	20	34483	273	mg/l
$[Ca^{2+}]$ =	5	400	49	mg/l
$[HCO_3^-]$ =	10	140	121	mg/l
T =	20	20	20	degree C
	Example	Seawater	Tap water	

Table 3: Results Langelier Saturation Index

pH_s	6.8
LSI	0.65
Indication based on Langelier (1936)	Water is supersaturated with respect to calcium carbonate (CaCO3) and scale forming may occur.
Indication based on improved Langelier by Carrier (1965)	Scale forming but non corrosive.

The Langelier Saturation Index formula is

$$LSI = pH - pH_s$$

For an explanation of the formula click here.

The indications for the LSI and the improved LSI by Carrier are based on the following values:

LSI	Indication
LSI<0	Water is undersaturated with respect to calcium carbonate. Undersaturated water has a tendency to remove existing calcium carbonate protective coatings in pipelines and equipment.
LSI=0	Water is considered to be neutral. Neither scale-forming nor scale removing.
LSI>0	Water is supersaturated with respect to calcium carbonate ($CaCO_3$) and scale forming may occur.

LSI (Carrier)	Indication
-2,0<-0,5	Serious corrosion
-0,5<0	Slightly corrosion but non-scale forming
LSI = 0,0	Balanced but pitting corrosion possible
0,0<0,5	Sligthly scale forming and corrosive
0,5<2	Scale forming but non corrosive

References:
[1] : Kevin Rafferty, Scaling in geothermal heat pump systems, U.S. Department of Energy (july 1999)
[2] : Metcalf and Eddy, Wastewater Engineering Treatment and Reuse 2003

Explanation of the Langelier Saturation formula.

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More from 'Calculators'

< to top

APPENDIX

F

CLIMATIC WATER BUDGET CALCULATIONS

TABLE E-1
CLIMATIC WATER BUDGET: CLIMATE NORMAL 1981-2010 (OTTAWA MACDONALD-CARTIER INT'L A)
Ontario Soccer United
Preliminary Nitrate Impact Assessment

	Thornthwaite (1948)							
Month	**Mean Temperature (°C)**	**Heat Index**	**Potential Evapo-transpiration (mm)**	**Daylight Correction Value**	**Adjusted Potential Evapo-transpiration (mm)**	**Total Precipitation (mm)**	**Surplus (mm)**	**Deficit (mm)**
January	-10.3	0.0	0.0	0.7742	0.00	65.4	65.4	0.0
February	-8.1	0.0	0.0	0.8679	0.00	54.3	54.3	0.0
March	-2.3	0.0	0.0	0.9871	0.00	64.4	64.4	0.0
April	6.3	1.4	28.5	1.1300	32.23	74.5	42.3	0.0
May	13.3	4.4	64.0	1.2387	79.30	80.3	1.0	0.0
June	18.5	7.2	91.5	1.2900	118.04	92.8	0.0	25.2
July	21	8.8	105.0	1.2677	133.06	91.9	0.0	41.2
August	19.8	8.0	98.5	1.1710	115.32	85.5	0.0	29.8
September	15	5.3	72.9	1.0400	75.84	90.1	14.3	0.0
October	8	2.0	36.9	0.9097	33.60	86.1	52.5	0.0
November	1.5	0.2	6.0	0.7900	4.77	81.9	77.1	0.0
December	-6.2	0.0	0.0	0.7258	0.00	76.4	76.4	0.0
TOTALS		**37.4**			**592.1**	**943.6**	**447.7**	**96.2**

TOTAL WATER SURPLUS **351.5** **mm**

NOTES:

1) Water budget adjusted for latitude and daylight.

2) (°C) - Represents calculated mean of daily temperatures for the month.

3) Precipitation and Temperature data from the OTTAWA MACDONALD-CARTIER INT'L A Climate Station located at latitude 45°19'21.000" N, longitude 75°40'09.000" W, elevation 114.0 m.

4) Total Water Surplus (Thornthwaite, 1948) is calculated as total precipitation minus adjusted potential evapotranspiration.

5) Total Moisture Surplus (Thornthwaite and Mather, 1957) is calculated as total precipitation minus actual evapotranspiration.

APPENDIX

G NITRATE IMPACT ASSESSMENT

Nitrate Impact Assessment

Project: Ottawa Soccer United Clubhouse
File: 211-13935-00
Condition: TDDSF of 4,800 L/day

Groundwater Flow Calculation

Background Nitrate Concentration (C_b) =	0	mg/L
Hydraulic Conductivity (k) =	0	m/s
Horizontal Gradient (i) =	0	
Length (L) =	0	m
Aquifer Thickness (t) =	0	m
Groundwater Flow (Q_b) =	0	m3/day

Infiltration Calculation

Nitrate Concentration in Precipitation (C_i) =	0	mg/L
Surplus Water (Environment Canada)	351	mm/yr
Factored Water Surplus =	140.40	mm/yr
Additional Surplus from Landscape Runoff =	0	mm/yr
Infiltration Flow Entering the System (Q_i) =	44.84	m^3/day

Mass Balance Model (MOEE 1995)

$C_T = (Q_bC_b+Q_eC_e+Q_iC_i)/(Q_b+Q_e+Q_i)$ = Cumulative Nitrate Concentration

where:	Q_b = flow entering the system across the upgradient area =	0	m^3/day
	C_b = background nitrate concentration =	0	mg/L
	Q_e = flow entering the system from the septic drainfield =	4.8	m^3/day
	C_e = concentration of nitrates in the septic effluent =	40	mg/L
	Q_i = flow entering the system from infiltration =	44.84	m^3/day
	C_i = Concentration of nitrates in the infiltrate =	0	mg/L

Therefore: **C_T = 3.868 mg/L**

Weighted Infiltration Factors

Topography	0.20
Soil	0.1
Cover	0.1
Total	**0.4**

Septic Effluent

Concentration of Effluent (Cs) =	40	mg/L
Number of Lots:	1	
Daily Sewage Flow (Qs)=	4.8	m^3

Site Characteristics

Area of Site :	129,531	m^2
Roof and Driveway Areas:	12,953	m^2
Length of Street (6 m wide):	-	m
Impervious Area	12,953	m^2
Percent Impervious Area =	10	%
Infiltration Area =	116,578	m^2

Nitrate Impact Assessment

Project: Ottawa Soccer United Clubhouse
File: 211-13935-00
Condition: Oveall Site Attentuative Capacity

Groundwater Flow Calculation

Background Nitrate Concentration (C_b) =	0	mg/L
Hydraulic Conductivity (k) =	0	m/s
Horizontal Gradient (i) =	0	
Length (L) =	0	m
Aquifer Thickness (t) =	0	m
Groundwater Flow (Q_b) =	0	m3/day

Infiltration Calculation

Nitrate Concentration in Precipitation (C_i) =	0	mg/L
Surplus Water (Environment Canada)	351	mm/yr
Factored Water Surplus =	140.40	mm/yr
Additional Surplus from Landscape Runoff =	0	mm/yr
Infiltration Flow Entering the System (Q_i) =	44.84	m^3/day

Mass Balance Model (MOEE 1995)

$C_T = (Q_bC_b+Q_eC_e+Q_iC_i)/(Q_b+Q_e+Q_i)$ = Cumulative Nitrate Concentration

where:	Q_b = flow entering the system across the upgradient area =	0	m^3/day
	C_b = background nitrate concentration =	0	mg/L
	Q_e = flow entering the system from the septic drainfield =	14.8	m^3/day
	C_e = concentration of nitrates in the septic effluent =	40	mg/L
	Q_i = flow entering the system from infiltration =	44.84	m^3/day
	C_i = Concentration of nitrates in the infiltrate =	0	mg/L

Therefore: **C_T = 9.926 mg/L**

Weighted Infiltration Factors

Topography	0.20
Soil	0.1
Cover	0.1
Total	**0.4**

Septic Effluent

Concentration of Effluent (Cs) =	40	mg/L
Number of Lots:	1	
Daily Sewage Flow (Qs)=	14.8	m^3

Site Characteristics

Area of Site :	129,531	m^2
Roof and Driveway Areas:	12,953	m^2
Length of Street (6 m wide):	-	m
Impervious Area	12,953	m^2
Percent Impervious Area =	10	%
Infiltration Area =	116,578	m^2