APPENDIX 1

Associated Erbsville South Environmental Study Documents (IBI Group):

1.1 Terms of Reference (October 2012)
1.2 City of Waterloo Council Approval (October, 2012) for Terms of Reference, Erbsville South Environmental Study
1.3 Technical Work Plan, Erbsville South Environmental Study (October, 2013)
1.4 Erbsville South Environmental Study, 1st Interim Technical Memo (February, 2014)
1.5 Erbsville South Environmental Study, 2nd Interim Technical Memo (June 2014)

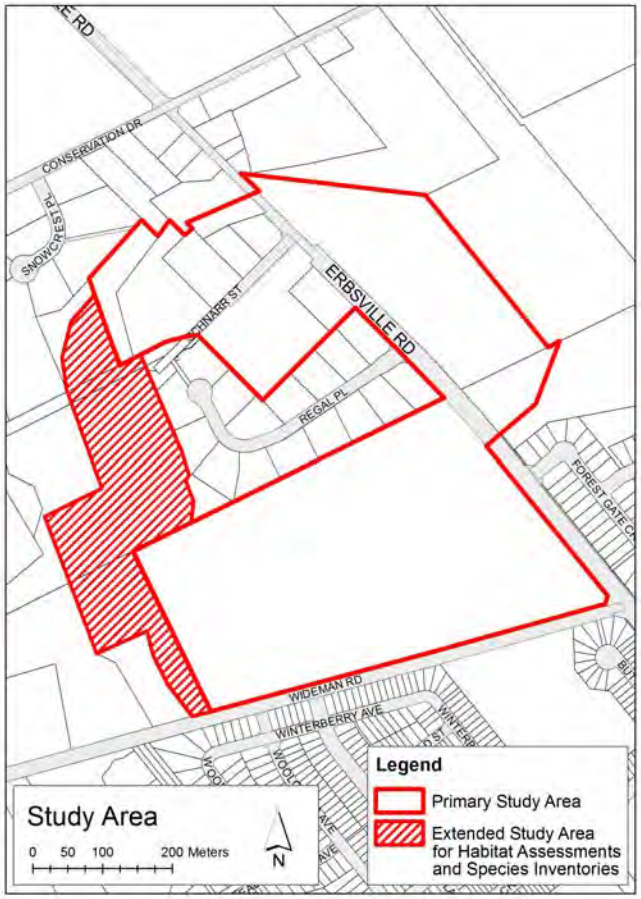
Terms of Reference

Environmental Study
for
Erbsville South Lands, Waterloo
Sunvest Development Corporation

1.0 OVERVIEW

The following Terms of Reference have been prepared by IBI Group to direct environmental research and preparation of an Environmental Study (ES) to support a block planning exercise for the Erbsville South Lands. This study will supplement existing environmental investigations including the *Final Subwatershed Management Plan 309/313* (SWS), prepared by Planning Initiatives Ltd. and Associates, 1996. The purpose of the ES is to identify and categorize natural features and functions, delineate potential development areas and protection areas, and recommend development setbacks and mitigation measures necessary to maintain or improve the ecological sustainability of the area. In this regard, the features and functions of the Laurel Creek Headwater Environmentally Sensitive Landscape will be considered along with those of the Schaefer's Woods Environmentally Sensitive Policy Area (ESPA #17) and Laurel Creek Forest Environmentally Sensitive Policy Area (ESPA #80).

The study area consists of lands located on the east and west side of Erbsville Road at the southern limits of Erbsville that are anticipated to be serviceable by gravity sanitary sewers.



These Terms of Reference have been based on site visits as well as discussions and correspondence with staff from the City of Waterloo, the Regional Municipality of Waterloo and the Grand River Conservation Authority (GRCA). The ES will address issues related to natural heritage including terrestrial and aquatic features, natural hazards, hydrogeology and stormwater management and will be consistent with the recommendations and requirements of the Laurel Creek Watershed Study, Subwatershed Plan #309/313 as well as in accordance with Section 6.35 of the City of Waterloo Official Plan. Consideration will also be given to the City of Waterloo's Draft Official Plan (February 2012), Regional Official Plan (R.O.P.) policies 7.B.12, 7B.13 and 7.C.8 to 7.C.10, the Region's Draft Greenlands Network Implementation Guideline (2011) as well as the Grand River Fisheries Management Plan (1998) and complementary Implementation Plan (2001). A technical work plan will be submitted for review and acceptance prior to the commencement of any field work and must include the actual location, type and number of field surveys and sampling points, a detailed schedule for field work and assessment methodologies and protocols.

2.0 NATURAL HERITAGE

Assessment of vegetation communities will include a review and summary of background information and previous studies, coupled with field inventories to ensure information is current and covers a minimum of three seasons (spring, summer and fall) of data. The Region of Waterloo's Draft Greenlands Network Implementation Guide (Section 3.4) will be referenced for the timing of specific surveys. Existing vegetation communities will be mapped as polygons onto aerial photographs and biophysical data will be collected from all natural and cultural communities according to the Ecological Land Classification System for Southern Ontario (ELC). The botanical survey will include identification of rare, threatened or endangered species based on regional/local, provincial and federal lists. This data will be used for analysis of constraint sensitivities and potential impacts. The Ontario Wetland Evaluation System (OWES) for southern Ontario will be used to delineate all wetland boundaries, which will be confirmed with the GRCA ecologist before being surveyed and mapped. The sedge marsh nearest the intersection of Wideman and Erbsville Roads will be evaluated for potential inclusion within the Sunfish Lake – Laurel Creek Provincially Significant Wetland Complex. Any discrepancies between GRCA and MNR wetland boundaries (>30 metres) will be reviewed with Ministry of Natural Resources staff. The study will also include confirmation to the satisfaction of Region staff of ecologically and topographically appropriate boundaries for ESPA #17 and ESPA #80 consistent with the boundary delineation principles in the Greenlands Network Implementation Guideline, as well as the Laurel Creek Headwater's Environmentally Sensitive Landscape.

The wildlife habitat assessment will include an assessment of the type, structure and quality of vegetative habitats for wildlife use, and the presence of corridors and linkage features to nearby habitats including Monastery Creek and Laurel Creek. Wildlife studies will incorporate review of available wildlife information, supplemented by field assessments. Specifically wildlife surveys will be completed in accordance with the Region of Waterloo's Draft Greenlands Network Implementation Guide during all seasons with emphasis on spring, summer and fall and will include breeding birds following breeding bird atlas protocols, breeding amphibians throughout the spring using the marsh monitoring protocol; and mammals, reptiles, butterflies, and odonates. The presence of species will be based on actual observations as well as the examination of signs such as scats, castings, and tracks. The summary inventory will identify any species of regional/local, provincial and federal significance including species at risk (SAR) in accordance with Ministry of Natural Resources protocols.

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GRCA's Aquatic Resource Pre-consultation Checklist will be completed as part of the ES and habitat features such as groundwater recharge and discharge points and constraints will be mapped. An inventory of benthic invertebrates will be undertaken as an indicator of water and habitat quality. Identification will be provided to the lowest practical taxonomic level (genus or species) and will be analyzed according to the reference condition approach (RCA). As the watercourses have been identified as a coldwater fishery, protection will be premised on enhanced criteria. Areas for protection and enhancement will be identified including appropriate buffers from the watercourse. The impact of the existing pond on the wetland and coldwater creek will also be assessed.

A Fluvial Geomorphology component will be included to identify the form and function of the watercourses on the subject lands, to assess the overall stability of the channels based on geomorphic principals, and to provide a general evaluation of the channels and their interaction with the surrounding floodplain. The channel form will be determined by field reconnaissance and reach assessment techniques. Cross sectional bankfull parameters will be determined using standard field indicators, and the plan form and channel profile characteristics will be determined from desk top analysis. Bed form and sedimentary characteristics will be included in the field assessment as an indicator of channel stability and diversity. The critical flow velocity of Wideman Creek will be determined. Indicators of historical and recent erosion and aggradation will be included in the evaluation as an additional indicator of channel dynamics and stability. If deemed appropriate based on the findings, this assessment will include recommendations for stream channel enhancement.

3.0 NATURAL HAZARDS

The Natural Hazard component will address flooding and erosion hazards associated with the two watercourses, Wideman Creek and Laurel Creek. In this regard the floodplain is delineated by the Regulatory Floodline. The ES will explore the possibility of increasing the size of the culvert under Erbsville Road to reduce the floodplain depth on the upstream West Parcel. Various scenarios will be simulated using the most current version of the HEC-RAS hydraulic model and will consider resulting hydrological impacts, ecological impacts to the wetland/forest complex and other onsite vegetation, as well as flooding and erosion impacts downstream of the culvert. Preliminary design investigations will include an open bottom and bridge options to benefit aquatic resources and which allow passage of wildlife under Erbsville Road. All on-site constraints as a result of the Regulatory Floodline (including any changes as a result of culvert upgrading) will be identified and mapped as part of the ES.

4.0 HYDROGEOLOGY

The local hydrogeologic characteristics will be determined through a literature review of existing Studies and Reports previously undertaken in the area. Fieldwork will be completed to provide the required level of site-specific detail including a complete characterization of the shallow overburden groundwater flow regime. The ES will address the linkages between local surface water features, the shallow ground water system and the deeper regional aquifer system.

Borehole locations will be identified and reviewed with City, Region and GRCA staff and may include multi-level monitoring wells. It should be noted that any boreholes within the wooded areas of the properties will be installed with hand-held augers to minimize disturbance to sensitive areas. A survey of private wells within one kilometer of the study area will be undertaken to provide baseline information with respect to groundwater quantity and quality in local private water supplies. A timeframe (minimum one year) for groundwater monitoring will be established in order to identify an appropriate seasonal high groundwater table elevation.

Recharge and discharge areas will be identified, as well as areas vulnerable to groundwater contamination. An assessment of vertical hydraulic gradients and depth to the Regional aquifer will also be undertaken. Water table elevations and flow gradients will be identified as part of geotechnical and hydrogeological investigations. In addition, a water budget assessment will be completed in conjunction

with the surface water component of the ES. These analyses will include a discussion of impacts on Regional well capture zones, a chloride impact assessment, impacts of proposed residential densities, impacts of buried services, and a description of Best Management Practices to allow for existing infiltration rates to be maintained.

5.0 LINKAGES

The significance and role of the study area within the larger landscape and how this will be affected by development will be discussed. The ES will identify existing and potential linkages to core natural features as well as the connection with the adjacent Environmentally Significant Landscape in accordance with Part V of the Region's Draft Greenlands Network Implementation Guideline. This will include consideration of an eco-passage beneath Erbsville Road along Wideman Creek.

6.0 MITIGATION MEASURES

In light of construction activities on adjoining lands, stormwater flows from new development and previous agricultural use, the ES will identify existing impacts in accordance with Section 3.9 of the Region's Draft Greenlands Network Implementation Guideline.

The study will identify mitigation measures and specific construction methods to protect and enhance Core and Supporting natural features and ecological functions and minimize environmental impacts. Consideration will include, but not be limited to, grading activities and secondary containment of any hazardous materials on site. Appropriate buffers will be recommended to protect the significant natural features and ecological functions on site including wetlands, watercourse, the ESPAs and existing hedgerows from future development, and that maintain and/or enhance ecological linkages on and off site with other natural areas including the ESPAs and Wideman Creek corridor. Ecological enhancements, as defined in the Region's Draft Greenlands Network Implementation Guideline, will be identified. The buffer analysis will take into account the recharge/discharge relationship within the watershed when reviewing potential water quality impacts from land use activities. Any buffer evaluation will be in accordance with Sections 8.2.4 and 8.2.5 of the City of Waterloo's Draft Official Plan, and Part IV of the Region's Draft Greenlands network Implementation Guideline. Potential restoration areas will also be identified. Special focus on management of human uses after construction will be addressed, including demarcation of buffers and/or natural features, trails, invasive landscape materials, domestic pets, increased noise and exposure to artificial light. Proposed stewardship options for the ESPAs and buffer areas on the site will also be provided.

7.0 STORMWATER MANAGEMENT

Specific stormwater management criteria for the study area are identified in the approved Subwatershed Study #309/313 (Table D1.3). The proposed conditions hydrologic modeling will be completed using the SWMHYMO computer model to determine pond storage requirements for a range of events including the 25mm, and 2, 5, 25, and 100-year storms. Control of the Regulatory storm event is not required as outlined in the SWS. Controlling proposed conditions peak flows to pre-development conditions (as defined in the SWS) will be the required quantity criteria. An Enhanced Protection Level for water quality control is required, including modelling and retention times for the 25mm storm, as is extended detention for erosion control as per the SWS. In addition, infiltration targets in accordance with the SWS will be addressed.

The study will assess current stormwater flow from the Laurel Creek Village subdivision, south of Wideman Road and the effects of such flow to either sustain or impact the current site water balance. Preliminary plans for stormwater management facilities, including ponds and infiltration areas will be prepared. The stormwater management pond preliminary design will account for thermal impacts of storm runoff. A complete analysis will be undertaken of all proposed stormwater management facilities relative to the existing water balance and natural areas. Water balance calculations, utilizing GRCA's

most recent GAWSER model, will be completed based on the results of the hydrogeological component of the ES to ensure that the hydrologic balance for the site, including the quantitative and qualitative aspects of the hydrological and hydrogeological regimes sustaining the ESPAs, wetlands and watercourses, is maintained.

A Pre-Development Monitoring Program for the developing lands will be outlined in the ES, and will follow the criteria set out in the SWS for collecting baseline conditions. Specific parameters will be identified including but not limited to dissolved oxygen (preferably pre-dawn DO measurements), total suspended solids, total phosphorus, water temperature and *E. coli*. A Terms of Reference for Pre-Development Monitoring will be prepared and submitted to the City, Region and GRCA for review and approval and will be appended to the ES. The program will include in-stream temperature monitoring in locations above and below any future stormwater management facilities.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Utilizing the findings from all components, an Opportunities and Constraint Map will be prepared to guide the block planning exercise and future residential development proposed for the study area. In addition, any revisions to the SWS constraint mapping will be identified. Recommendations for next steps and mitigation of any adverse impacts and special issues will also be provided.

Moved by Councillor Durrell, seconded by Councillor Scian:

"That Council approve Development Services report DS2012-045 and approve Z-12-01 General Amendments to Zoning By-Law No. 1108 and Zoning By-Law No. 1418, in accordance with Appendices A-E of Staff Report DS2012-045."

Carried Unanimously

6. STAFF REPORTS

a) Proposed Erbsville South Block Plan Study and Environmental Study Terms of Reference

Report No. DS2012-025.1
Prepared By: Cameron Salisbury and Robyn McMullen

Robyn McMullen, Environment Planner reviewed the report and responded to questions from Council.

Mayor Halloran joined the meeting. (Time: 6:38 p.m.)

Deb Lehman, a Kitchener resident and photographer, described her wildlife findings within the Erbsville South area and discussed her concerns with the Environmental Study not extending to the Schnarr Street area. Ms. Lehman spent over 1500 hours photographing many species throughout the proposed lands, finding many Special Concern Animals such as the Northern Map Turtle, Read Headed Woodpecker and Snapping Turtles and is concerned that these animals will diminish once development begins.

Deb Swidrovich of Waterloo described the significant wildlife within the Block Plan and expressed concerns with the proposed development area. Mrs. Swidrovich requested an extension of the Environmental Study area at the end of Schnarr Street and that wording be put in place to ensure the North Waterloo Scoped Subwatershed Study is complete before proceeding with the Erbsville Block Plan.

Moved by Mayor Halloran, seconded by Councillor Scian:

"That DS2012-025.1 be approved and,

1) that Council endorse the proposed Terms of Reference for the Environmental Study attached as Appendix A, **and direct staff to extend the study area to include land within a 120m circumference of the end of Schnarr Street, excluding existing residential development**;

2) that Council approve the proposed Terms of Reference for the Erbsville South Block Plan Study attached as Appendix B; and

3) that Council receive as information the documents attached as Appendices C, D and E."

Carried Unanimously

b) **New Sign By-law**
Report No. DS2012-056
Prepared By: Danielle Ingram

Danielle Ingram reviewed the report and responded to questions from Council.

Mike Gaudreau, React Signs expressed his concerns with respect to the proposed Sign By-law and implementation of sign zones which will significantly decrease the portable sign allowance throughout the City. He also noted that portable signs are the most heavily regulated signs, are proactively enforced by the Waterloo By-Law division and this year the portable sign permit fees brought in about $84,000 in revenue to the City to date. Mike Gaudreau provided the Clerk with a petition opposing the proposed changes to the zoning for portable signs.

Councillor Scian left meeting: (Time: 8:28 p.m.)
Councillor Scian returned to meeting: (Time: 8:32 p.m.)

Cindy Watkin, Chair, Eastbridge Neighbourhood Association, shared her appreciation of the new Sign By-law in regard to the leniency for neighbourhood associations. Mrs. Watkin also suggested that sign permit applications be available online for convenience.

Dave Lamka, A to Z Signs Ltd., expressed his concerns regarding the portable sign zoning changes, stating that small business owners will lose sales and potentially jobs as a direct result of the constraints in the new By-law. Mr. Lamka requested there not be a ban on mobile portable signs from any zone in Waterloo.

Nima Kia, Planner, Lakeshore Group expressed his concerns regarding the maximum number of signs per property, the discontinuation of freestanding signs at commercial plazas and the lack of a transitioning clause which would permit the property at 315 Lincoln Road to continue with their current sign variance application. Mr. Kia requested that these concerns be considered before the new Sign by-law is approved.

Ben Nightingale, owner of Shoes 22, expressed his concerns regarding the exclusion of portable signs at commercial plazas as 70% of the businesses at his location do not have street facing signs. Mr. Nightingale explained how pertinent portable signs are to their small businesses and the potential negative impact due to proposed zone change in the By-law. He described the accessory signs as not being reasonable as slush and snow will cover them in the winter, and they are subject to vandalism and theft.

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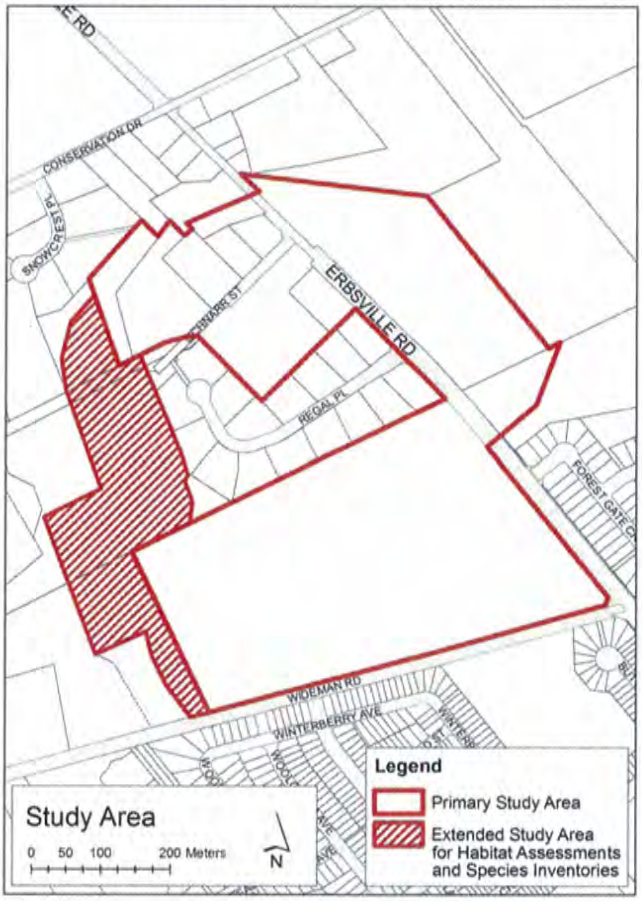

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A Pre-Development Monitoring Program for the developing lands will be outlined in the ES, and will follow the criteria set out in the SWS for collecting baseline conditions. Specific parameters will be identified including but not limited to dissolved oxygen (preferably pre-dawn DO measurements), total suspended solids, total phosphorus, water temperature and *E. coli*. A Terms of Reference for Pre-Development Monitoring will be prepared and submitted to the City, Region and GRCA for review and approval and will be appended to the ES. The program will include in-stream temperature monitoring in locations above and below any future stormwater management facilities.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Utilizing the findings from all components, an Opportunities and Constraint Map will be prepared to guide the block planning exercise and future residential development proposed for the study area. In addition, any revisions to the SWS constraint mapping will be identified. Recommendations for next steps and mitigation of any adverse impacts and special issues will also be provided.

IBI GROUP

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Technical Work Plan

Erbsville South Environmental Study

(October 2013)

1.0 Introduction

In October 2012, the Council for the City of Waterloo approved the Terms of Reference for the *Erbsville South Environmental Study* (ES) found in Appendix A. The purpose of the study is to supplement existing environmental information that is contained within the *Laurel Watershed Study* (1993) and the subsequent *Final Subwatershed Management Plan 309/313* (SWS, 1996) and will constitute a Comprehensive Environmental Impact Study. In accordance with the Terms of Reference for the ES, this Technical Work Plan has been prepared to outline in more detail the process that will be utilized to complete this study. The ES will identify and categorize natural features and functions, delineate potential development areas and protection areas, and recommend development setbacks and mitigation measures necessary to maintain or improve the ecological sustainability within the study area. Consideration will also be given to the *City of Waterloo's Official Plan* (December 2012), *Region of Waterloo Official Plan* (ROP) policies 7.B.12, 7.B.13 and 7.C.8 to 7.C.10, the Region's *Draft Greenlands Network Implementation Guideline* (2011) as well as the *Grand River Fisheries Management Plan* (1998) and complementary *Implementation Plan* (2001). The findings and recommendations of this study will be integrated into the environmental component of the *Erbsville South Block Plan Study*.

The Erbsville South Study Area is located on the east and west side of Erbsville Road and north of Wideman Road at the southern limits of Erbsville. These lands are anticipated to be serviceable by gravity sanitary sewers.

On behalf of Sunvest Development Corporation, **IBI Group** will be responsible for the coordination and preparation of the ES. In this regard a team of experts has been engaged to investigate the various disciplines that will be examined during this study. They include **Dougan & Associates** for terrestrial resources including flora and fauna, **C. Port and Associates** for aquatic resources, **JTB Environmental Systems Inc.** for the fluvial geomorphology component, **LVM inc.** for hydrogeology and **IBI Group** for civil engineering, hydrology and stormwater management. Study Team members will be responsible for securing any necessary permits and approvals needed to undertake their respective fieldwork.

It is anticipated that the study will take a year or more to complete in order to ensure that a full range of field investigations are undertaken. A Timeline Chart has been provided in Appendix B. The findings and recommendations of this study will input into the Erbsville South Block Plan Study being undertaken as a separate process by a third party consultant and managed by the City of Waterloo.

The details of the various study components are as follows:

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2.0 Natural Heritage

2.1 Terrestrial Resources (Dougan & Associates)

Background Review and Summary

Sources of background information will be collected and reviewed for relevance to the study including the following:

a) Laurel Creek Watershed Study
b) Final Subwatershed Management Plan 309/313 (PEIL et al., 1996)
c) Section 6.35 of the City of Waterloo O.P.
d) City of Waterloo Official Plan (Dec. 2012)
e) ROP policies 7.B.12-13, 7.C.8-10
f) Region of Waterloo Draft Greenlands Network Implementation Guideline (DGNIG) (2011)
g) GRCA Fisheries Management Plan
h) Natural Heritage Reference Manual (OMNR 2010)
i) Schaefer's Woods ESPA (#17) and Laurel Creek ESPA (#80)
j) Laurel Creek Headwater Environmentally Sensitive Landscape
k) NHIC database
l) Simpson Lands Stage I Monitoring Reports (2006 - 2011) (Stantec, 2006 - 2011)
m) Wideman Road EIS (Draft) (Dougan & Assoc., 2008)
n) Hydrogeological Study Report, Michael Property, Waterloo (Mitz & Assoc., 2010)
o) Regal Place Scoped EIS (Dougan & Assoc., 2012)
p) Sunfish Lake – Laurel Creek PSW data record
q) Revised Draft North Waterloo Scoped Subwatershed Study
r) MNR comments on T.O.R.
s) Wildlife data from local naturalists; and
t) Other available documents

Information gathered in this phase will provide field staff with an initial understanding of the Primary Study Area and Extended Study Area, facilitate decision-making during the study, and be incorporated into reporting.

Field Investigations

The following field investigations are planned to take place in 2013/2014:

- Vegetation Assessment: Vegetation communities in the Primary and Extended Study Areas will be classified to Vegetation Type as per the protocol of the Ecological Land Classification (ELC) System for Southern Ontario, 1st approximation (Lee et. al., 1998). Spring, summer and fall botanical surveys will be carried out within each unique vegetation community. ELC and botanical surveys will be completed simultaneously by an Ecologist during three field visits (spring, summer and fall 2013). Plant rarity status will be assessed using COSEWIC rankings for federal status, S-rank for provincial status, and Region of Waterloo (1999 Significant Species List) for local status.

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- Wetland Assessment: A small unevaluated wetland has been identified and will be reviewed by a Certified OWES Wetland Evaluator. The assessment will include correspondence with MNR and GRCA, one field visit in summer 2013, formation of an opinion on whether the wetland should be complexed with the existing PSW – Sunfish Lake Laurel Creek Wetland Complex, and submission of a brief letter report to MNR for approval and copied to GRCA. This is not intended to be a full wetland evaluation update as per the Ontario Wetland Evaluation System.
- Feature Staking and Confirmation: Natural feature boundaries will be established onsite with agency staff (GRCA, City of Waterloo, Region of Waterloo, MNR & IBI Group). Site walks for this purpose will be scheduled for summer 2013. Features to be staked include wetlands (PSW and/or non-PSW), ESPA and hazard lands.
- Winter Wildlife Survey: One visit will be carried out by a wildlife ecologist in late December 2013 or early 2014. The survey will take place within 48 to 72 hours after a snow fall event. Areas with the highest likelihood to support animal movement will be given priority. All tracks and other miscellaneous signs of animal activity will be documented and identified to species whenever possible. Special attention will also be given to documenting birds present in winter as well as the presence and movements of deer within the known deer wintering area.
- Nocturnal Amphibian Call Surveys: Three rounds of nocturnal amphibian call surveys will be completed at approximately monthly intervals between mid-April and mid-June. The surveys will follow the protocol outlined in the Marsh Monitoring Program (MMP) (BSC, 2009) with regard to timing and weather conditions, however, survey locations will include all potentially suitable amphibian breeding habitats (i.e., swamps) in addition to marsh habitats. Some deviation from the MMP protocol will be used to ensure adequate survey coverage of existing amphibian populations. Point counts will be used to document amphibians recorded within a 360˚ radius, as opposed to the MMP 180˚ radius. The duration of each point count will be extended from the standard 3 minute length to 6 minutes to help ensure the data collected is as representative of the habitat conditions on the property as possible. Eight point count stations will be surveyed allowing all habitats potentially supporting amphibian breeding to be surveyed (Appendix C, Figure 1).
- Snake Surveys: Snake surveys will be undertaken in accordance with MNR Guelph District Milksnake Survey Protocol. Three surveys, at least two weeks apart will be undertaken between late April and late June, under sunny conditions between 8 - 25°C or at least 15°C if overcast. Active hand searches will be utilized with Animal Care Protocol.
- Turtle Surveys: Turtle Surveys will be undertaken referencing MNR's Occurrence Survey Protocol for Blandings Turtle in Ontario. At least three visits will be undertaken between mid-April and mid-June under appropriate weather conditions, on sunny days after days of inclement weather when turtles are most likely to be observed basking. Only two suitable foraging/overwintering areas are known to be present within the Primary and Extended Study Areas. One is a pond and the other is a slightly wider and more open section of Laurel Creek (Figure1, Appendix C). Both will be surveyed using high quality, 12 power, image-stabilized binoculars. The species and number of individuals will be documented.
- Salamander Surveys: Two ponds will be surveyed on the southerly property, one immediately north of Wideman Road and the other south of Wideman Creek. In accordance with current protocols, traps will be set out on five separate nights during early spring March-April 2014.

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Approvals will be obtained for a Wildlife Animal Care Committee research protocol, a Wildlife Scientific Collectors Authorization, and an Endangered Species Act permit.

- Breeding Bird Surveys: Two field visits will be carried out between the last week of May, 2013 and first week of July, 2013, as per the Ontario Breeding Bird Atlas protocol (Cadman et al., 2007). If possible, survey visits will take place as close as possible to the middle of June when song output is highest and detection rates are greatest. Each survey will be conducted a week apart and under appropriate weather conditions (*i.e.,* light winds and little to no rain). Breeding bird evidence will be documented visually on aerial photography for future reference and review. Each survey visit will follow a wandering transect in such a way that both the Primary Study Area and Extended Study Areas are appropriately covered (*i.e*., that no location is greater than 125 metres away from any given survey location). In fact, most habitats will not be more than 75 metres away from a given survey station. Figure 1 in Appendix C shows an anticipated route through the study area.
- Incidental Wildlife Surveys: All wildlife species (*e.g*., mammals, butterflies, odonates, etc.) observed by ecologists during other field surveys conducted in the study area will be recorded. Information will include species name, number of individuals, and location.
- Road Kill Survey: A dedicated Road Kill Survey will be conducted on foot along Erbsville Road. Although all wildlife species will be noted, documenting amphibian movement will be the focus. To maximize success, the survey will take place within 36 hours of a rain event. Other incidental road kill observations will be duly documented throughout the field season.

Data Analysis & Reporting

- Plant and wildlife records will be entered into a Microsoft Access database to allow for easy data assessment and preparation of a species lists to be included in the final report. Species lists will be keyed to individual ELC mapping units.
- Spring and summer field tasks will provide insight into the environmental constraints within the study area. A brief letter and map will be prepared and shared with IBI Group to communicate these preliminary findings and discuss initial opinions on opportunities and constraints.
- Text for the Environmental Study Report will be prepared and submitted to IBI Group. Accompanying maps will be prepared in ArcMap by a qualified GIS Technician.

Potential Additional Tasks

A number of extra tasks outside the scope of the above work plan may become necessary as the project progresses including:

- Species at Risk (SAR) Surveys: The MNR may request additional field surveys specific to plant or wildlife SAR that they suspect may be present in the Primary and Extended Study Areas. If any such surveys become necessary, specific survey methodologies will be determined in consultation with MNR as needed. The MNR may also request additional field surveys for SAR based on the findings of 2013/2014 field findings. For example, if Butternut trees (*Juglans cinerea*) are found during botanical surveys, MNR may request that a Butternut Health Assessment be carried out.

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- OWES Wetland Evaluation: The wetland assessment in the current work plan is not intended to include a full wetland evaluation update based on OWES protocol, however if this becomes necessary it will be added to the work plan.

2.2 Aquatic Resources (C. Portt and Associates)

Background review

- Acquire existing fish community, fish habitat, and benthic invertebrate information from MNR/GRCA/City of Waterloo and C. Portt and Associates files. Compile this information and refine data needs.

Field investigations

- Conduct reconnaissance level habitat assessments of Wideman Creek and reaches of Laurel Creek adjacent to the subject property in spring, summer and autumn, to assess permanence of flow and identify key features such as areas of groundwater seepage, barriers to fish migration, etc.
- Conduct electrofishing (OSAP screening survey) of potential seasonal fish habitats in the spring to determine if fish are present.
- Conduct OSAP Standard Single Pass electrofishing survey, and complete OSAP Section 1 Modules 1, 2, 3, and Section 4, Module 2, at three locations, two on Laurel Creek and one on Wideman creek corresponding to the locations identified for temperature loggersduring the summer low flow period (see Figure 2, Appendix C). No fish sampling will be taken at location 4 as there is insufficient length of stream to establish a station between locations 3 and 5. Existing data from the recent Draft North Waterloo Scoped Subwatershed Study (Stantec, April 2013) will be utilized for this reach of Laurel Creek.
- Deploy water temperature loggers between June 1 and September 30 at one location in Wideman Creek and five locations in Laurel Creek as follows (see Figure 2, Appendix C):
    1. Laurel Creek upstream from the existing stormwater discharge from Regal Place.
    2. Laurel Creek downstream from the existing stormwater discharge from Regal Place and upstream from Erbsville Road. This location may be upstream or downstream from Schnarr Street, depending upon where the most appropriate habitat occurs.
    3. Laurel Creek downstream from Erbsville Road and upstream of the potential stormwater discharge location for the property east of Erbsville Road.
    4. Laurel Creek between the potential stormwater discharge location for the property east of Erbsville Road and Wideman Creek.
    5. Laurel Creek downstream from Wideman Creek.
    6. Wideman Creek downstream from Erbsville Road.
- Conduct a salmonid spawning survey of Wideman Creek and the reaches of Laurel Creek within the study area, consisting of at least two sets of observations, one in the latter half of October for brown trout (*Salmo trutta*) and one in mid- to late November, after brook trout (*Salvelinus fontinalis*) spawning would have occurred.
- Conduct benthic invertebrate sampling according to the OBBN protocol at the locations where OSAP Single Pass electrofishing is conducted (Figure 2, Appendix C), with identification to the lowest practical taxonomic level. Existing data from the recent Draft North Waterloo Scoped

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Subwatershed Study (Stantec, April 2013) will be utilized for the reach between Temperature Logger locations 3 and 5 on Laurel Creek.

Data Analysis

- Characterize the aquatic habitats based on the habitat condition and the fish and benthic invertebrate communities.
- Identify potential impacts to aquatic habitats using the Pathways of Effect approach.
- Identify methods to prevent or mitigate negative effects.
- Identify opportunities for the enhancement, restoration, and long-term conservation of aquatic habitats.
- Assess the risk/benefit to fish and aquatic habitats using the DFO Risk Management Framework.

Monitoring Plan

- Develop a monitoring plan to assess the condition of aquatic habitats so that adaptive management can be undertaken if unpredicted and undesirable effects occur.

2.3 Fluvial Geomorphology (JTB Environmental Systems Inc.)

- A full geomorphic assessment of all surface watercourses within the Primary Study Area will be completed. The geomorphic assessment will include the examination of channel and valley morphological characteristics (sinuosity, meander wavelength, valley and channel profiles, bed material composition, physical habitat attributes (pool-riffle sequencing and stability)), evaluation of fluvial processes including bedload transport, hydraulic and energy properties of the flow regime, bed and bank stability, and the identification of sites sensitive to erosion and sedimentation. The result of this analysis will be a detailed stream characterization based on morphological properties of the channels and fluvial process, which will be the basis for the development of various alternative strategies for the area.
- The detailed geomorphological assessment will include:
  - **a) Flow Assessment**: Flow analysis will be completed in two ways: during channel stability/channel form surveys, flows will be measured using an AVP measurement device, which determines discharge and velocity under various flow conditions. Additionally, HOBO U20 water level loggers will be installed in the channels at measurement locations to obtain a continuous flow record. These loggers, through the use of pressure transducers, are able to track water levels which are then converted to discharge values using the cross-section and velocity measurements. The result is a stage/discharge curve which can be integrated into the hydrology component of the study. Through understanding flow behaviour in response to storm events as well as base flows, erosion/sedimentation risk at critical points in the Study Area can be thoroughly assessed. Flow monitoring will ensure the capture of the 2014 spring freshet.
  - **b) Channel Stability**: Information on channel stability will be collected at each of the flow monitoring locations in section a) above. In order to assess channel stability, detailed studies into the sediment characteristics of each location are required. This includes samples of bed material (pavement and subpavement); bank material; near-bed sediment transport rates; and Total Suspended Solids sampling. This component of the study assists

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in determining critical thresholds for erosion on sensitive reaches, which is used as input into any stormwater pond release rates.

c) **Reach Stability**: Cross-sectional transects for the purpose of flow assessment are not detailed enough to establish stability criteria within the system. As a result, the areas of study will be mapped and used for reach stability assessment. Each reach will be visited and mapped at the same time flow measurements are collected.

d) **Historical Channel Patterns**: In order to understand what the creek is trying to achieve, the historical changes in channel pattern will be reviewed through the use of air photo interpretation/analysis. The result of this study component is a determination of meander characteristics and setbacks for development based on fluvial patterns.

- Erosion thresholds will be determined utilizing a 14-step protocol which includes:
    1. A stream walk will be undertaken at the start of the assessment to document overall watercourse conditions and to identify areas of potential erosion risk. During this walk notations of changes in soil type and bed characteristics are made and digital photographs are taken. A further purpose of the creek walk is to choose potential cross-sections for further study. The number of cross-sections chosen reflects the concerns of the study TOR. Additional creek walks will be completed in the spring during recession of the freshet to review high–energy events. At this time loggers will be installed at critical locations (and in conjunction with flow nodes of interest from the hydrology component of the study).
    2. A rapid reach assessment is undertaken which identifies particular concerns with respect to channel form, bank properties, riparian conditions, substrate and flow characteristics. A numerical score of out of 100 results which can be used comparatively to select reaches for further study. Additional metrics (RGA, RSAT) will also be collected and reported upon.
    3. Once all potential cross-sections have been identified choices are made as to which ones would require further analysis. This decision is based on relative stability to other reaches and the proximity to areas of concern or specific interest: in particular areas of differing soil type, proximity to structures, or proximity to catchment nodes with respect to the hydrological modeling. A minimum of five cross-sections will be established. Each section will get a flow logger installation for recording of continuous flows.
    4. Each cross-section is monumented for future use. Cross-sectional measurements of channel and bankfull area are made at tight intervals to get a detailed indication of form. Local slope is determined using a levelling exercise. This cross-sectional data is input into a flow model along with information on channel roughness (Manning's 'n' and the Limerinos method) to determine stage/discharge relationships and specific velocities. All sections will be tied together using GPS coordinates and a sub-centimetre differential GPS system (RTK-type base station and rover as well as robotic total station). Velocities will be validated using an acoustic Doppler velocity meter.
    5. Bank and bed samples of pavement and sub-pavement will be collected and returned to the lab for grain-size analysis. The grain size distribution is used in the tractive force analysis. Each section will have a minimum of two bed and two bank samples collected

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for analysis. Analysis will be by standard grain size methods (sieve shaker). Total number of samples will be a minimum of 20.

6. Critical shear stress for the bank and bed material (pavement and sub-pavement) will be determined using standardized methods for the D_{10}, D_{50} and D_{90} fraction of each sample. Multiple modes of assessment will be used including Chow, Dunn and Freisenrich and reporting on those which are appropriate for each watercourse.
7. Critical velocities for entrainment for the bank and bed material (pavement and sub-pavement) will be determined using standardized methods for the D_{10}, D_{50} and D_{90} fraction of each sample. Multiple modes of assessment will be used, ranging from Hjusltrom for finer materials to Komar for coarser materials.
8. Boundary shear stress will be determined from the cross-sectional profile, slope and roughness components measured in the field utilizing Shields calculations as standard practice. Comparisons are made between the critical and boundary shear at bankfull stage to establish erosion potential for each fraction.
9. Existing relationships between stage and velocity through the sections will be determined using standard equations (e.g., Komar, 1987) and a stage/velocity curve is developed. This curve is validated through direct measurement in the field of flow velocity on a minimum of three different flow events. Flowmaster will be used to create the hydraulic models for each of the sections to determine stage/discharge relationships. Velocity validation will be achieved using the acoustic Doppler velocity meter.
10. Critical velocities for the erosion of bank and bed material (pavement and sub-pavement) will be determined using standardized methods for the D_{10}, D_{50} and D_{90} fraction of each sample. Multiple modes of assessment will be used, ranging from Hjusltrom for finer materials to Komar for coarser materials.
11. Critical discharge to match the critical/boundary shear relationship as well as the critical velocity relationship is then mathematically determined and reported to the engineer for placement in the hydrological model as a threshold value. The hydrological model is then run against the threshold value to determine exceedence for the pre-development and post-development scenarios; this is input into the decision matrix for the sizing of the stormwater management pond.
12. Theoretical erosion and transport is based on ideal conditions; however ideal conditions in the field are not often found. Validation of the transport results are required and are achieved through direct bedload transport sampling at the cross-sections where calculated thresholds are determined, again using a minimum of three samples under different flow events. Field results are used to validate the erosion and transport model results. As required, the theoretical model shall be tweaked. Multiple sediment transport equations (including Ackers and White, Bagnold, Einstein, Meyer-Peter and Muller) will be used to determine theoretical sediment transport results. These results will be compared to field samples taken using a Helly-Smith bedload sampler to determine which equation best represents actual transport rates under varying flows.
13. Reporting will include critical shear, critical discharge, critical velocity, stream power and erosion potential for the selected cross-sections. These other critical thresholds are reported in case there are issues surrounding the use of shear stress as a decision-

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making tool. Reporting will include a graphic (map) showing threshold values along the length of each creek as necessary.

14. Recommendations will be made from the perspectives of fluvial functioning of the watercourse as a component of the final report.

3.0 Natural Hazards (IBI Group)

- Review existing reports and mapping available for the area.
- Review and analyze increasing the size of the culvert under Erbsville Road to reduce the floodplain depth, including simulation of various scenarios using HEC-RAS hydraulic model.
- In co-ordination with the Study Team review/mitigate resulting hydrological impacts, ecological impacts to upstream wetland/forest complex and other on-site vegetation, as well as flooding and erosion impacts downstream of the culvert.
- Provide preliminary design options for a new culvert which include an open bottom to benefit aquatic resources and small wildlife.
- All on-site constraints as a result of the Regulatory Floodline (including any changes as a result of culvert upgrading) will be identified and mapped.

4.0 Hydrogeology (LVM inc.)

Background Review

- Review of existing topographic, geological, and hydrogeological mapping and reports for the area including the draft North Waterloo Scoped Subwatershed Study (Stantec, April 2013) and the Waterloo North Water Supply Class EA Environmental Study Report (AECOM, November 2011).

Field Investigations

- Drill six boreholes in locations shown on Figure 3 in Appendix C. All boreholes will be completed as monitoring wells, with selected wells extending to the regional aquifer and completed as nested monitoring wells.
- Installation of approximately fifteen mini piezometers in and adjacent to the on-site wetland areas and surface water features, as shown on Figure 3 in Appendix C.
- Installation of electronic pressure transducers (dataloggers) in ten monitoring wells for continuous measurement of groundwater levels and fluctuations.
- In-situ single response (slug) testing of the new monitoring wells, and selected existing monitoring wells within the Primary Study Area.
- Grain size analysis of nine soil samples.
- Water chemistry sampling at six on-site monitoring wells and four residential water supply wells, with analysis for general chemistry parameters.
- A door-to-door survey of existing properties within a 500 metre radius of the Primary Study Area to obtain information about well construction, well depth, and existing water quantity and quality issues.

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Monitoring

- Groundwater monitoring will be undertaken for a minimum of one year, including quarterly manual water level measurements at all on site monitoring wells and mini piezometers, and quarterly downloading of dataloggers. Monitoring will ensure the capture of the 2014 spring freshet.
- Any monitoring wells that will not be used for long-term monitoring will be decommissioned by a licensed well contractor in accordance with O. Reg. 903.

Analysis

- Calculation of soil hydraulic conductivity from slug test results and grain size analysis.
- Assessment of the depth to shallow groundwater connections to local surface water features, and the vertical gradient between the shallow groundwater aquifer and the deep regional aquifer system.
- Calculation of a pre-development site water balance.
- Performing a chloride impact assessment for the shallow groundwater table under proposed conditions.
- Assessment of potential impacts to municipal wellhead protection areas.
- Assessment of potential impacts of site servicing and development on surface water features and groundwater, and provision of mitigation measures.
- Providing options for post-development infiltration.
- The hydrogeology report will include conclusions about the connection between surface water features and shallow groundwater, recommendations for post-development site infiltration, and recommended methods to maintain the shallow groundwater processes and their contribution to surface water features.
- Recommendations will be made for ongoing monitoring, including establishing trigger levels as appropriate.

5.0 Impact Assessment and Mitigation Measures

- An assessment of all potential impacts will be undertaken for all disciplines. This will include identifying potential for adverse environmental impacts (as defined the R.O.P. Glossary) to occur pre-, during-, and post development. Significance of the identified adverse impacts will be assessed.
- Ways to prevent, minimize, or mitigate potential adverse environmental impacts (in that order of precedence) will be identified in that no such impacts are permitted within Core Environmental Features.
- Mitigation measures and specific construction methods will be identified that protect and enhance core and supporting natural features and functions and minimize environmental impact.
- Appropriate buffers will be recommended to protect the significant natural features and ecological functions on site including wetlands, watercourse, the ESPAs and existing hedgerows from future development, and features that maintain and/or enhance ecological linkages on and off site with other natural areas including the ESPAs and Wideman Creek corridor.
- The buffer analysis will take into account the recharge/discharge relationship within the watershed when reviewing potential water quality impacts from land use activities. Any buffer evaluation will be in accordance with Sections 8.2.4 and 8.2.5 of the City of Waterloo's Official Plan, Part IV of

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the Region's Draft Greenlands network Implementation Guideline, and Section 16 of the Natural Heritage Reference Manual (OMNR 2010).

- Ecological enhancements, as defined in the Region's Draft Greenlands Network Implementation Guideline, will be identified.
- Potential restoration areas will also be identified.
- Management of human uses after construction will be addressed, including demarcation of buffers and/or natural features, trails, invasive landscape materials, domestic pets, increased noise and exposure to artificial light. Proposed stewardship options will be provided for all components of the natural heritage system, including core natural areas, buffer zones and ecological linkages.

6.0 Stormwater Management (IBI Group)

- Water balance calculations utilizing the GRCA's most recent version of GAWSER (as required) will be completed based on the results of the hydrogeological component of the study to ensure that the hydrologic balance for the Primary Study Area and hydrogeological regimes sustaining the ESPAs, wetlands, and watercourses are maintained. An analysis of wetland hydroperiod (depth, duration, and extent of flooding) and lag times between storm events and peak discharge rates will be undertaken.
- Recommendations and preliminary designs for infiltration methods and infrastructure will be provided.
- An assessment will be undertaken of current stormwater flow from the Laurel Creek Village Subdivision south of Wideman Road and the effects of such flow on the water balance for the subject lands. Impacts to water quality from the effluent of the Laurel Creek Village stormwater management facility, as well as potential impacts to the physical integrity of the wetland and any downstream water channel will also be considered.
- The proposed conditions hydrologic modelling will be completed using the SWMHYMO computer model to determine storage requirements for a range of events including the 25mm, and 2, 5, 25, and 100-year storms
- The required quantity criteria will be controlling proposed conditions peak flows to pre-development conditions as defined in the SWS.
- An Enhanced Protection Level for water quality control is required, including modelling and retention times for the 25mm storm, as is extended detention for erosion control as per the SWS.
- Preliminary plans for stormwater management facilities, including ponds and infiltration facilities will be prepared. The stormwater management pond designs will account for thermal impacts of storm runoff. A complete analysis will be undertaken of all proposed stormwater management facilities relative to the existing water balance and natural areas.
- A comprehensive Monitoring Plan will be prepared based on Subwatershed guidelines for pre-development, during-construction, and post-construction stages.

7.0 Coordination and Reporting

7.1 Coordination

- Findings will be provided to consultants undertaking the Erbsville South Block Plan Study.
- Environmental Study team members will coordinate with the Block Plan study team as required.

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7.2 Interim Technical Memos

- Interim Technical Memos covering all parameters of the study will be prepared and issued at the 4 and 8 month mark from the commencement of the study, immediately following acceptance of this Technical Work Plan, for City of Waterloo, Regional Municipality of Waterloo, Grand River Conservation Authority and Ministry of Natural Resources review.
- The Technical Memos will summarize the findings to date and demonstrate how they fit within the context of/align with existing data as understood through the *Laurel Creek Watershed Study* and subsequent *Subwatershed Management Plan 309/313*.
- Should the data not align, the Technical Memos will outline how the fieldwork program will be modified to address anomalies/inconsistencies.
- If substantive work plan changes are required it is understood that City staff will report back to Council.
- The Interim Technical Memos will be made available to members of the public as information upon request and will be available on the City's website.

7.3 Final Report

- Prepare a draft Environmental Study Report outlining findings and recommendations for submission and review by agencies.
- Make editorial changes based on agency comments and prepare Final Environmental Study Report.

APPENDIX A

CITY OF WATERLOO COUNCIL APPROVAL (OCTOBER, 2012) FOR TERMS OF REFERENCE, ERBSVILLE SOUTH ENVIRONMENTAL STUDY

Moved by Councillor Durrell, seconded by Councillor Scian:

"That Council approve Development Services report DS2012-045 and approve Z-12-01 General Amendments to Zoning By-Law No. 1108 and Zoning By-Law No. 1418, in accordance with Appendices A-E of Staff Report DS2012-045."

Carried Unanimously

6. STAFF REPORTS

a) Proposed Erbsville South Block Plan Study and Environmental Study Terms of Reference

Report No. DS2012-025.1
Prepared By: Cameron Salisbury and Robyn McMullen

Robyn McMullen, Environment Planner reviewed the report and responded to questions from Council.

Mayor Halloran joined the meeting. (Time: 6:38 p.m.)

Deb Lehman, a Kitchener resident and photographer, described her wildlife findings within the Erbsville South area and discussed her concerns with the Environmental Study not extending to the Schnarr Street area. Ms. Lehman spent over 1500 hours photographing many species throughout the proposed lands, finding many Special Concern Animals such as the Northern Map Turtle, Read Headed Woodpecker and Snapping Turtles and is concerned that these animals will diminish once development begins.

Deb Swidrovich of Waterloo described the significant wildlife within the Block Plan and expressed concerns with the proposed development area. Mrs. Swidrovich requested an extension of the Environmental Study area at the end of Schnarr Street and that wording be put in place to ensure the North Waterloo Scoped Subwatershed Study is complete before proceeding with the Erbsville Block Plan.

Moved by Mayor Halloran, seconded by Councillor Scian:

"That DS2012-025.1 be approved and,

1) that Council endorse the proposed Terms of Reference for the Environmental Study attached as Appendix A, **and direct staff to extend the study area to include land within a 120m circumference of the end of Schnarr Street, excluding existing residential development**;

2) that Council approve the proposed Terms of Reference for the Erbsville South Block Plan Study attached as Appendix B; and

3) that Council receive as information the documents attached as Appendices C, D and E."

Carried Unanimously

b) **New Sign By-law**
Report No. DS2012-056
Prepared By: Danielle Ingram

Danielle Ingram reviewed the report and responded to questions from Council.

Mike Gaudreau, React Signs expressed his concerns with respect to the proposed Sign By-law and implementation of sign zones which will significantly decrease the portable sign allowance throughout the City. He also noted that portable signs are the most heavily regulated signs, are proactively enforced by the Waterloo By-Law division and this year the portable sign permit fees brought in about $84,000 in revenue to the City to date. Mike Gaudreau provided the Clerk with a petition opposing the proposed changes to the zoning for portable signs.

Councillor Scian left meeting: (Time: 8:28 p.m.)
Councillor Scian returned to meeting: (Time: 8:32 p.m.)

Cindy Watkin, Chair, Eastbridge Neighbourhood Association, shared her appreciation of the new Sign By-law in regard to the leniency for neighbourhood associations. Mrs. Watkin also suggested that sign permit applications be available online for convenience.

Dave Lamka, A to Z Signs Ltd., expressed his concerns regarding the portable sign zoning changes, stating that small business owners will lose sales and potentially jobs as a direct result of the constraints in the new By-law. Mr. Lamka requested there not be a ban on mobile portable signs from any zone in Waterloo.

Nima Kia, Planner, Lakeshore Group expressed his concerns regarding the maximum number of signs per property, the discontinuation of freestanding signs at commercial plazas and the lack of a transitioning clause which would permit the property at 315 Lincoln Road to continue with their current sign variance application. Mr. Kia requested that these concerns be considered before the new Sign by-law is approved.

Ben Nightingale, owner of Shoes 22, expressed his concerns regarding the exclusion of portable signs at commercial plazas as 70% of the businesses at his location do not have street facing signs. Mr. Nightingale explained how pertinent portable signs are to their small businesses and the potential negative impact due to proposed zone change in the By-law. He described the accessory signs as not being reasonable as slush and snow will cover them in the winter, and they are subject to vandalism and theft.

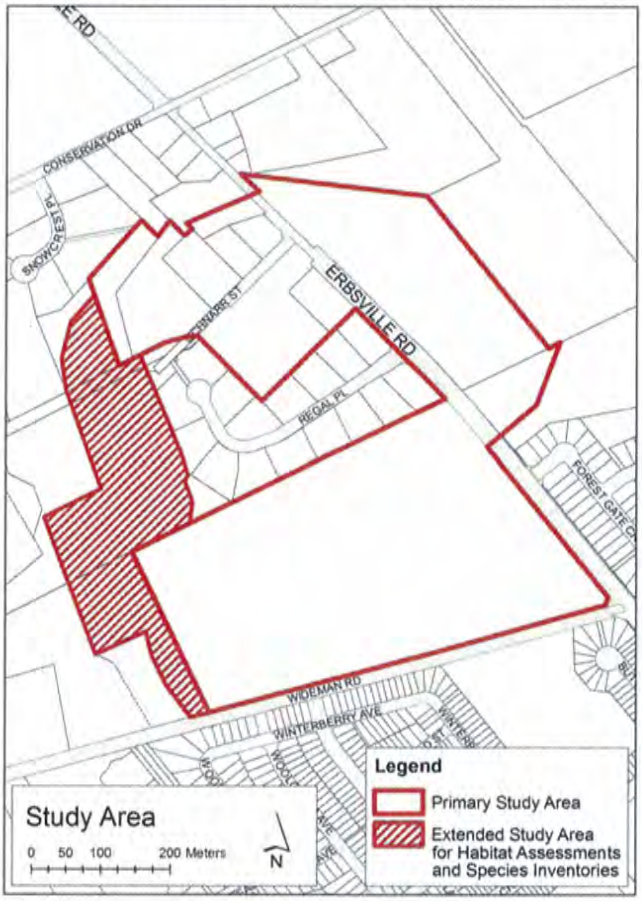
Terms of Reference

Environmental Study
for
Erbsville South Lands, Waterloo
Sunvest Development Corporation

1.0 OVERVIEW

The following Terms of Reference have been prepared by IBI Group to direct environmental research and preparation of an Environmental Study (ES) to support a block planning exercise for the Erbsville South Lands. This study will supplement existing environmental investigations including the *Final Subwatershed Management Plan 309/313* (SWS), prepared by Planning Initiatives Ltd. and Associates, 1996. The purpose of the ES is to identify and categorize natural features and functions, delineate potential development areas and protection areas, and recommend development setbacks and mitigation measures necessary to maintain or improve the ecological sustainability of the area. In this regard, the features and functions of the Laurel Creek Headwater Environmentally Sensitive Landscape will be considered along with those of the Schaefer's Woods Environmentally Sensitive Policy Area (ESPA #17) and Laurel Creek Forest Environmentally Sensitive Policy Area (ESPA #80).

The study area consists of lands located on the east and west side of Erbsville Road at the southern limits of Erbsville that are anticipated to be serviceable by gravity sanitary sewers.



These Terms of Reference have been based on site visits as well as discussions and correspondence with staff from the City of Waterloo, the Regional Municipality of Waterloo and the Grand River Conservation Authority (GRCA). The ES will address issues related to natural heritage including terrestrial and aquatic features, natural hazards, hydrogeology and stormwater management and will be consistent with the recommendations and requirements of the Laurel Creek Watershed Study, Subwatershed Plan #309/313 as well as in accordance with Section 6.35 of the City of Waterloo Official Plan. Consideration will also be given to the City of Waterloo's Draft Official Plan (February 2012), Regional Official Plan (R.O.P.) policies 7.B.12, 7B.13 and 7.C.8 to 7.C.10, the Region's Draft Greenlands Network Implementation Guideline (2011) as well as the Grand River Fisheries Management Plan (1998) and complementary Implementation Plan (2001). A technical work plan will be submitted for review and acceptance prior to the commencement of any field work and must include the actual location, type and number of field surveys and sampling points, a detailed schedule for field work and assessment methodologies and protocols.

2.0 NATURAL HERITAGE

Assessment of vegetation communities will include a review and summary of background information and previous studies, coupled with field inventories to ensure information is current and covers a minimum of three seasons (spring, summer and fall) of data. The Region of Waterloo's Draft Greenlands Network Implementation Guide (Section 3.4) will be referenced for the timing of specific surveys. Existing vegetation communities will be mapped as polygons onto aerial photographs and biophysical data will be collected from all natural and cultural communities according to the Ecological Land Classification System for Southern Ontario (ELC). The botanical survey will include identification of rare, threatened or endangered species based on regional/local, provincial and federal lists. This data will be used for analysis of constraint sensitivities and potential impacts. The Ontario Wetland Evaluation System (OWES) for southern Ontario will be used to delineate all wetland boundaries, which will be confirmed with the GRCA ecologist before being surveyed and mapped. The sedge marsh nearest the intersection of Wideman and Erbsville Roads will be evaluated for potential inclusion within the Sunfish Lake – Laurel Creek Provincially Significant Wetland Complex. Any discrepancies between GRCA and MNR wetland boundaries (>30 metres) will be reviewed with Ministry of Natural Resources staff. The study will also include confirmation to the satisfaction of Region staff of ecologically and topographically appropriate boundaries for ESPA #17 and ESPA #80 consistent with the boundary delineation principles in the Greenlands Network Implementation Guideline, as well as the Laurel Creek Headwater's Environmentally Sensitive Landscape.

The wildlife habitat assessment will include an assessment of the type, structure and quality of vegetative habitats for wildlife use, and the presence of corridors and linkage features to nearby habitats including Monastery Creek and Laurel Creek. Wildlife studies will incorporate review of available wildlife information, supplemented by field assessments. Specifically wildlife surveys will be completed in accordance with the Region of Waterloo's Draft Greenlands Network Implementation Guide during all seasons with emphasis on spring, summer and fall and will include breeding birds following breeding bird atlas protocols, breeding amphibians throughout the spring using the marsh monitoring protocol; and mammals, reptiles, butterflies, and odonates. The presence of species will be based on actual observations as well as the examination of signs such as scats, castings, and tracks. The summary inventory will identify any species of regional/local, provincial and federal significance including species at risk (SAR) in accordance with Ministry of Natural Resources protocols.

Following a review of existing information on aquatic and fish species, including any previous fish assessments, Wideman Creek, the existing pond on the southwesterly parcel as well as the reaches of Laurel Creek that border the study area will be assessed for presence of fish species and quality of fish habitat. A multiple season sampling period (spring, summer, fall) including a fall spawning survey for trout, will be undertaken utilizing the Standard Single Pass Survey approach of the Ontario Stream Assessment Protocol. Classification of fish assemblage (cold, cool or warm water) will be confirmed based on the species observed and habitat will be classified as direct or indirect habitat. In this regard water quality and flow conditions will be assessed when determining the quality of fish habitat. The

GRCA's Aquatic Resource Pre-consultation Checklist will be completed as part of the ES and habitat features such as groundwater recharge and discharge points and constraints will be mapped. An inventory of benthic invertebrates will be undertaken as an indicator of water and habitat quality. Identification will be provided to the lowest practical taxonomic level (genus or species) and will be analyzed according to the reference condition approach (RCA). As the watercourses have been identified as a coldwater fishery, protection will be premised on enhanced criteria. Areas for protection and enhancement will be identified including appropriate buffers from the watercourse. The impact of the existing pond on the wetland and coldwater creek will also be assessed.

A Fluvial Geomorphology component will be included to identify the form and function of the watercourses on the subject lands, to assess the overall stability of the channels based on geomorphic principals, and to provide a general evaluation of the channels and their interaction with the surrounding floodplain. The channel form will be determined by field reconnaissance and reach assessment techniques. Cross sectional bankfull parameters will be determined using standard field indicators, and the plan form and channel profile characteristics will be determined from desk top analysis. Bed form and sedimentary characteristics will be included in the field assessment as an indicator of channel stability and diversity. The critical flow velocity of Wideman Creek will be determined. Indicators of historical and recent erosion and aggradation will be included in the evaluation as an additional indicator of channel dynamics and stability. If deemed appropriate based on the findings, this assessment will include recommendations for stream channel enhancement.

3.0 NATURAL HAZARDS

The Natural Hazard component will address flooding and erosion hazards associated with the two watercourses, Wideman Creek and Laurel Creek. In this regard the floodplain is delineated by the Regulatory Floodline. The ES will explore the possibility of increasing the size of the culvert under Erbsville Road to reduce the floodplain depth on the upstream West Parcel. Various scenarios will be simulated using the most current version of the HEC-RAS hydraulic model and will consider resulting hydrological impacts, ecological impacts to the wetland/forest complex and other onsite vegetation, as well as flooding and erosion impacts downstream of the culvert. Preliminary design investigations will include an open bottom and bridge options to benefit aquatic resources and which allow passage of wildlife under Erbsville Road. All on-site constraints as a result of the Regulatory Floodline (including any changes as a result of culvert upgrading) will be identified and mapped as part of the ES.

4.0 HYDROGEOLOGY

The local hydrogeologic characteristics will be determined through a literature review of existing Studies and Reports previously undertaken in the area. Fieldwork will be completed to provide the required level of site-specific detail including a complete characterization of the shallow overburden groundwater flow regime. The ES will address the linkages between local surface water features, the shallow ground water system and the deeper regional aquifer system.

Borehole locations will be identified and reviewed with City, Region and GRCA staff and may include multi-level monitoring wells. It should be noted that any boreholes within the wooded areas of the properties will be installed with hand-held augers to minimize disturbance to sensitive areas. A survey of private wells within one kilometer of the study area will be undertaken to provide baseline information with respect to groundwater quantity and quality in local private water supplies. A timeframe (minimum one year) for groundwater monitoring will be established in order to identify an appropriate seasonal high groundwater table elevation.

Recharge and discharge areas will be identified, as well as areas vulnerable to groundwater contamination. An assessment of vertical hydraulic gradients and depth to the Regional aquifer will also be undertaken. Water table elevations and flow gradients will be identified as part of geotechnical and hydrogeological investigations. In addition, a water budget assessment will be completed in conjunction

with the surface water component of the ES. These analyses will include a discussion of impacts on Regional well capture zones, a chloride impact assessment, impacts of proposed residential densities, impacts of buried services, and a description of Best Management Practices to allow for existing infiltration rates to be maintained.

5.0 LINKAGES

The significance and role of the study area within the larger landscape and how this will be affected by development will be discussed. The ES will identify existing and potential linkages to core natural features as well as the connection with the adjacent Environmentally Significant Landscape in accordance with Part V of the Region's Draft Greenlands Network Implementation Guideline. This will include consideration of an eco-passage beneath Erbsville Road along Wideman Creek.

6.0 MITIGATION MEASURES

In light of construction activities on adjoining lands, stormwater flows from new development and previous agricultural use, the ES will identify existing impacts in accordance with Section 3.9 of the Region's Draft Greenlands Network Implementation Guideline.

The study will identify mitigation measures and specific construction methods to protect and enhance Core and Supporting natural features and ecological functions and minimize environmental impacts. Consideration will include, but not be limited to, grading activities and secondary containment of any hazardous materials on site. Appropriate buffers will be recommended to protect the significant natural features and ecological functions on site including wetlands, watercourse, the ESPAs and existing hedgerows from future development, and that maintain and/or enhance ecological linkages on and off site with other natural areas including the ESPAs and Wideman Creek corridor. Ecological enhancements, as defined in the Region's Draft Greenlands Network Implementation Guideline, will be identified. The buffer analysis will take into account the recharge/discharge relationship within the watershed when reviewing potential water quality impacts from land use activities. Any buffer evaluation will be in accordance with Sections 8.2.4 and 8.2.5 of the City of Waterloo's Draft Official Plan, and Part IV of the Region's Draft Greenlands network Implementation Guideline. Potential restoration areas will also be identified. Special focus on management of human uses after construction will be addressed, including demarcation of buffers and/or natural features, trails, invasive landscape materials, domestic pets, increased noise and exposure to artificial light. Proposed stewardship options for the ESPAs and buffer areas on the site will also be provided.

7.0 STORMWATER MANAGEMENT

Specific stormwater management criteria for the study area are identified in the approved Subwatershed Study #309/313 (Table D1.3). The proposed conditions hydrologic modeling will be completed using the SWMHYMO computer model to determine pond storage requirements for a range of events including the 25mm, and 2, 5, 25, and 100-year storms. Control of the Regulatory storm event is not required as outlined in the SWS. Controlling proposed conditions peak flows to pre-development conditions (as defined in the SWS) will be the required quantity criteria. An Enhanced Protection Level for water quality control is required, including modelling and retention times for the 25mm storm, as is extended detention for erosion control as per the SWS. In addition, infiltration targets in accordance with the SWS will be addressed.

The study will assess current stormwater flow from the Laurel Creek Village subdivision, south of Wideman Road and the effects of such flow to either sustain or impact the current site water balance. Preliminary plans for stormwater management facilities, including ponds and infiltration areas will be prepared. The stormwater management pond preliminary design will account for thermal impacts of storm runoff. A complete analysis will be undertaken of all proposed stormwater management facilities relative to the existing water balance and natural areas. Water balance calculations, utilizing GRCA's

most recent GAWSER model, will be completed based on the results of the hydrogeological component of the ES to ensure that the hydrologic balance for the site, including the quantitative and qualitative aspects of the hydrological and hydrogeological regimes sustaining the ESPAs, wetlands and watercourses, is maintained.

A Pre-Development Monitoring Program for the developing lands will be outlined in the ES, and will follow the criteria set out in the SWS for collecting baseline conditions. Specific parameters will be identified including but not limited to dissolved oxygen (preferably pre-dawn DO measurements), total suspended solids, total phosphorus, water temperature and *E. coli*. A Terms of Reference for Pre-Development Monitoring will be prepared and submitted to the City, Region and GRCA for review and approval and will be appended to the ES. The program will include in-stream temperature monitoring in locations above and below any future stormwater management facilities.

8.0 CONCLUSIONS AND RECOMMENDATIONS

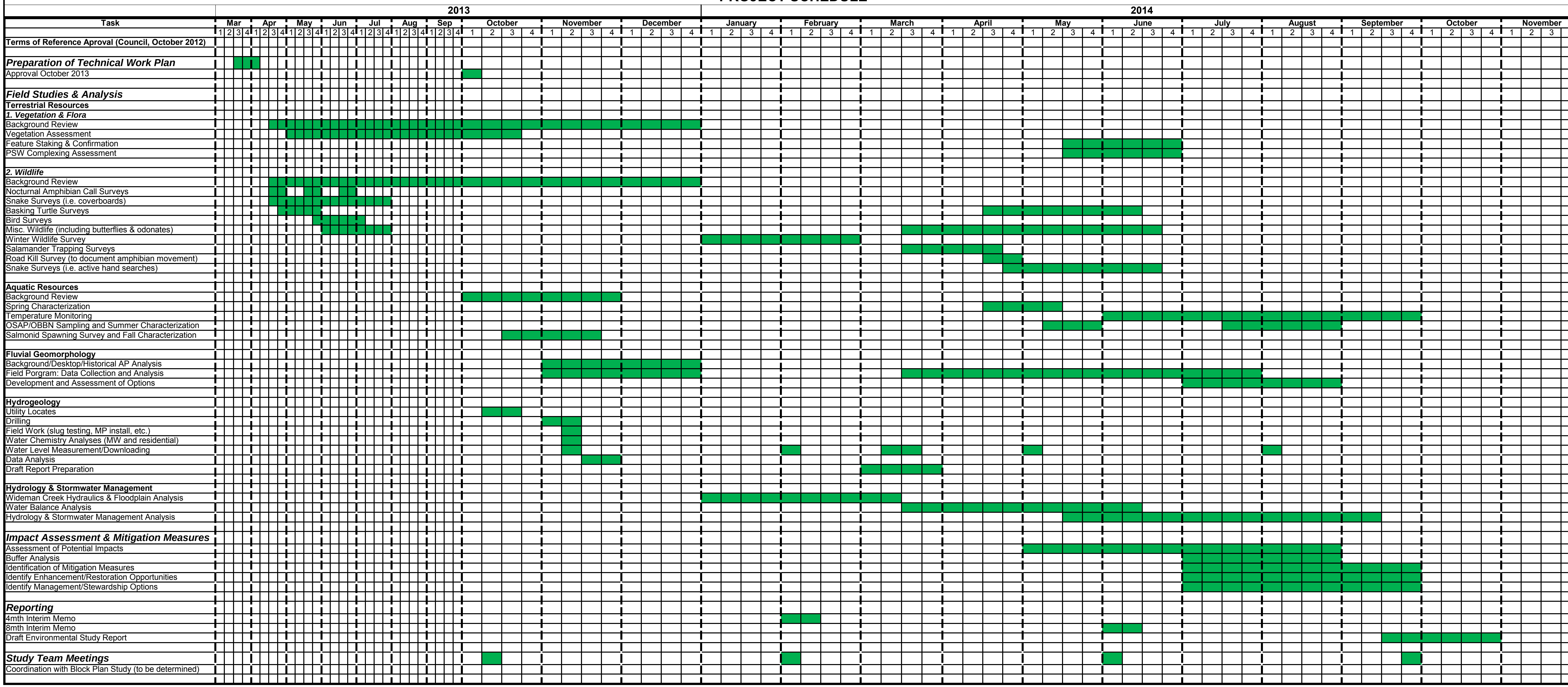
Utilizing the findings from all components, an Opportunities and Constraint Map will be prepared to guide the block planning exercise and future residential development proposed for the study area. In addition, any revisions to the SWS constraint mapping will be identified. Recommendations for next steps and mitigation of any adverse impacts and special issues will also be provided.

APPENDIX B

TIMELINE CHART

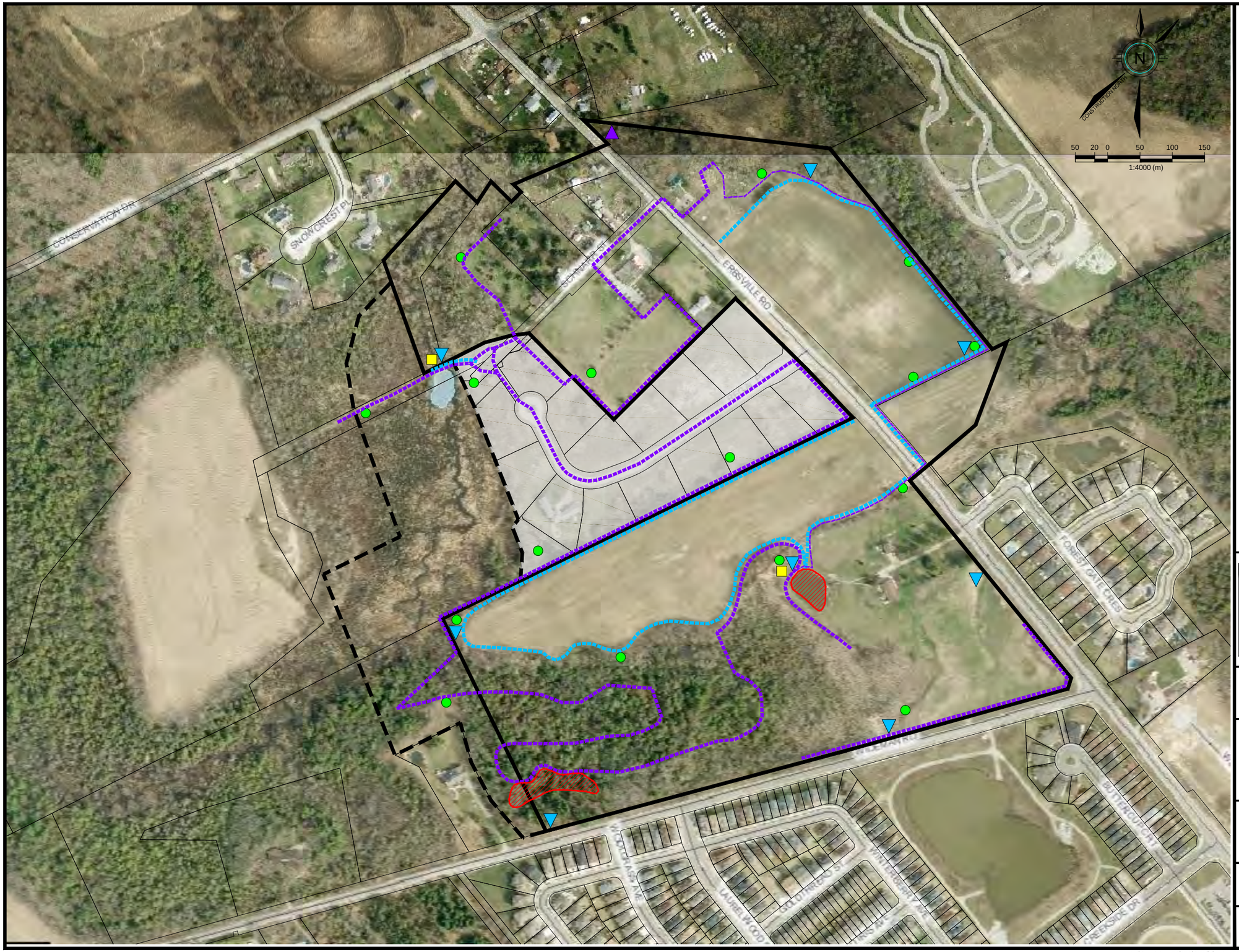
ERBSVILLE SOUTH ENVIRONMENTAL STUDY

PROJECT SCHEDULE



APPENDIX C

SURVEY LOCATION MAPPING



LEGEND

- STUDY AREA BOUNDARY
- EXTENDED STUDY AREA BOUNDARY FOR HABITAT ASSESSMENTS AND SPECIES INVENTORIES
- AREA NOT INCLUDED IN STUDY AREA
- BTS - BASKING TURTLE SURVEY
- BBS - BREEDING BIRD SURVEY
- BBS ROUTE
- CB - COVER BOARD SURVEY
- NACS - NOCTURNAL AMPHIBIAN CALL SURVEY
- NACS ROUTE
- SALAMANDER TRAPPING SURVEY

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PROJECT No.	34168

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REGIONAL MUNICIPALITY OF WATERLOO

ERBSVILLE SOUTH ENVIRONMENTAL STUDY

WILDLIFE SURVEY STATIONS & ROUTES

FIGURE 1

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LEGEND

- STUDY AREA BOUNDARY
- EXTENDED STUDY AREA BOUNDARY FOR HABITAT ASSESSMENTS AND SPECIES INVENTORIES
- AREA NOT INCLUDED IN STUDY AREA
- POTENTIAL OSAP AND OBBN SITES
- 4 POTENTIAL LOCATION OF TEMPERATURE LOGGERS

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ERBSVILLE SOUTH ENVIRONMENTAL STUDY

AQUATIC RESOURCES WORK PLAN

FIGURE 2

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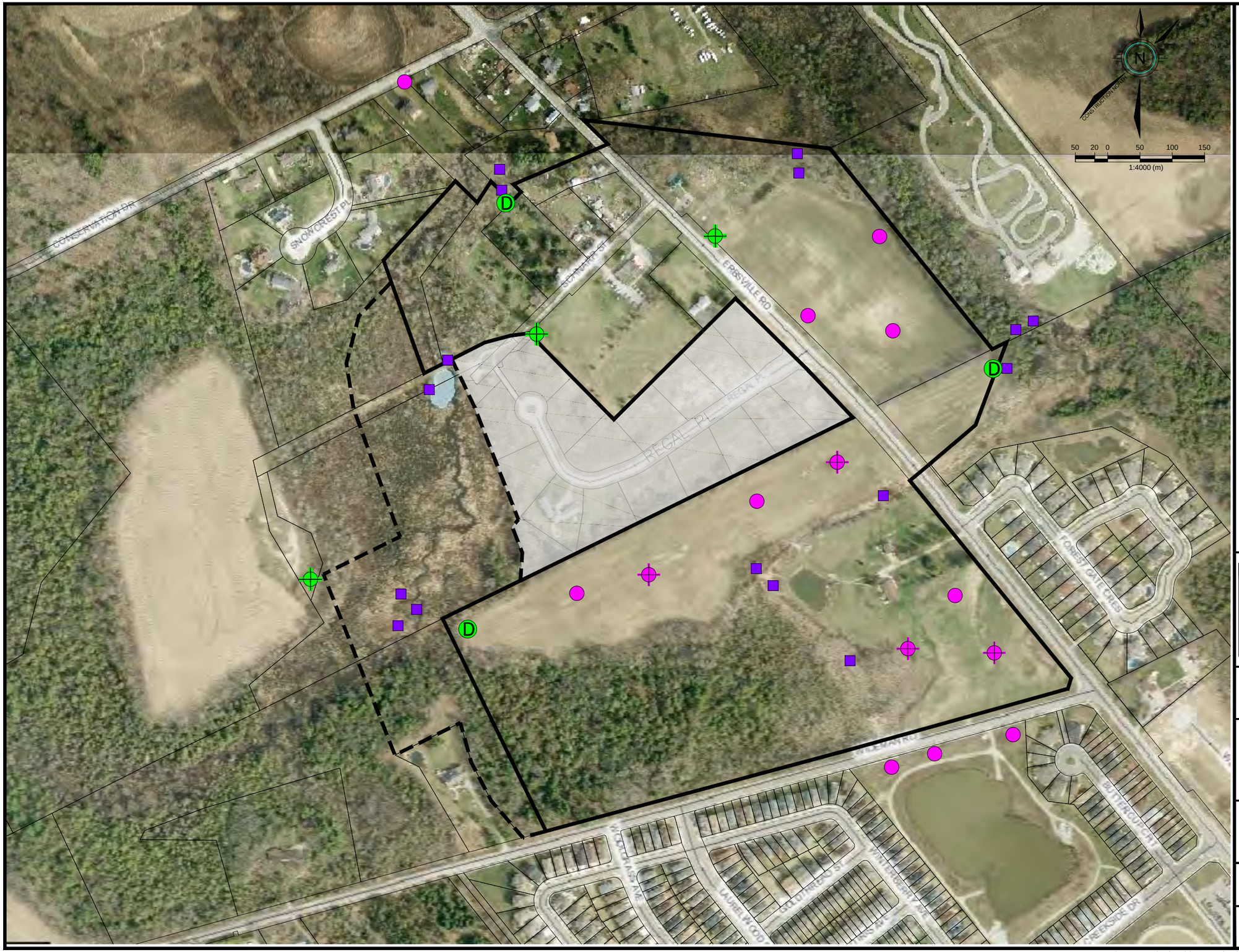

LEGEND

- STUDY AREA BOUNDARY
- EXTENDED STUDY AREA BOUNDARY FOR HABITAT ASSESSMENTS AND SPECIES INVENTORIES
- AREA NOT INCLUDED IN STUDY AREA
- APPROXIMATE LOCATION OF PREVIOUSLY DRILLED BOREHOLES/MONITORING WELLS
- APPROXIMATE LOCATION OF EXISTING MONITORING WELLS
- APPROXIMATE LOCATION OF PROPOSED NEW MONITORING WELLS
- D — APPROXIMATE LOCATION OF DEEP MONITORING WELLS INSTALLED IN REGIONAL AQUIFER
- APPROXIMATE LOCATION OF PROPOSED MINI PIEZOMETERS

NOTES

1) LOCATIONS OF NEW MONITORING WELLS ARE APPROXIMATE AND MAY BE ADJUSTED TO REFLECT PROPERTY ACCESS AND LANDOWNER AUTHORIZATION.
2) SOME NEW MONITORING WELLS WILL BE COMPLETED AS MULTI-LEVEL (NESTED) WELLS.
3) EXITING WELLS SELECTED FOR LONG TERM MONITORING PROGRAM ARE SUBJECT TO CHANGE, BASED ON ASSESSMENT OF WELL CONDITION DURING FIELD PROGRAM.

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HYDROGEOLOGY WORK PLAN

FIGURE 3

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Erbsville South Environmental Study

1st Interim Technical Memo
(4th Month Mark from Study Commencement)
February 14, 2014

1.0 INTRODUCTION

In October 2012, the Council for the City of Waterloo approved the Terms of Reference for the *Erbsville South Environmental Study* (ES). The purpose of the study is to supplement existing environmental information that is contained within the *Laurel Watershed Study* (1993) and the subsequent *Final Subwatershed Management Plan 309/313* (SWS, 1996) and will constitute a Comprehensive Environmental Impact Study for the Erbsville South Area. The findings and recommendations of the ES will be integrated into the environmental component of the *Erbsville South Block Plan Study*.

On behalf of Sunvest Development Corporation, **IBI Group** is responsible for the coordination and preparation of the ES. In this regard a team of experts has been engaged to investigate the various disciplines that will be examined during this study. They include **Dougan & Associates** for terrestrial resources including flora and fauna, **C. Port and Associates** for aquatic resources, **JTB Environmental Systems Inc.** for the fluvial geomorphology component, **LVM inc.** for hydrogeology and **IBI Group** for civil engineering, hydrology and stormwater management. Study Team members are responsible for securing any necessary permits and approvals needed to undertake their respective fieldwork.

In accordance with the Terms of Reference for the ES, a Technical Work Plan was prepared by the Study Team to outline in more detail the process that will be utilized to complete this study. The work plan was reviewed by various agencies including the City of Waterloo, Regional Municipality of Waterloo, Grand River Conservation Authority and the Ministry of Natural Resources with final approval given on October 4, 2013. This approval date marks the commencement of the Study.

As part of the Environmental Study process, the following protocol is to be adhered to for the purpose of embedding checkpoints to ensure study findings and results are aligning with existing information:

- *Interim Technical Memos covering all parameters of the study will be prepared and issued at the 4 and 8 month mark from the commencement of the study.*
- *The Technical Memos will summarize the findings to date and demonstrate how they fit within the context of/align with existing data.*
- *Should the data not align, the Technical Memos will outline how the fieldwork program will be modified to address anomalies/inconsistencies.*
- *If substantive work plan changes are required it is understood that City staff will report back to Council.*
- *The Interim Technical Memos will be made available to members of the public as information upon request and will be available on the City's website.*

This report is provided to satisfy the first Interim Technical Memo at the fourth month mark from the commencement of the study. The format of this report follows the various disciplines and study

components outlined in the Technical Work Plan (refer to attached). The Laurel Creek Watershed Study, the subsequent Subwatershed Management Plan 309/313, as well as the recently approved North Waterloo Scoped Subwatershed Study have been referenced as sources of existing data for comparison purposes. Given the time of year of the study commencement, some work has been completed, some is underway and some is yet to be initiated. It is expected that the next Interim Technical Memo at the eighth month mark from the study commencement will be more robust in content.

2.0 SUMMARY OF COMPLETED STUDY COMPONENTS AS OF FEBRUARY 4, 2013

2.1 Natural Heritage

2.11 Terrestrial Resources (Dougan & Associates)

The reader will note that many of the following field investigations were conducted by Dougan & Associates in the spring, summer and fall of 2013 prior to the approval of the Technical Work Plan. This was due largely because it was anticipated that approval of the TWP was imminent, and they did not want to miss seasonal timing windows. They also did not anticipate any concerns with the survey methodologies, as they are largely accepted as standards in the environmental consulting industry. Ultimately, all of the tasks completed were conducted in accordance with the approved Technical Work Plan, with the exception of the "Snake Surveys (i.e., coverboards)". MNR made it clear that it did not consider the use of cover boards an adequate methodology upon which to determine the presence/absence of snakes, unless the boards had been installed continuously on site for more than 2 years. As a result, "Snake Surveys (i.e. active hand searches)" will be undertaken in the spring and early summer of 2014. The results of the 2013 coverboard surveys will be considered supplementary. The City of Waterloo, Region of Waterloo and the Grand River Conservation Authority have confirmed their acceptance in this regard.

In accordance with the list of field investigations outlined in the Technical Work Plan, Dougan and Associates report the following:

- Vegetation Assessment: Vegetation communities in the Primary and Extended Study Areas were assessed and delineated through field studies as per the protocol of the Ecological Land Classification (ELC) System for Southern Ontario, 1st approximation (Lee *et. al.*, 1998). Field surveys were not completed for properties where permission to access had not been granted by landowners. A combination of air photo interpretation and roadside surveys were used to map these areas as accurately as possible. ELC polygon mapping is currently underway. Spring, summer and fall botanical surveys were carried out simultaneously with ELC field surveys. This data is currently being entered into a database so it may be analyzed. The findings of ELC and botanical studies are not yet available.
- Wetland Assessment: The small unevaluated wetland was assessed during 2013 field surveys (May 17 & July 16). LIO wetland map layers from MNR have been obtained and reviewed. A brief letter report will be prepared by Wendy Frise (Dougan & Associates Ecologist & Certified OWES Wetland Evaluator) and is expected to be completed and submitted to agencies prior to the initiation of spring 2014 field work. A conclusion on whether the wetland should be complexed with the existing PSW is yet to be determined.
- Feature Staking and Confirmation: D&A were prepared to move forward with these site walks in August 2013; however discussions with IBI Group indicated that site walks should be postponed until the Technical Work Plan (TWP) received final approval. Staking site walks to confirm natural feature boundaries are seasonally-dependent and the appropriate timeframe for 2013 had passed by the time the TWP received final approval. Agencies will be contacted in spring/summer 2014 for site walk scheduling. There are no findings to report at present.
- Winter Wildlife Survey: The winter wildlife survey has not been completed yet. It is scheduled take place before the end of February 2014. There are no findings to report at this time.

- Nocturnal Amphibian Call Surveys: In accordance with the Marsh Monitoring Program (MMP) (BSC, 2009), three nocturnal amphibian surveys were conducted under appropriate weather conditions on April 27th, May 22nd and June 15th, 2013. Eight (8) call stations were surveyed during each visit located a variety of applicable habitat types across the study area. Calling amphibians were detected at every station during each round of surveying. As to be expected within seasonal breeding windows, Spring Peepers (*Pseudacris crucifer*) were most prominent during the earliest survey and were not detected during the third survey. Meanwhile, Gray Treefrogs (*Hyla versicolor*) were most prominent during the second survey and remained fairly prominent through the third. Additional species detected include American Toad (*Anaxyrus americanus*), Northern Leopard Frog (*Lithobates pipiens*) and Green Frog (*Lithobates clamitans*). Amphibians were detected in a wide range of habitat on and offsite. Large wetland areas such as the riverine marshes west of the study area were clearly significant for amphibian breeding, but smaller features throughout including vernal pools in woodlands and hedgerows and farm ponds were also active.
- Snake Surveys: Prior to receiving guidance from MNR with respect to recommended survey techniques, a coverboard survey was initiated. Twenty-four (24) coverboards were set out within the study area on May 8th, 2013. Each of these coverboards was surveyed on June 4th, June 19th and October 21st. They were removed following the final check. Although late in the season the October survey was carried out under appropriate weather conditions. Coverboards were placed to encompass a range of potential snake habitat including forest, field and marsh edges as well as adjacent to basking habitat such as rocks and other debris. Additionally several of the coverboards were placed in potential salamander habitat, which included low-lying forested areas near to vernal pools. As per guidance from MNR (see above), three snake surveys (*i.e.* active hand searches) are still scheduled to take place in the spring and early summer of 2014. Over the course of the three coverboard surveys, only one snake was actually observed under a coverboard. On June 4th, an Eastern Gartersnake (*Thamnophis sirtalis sirtalis*) was observed resting under coverboard 17. Under coverboard 15, a Shrew (*Sorex sp.*) was observed on June 19th and on October 21st a Meadow Vole (*Microtus pennsylvanicus*) was observed in its nest under coverboard 18. All three of these coverboards (15, 17 and 18) were placed at the edge of forest and field and near to marsh near the southwestern part of the study area. There are no results to report for the active hand searches. These will be completed during the spring and early summer of 2014.
- Turtle Surveys: Dedicated basking turtle surveys took place on April 27, May 16 and September 20, 2013. Two locations were carefully checked, the Laurel Creek crossing west of Schnarr Street and the pond north of Wideman Road. These two features were also checked during the breeding bird surveys conducted on June 7 and June 14, 2013. According to MNR's Blanding's Turtle survey protocol, three additional surveys will need to be conducted in 2014. These will take place after ice cover has melted and before June 15th. A hatchling turtle survey was conducted on and adjacent to the Regal Place property on September 20, 2013. No turtles were observed during the dedicated turtle surveys. However, two Midland Painted Turtles were documented from the pond feature during the breeding bird survey on June 14, 2013. On September 20, 2013 the residents (665 Erbsville Road) who own the pond indicated that they have seen two Snapping Turtles in the pond. They also showed D&A staff where one of them had nested in their yard, east of the pond. Snapping Turtle is designated Special Concern in Ontario and Canada. Evidence of turtle nesting was found at three locations during the September 20, 2013 visit. All three locations were on the Regal Place property. The first appeared to be a raided Snapping Turtle nest, the second possibly an abandoned nesting attempt, and the third, a raided Midland Painted Turtle nest. The first two locations were in an area of mowed grass near the turning circle. Clearly, some turtles are using the available aquatic features present to forage within and nest.
- Salamander Surveys: Salamander surveys have not been completed, hence there are no findings to report at this time. Surveys will take place in early spring (March-April) of 2014. The next step will be to get the necessary permits from MNR to undertake the work. Permit applications are due February 15, 2014.
- Breeding Bird Surveys: Two breeding bird surveys were conducted on June 7 and June 14, 2013. Fifty-two (52) species of birds were detected during the surveys, with 43 species tallied on June 7

and 47 species on June 14. None of the species documented are unexpected given the variety of habitat types present. Two Species at Risk (SAR) were detected during the surveys: Eastern Wood-Pewee, (designated "Special Concern" in Canada by COSEWIC), and Barn Swallow (designated "Threatened" in Ontario and Canada). The Eastern Wood-Pewee involved one territorial bird in the woods adjacent to Wideman Road, in the southwest corner of the property. There were at least two pairs of Barn Swallows foraging in the open areas around the pond and house at the northwest corner of Wideman Road and Erbsville Road. At least one pair was nesting in a gazebo adjacent to the pond, and there was evidence of past nesting on the nearby house. According NHIC, all 49 native breeding species have a provincial conservation rank of S4 or S5, which indicates that they are "apparently secure" or "secure", respectively. At a regional level, 8 species have been designated by Partners in Flight as priority species for conservation in Bird Conservation Region (BCR) 13 (Lower Great Lakes/St. Lawrence plain): Black-billed Cuckoo, Northern Flicker, Eastern Wood-Pewee, Eastern Kingbird, Brown Thrasher, Field Sparrow, Rose-breasted Grosbeak, and Baltimore Oriole. At a local level, most of the 49 native species recorded are considered common in the Regional Municipality of Waterloo (RMW 1996). **However the RMW list is out of date and may no longer accurately reflect local status.** The exceptions are as follows: Rare (R) – Hooded Merganser, Sharp-shinned Hawk, Red-bellied Woodpecker; Uncommon (U) – Black-billed Cuckoo, Pileated Woodpecker, Alder Flycatcher, Warbling Vireo, Brown Thrasher, Mourning Warbler, and Swamp Sparrow. According to MNR, 3 of these breeding bird species are Area Sensitive: Sharp-shinned Hawk, Pileated Woodpecker, and White-breasted Nuthatch (OMNR 2000). This indicates that these species require large areas of suitable habitat for their long-term survival.

- Incidental Wildlife Surveys: Incidental wildlife observations were made during most survey visits to the study area. This included the following dates: April 27, May 8, May 16, May 17, May 22, June 4, June 7, June 14, June 15, June 19, July 16, August 14, September 20, October 21, and October 22, 2013. Of the wildlife species documented, the most noteworthy observations pertain to Snapping Turtle, Bullfrog, Monarch, and Great Egret. The Snapping Turtle and Bullfrog observation information (collected July 16, 2013) was passed along by the local resident. According to the resident, Snapping Turtles have been observed nesting in the lawn. Snapping Turtle is designated Special Concern in Ontario and Canada. Bullfrog is designated "rare" in the Regional Municipality of Waterloo. Although there is likely little concern over the identification of Snapping Turtle, it is assumed that Bullfrog was identified correctly. The Monarch documented from the Regal Place property on September 20, 2013 was considered a migrant passing through on its way south. Monarch is designated Special Concern in Ontario and Canada. The Great Egret observed at the stormwater management pond south of Wideman Road on September 20, 2013 was also considered a non-breeder at the site or adjacent lands. Great Egret has a provincial conservation rank of S2, which means it is considered an "imperiled" breeder with typically less than 20 breeding populations in Ontario. Additional records of potential breeding birds were recorded by local residents. These nine (9) species, which are only those that were not observed during the breeding bird surveys on June 7 and 14, 2013, are listed in Table 2 below.

Table 1 – Potential breeding bird species documented by local residents.

SPECIES	DATE	OBSERVER(S)	COMMENTS*
American Bittern	May – June, 2013	Local observers	Scarce in RMW; Area-sensitive
Great Egret	May 25, 2013	Janice Fritz	Considered non-breeding visitant only.
Turkey Vulture	May – June, 2013	Local observers	Non-breeding visitants (flyovers)
Ruby-throated Hummingbird	May – June, 2013	Local observers	Uncommon in RMW
Red-headed Woodpecker	May 18, 2013	Deb Lehman	Outside Erbsville South study area; THR nationally; SC provincially; PLS in BCR 13; uncommon in RMW
Willow Flycatcher	May – June, 2013	Local observers	Uncommon in RMW; PLS in BCR 13.
Eastern Bluebird	May – June, 2013	Local observers	Uncommon in RMW
Northern Mockingbird	May – June, 2013	Local observers	Potential in RMW (status needs updating)
Canada Warbler	May 18, 2013	Deb Lehman	Outside Erbsville South study area; considered migrant only; THR nationally; SC provincially; PLS in BCR 13; AS

* RMW = Regional Municipality of Waterloo; THR = Threatened; SC = Special Concern; AS = Area Sensitive; PLS = Priority Landbird Species in BCR 13 = Bird Conservation Area 13 (i.e. Lower Great Lakes/St. Lawrence Plain).

- Road Kill Survey: The dedicated survey has not been completed yet. It will take place in the spring of 2014. Following the nocturnal amphibian call surveys conducted on April 27th, May 22nd and June 15th 2013, Erbsville Road and Wideman Road were scanned slowly, looking for evidence of any dead frogs or toads. On June 7 and June 14, Wideman Road and Erbsville Road, opposite the study area, were checked for dead turtles. None were observed.

2.12 Aquatic Resources (C. Portt and Associates)

- A trout spawning survey was conducted by C. Portt on November 10, 14 and 19, 2013. Laurel Creek was examined from just downstream of its confluence with the Wideman Tributary to Erbsville Road and from the limit of the City of Waterloo property downstream from Schnarr Street upstream to the study limit. A reach approximately 150 m long, immediately upstream from Erbsville Road was not examined because permission to access the private properties was not granted. The Wideman Tributary was examined from its confluence with Laurel Creek upstream to Erbsville Road.
- The creeks were carefully examined looking for evidence of the substrate being disturbed in a manner consistent with spawning activity by brown trout or brook trout. The substrate was noted and representative reaches and features of interest were photographed. The locations of features and photographs were determined using a Garmin model CS76CSx gps.
- No evidence of trout spawning was observed in any of the reaches examined. The substrate appeared to be too fine for brown trout spawning through most of the reaches of Laurel Creek that were examined. The exception was from Erbsville Road downstream for approximately 200 m, where the substrate was appropriate (pebble/gravel) and riffles were present. The Wideman tributary also had fine substrate and the bottom was covered in senescent vegetation (mostly grasses), and not suitable as trout spawning habitat (Photograph 1).
- A beaver dam located just upstream from the confluence of Laurel Creek and the Wideman tributary (Photograph 2), flooding the immediate area and increasing the depth and decreasing the gradient and velocity for approximately 300 m upstream. There has also been beaver activity upstream from Schnarr Street in the past, with remnants of dams and a lodge present. Although there was no active dam, this area had extensive areas of flooding when it was examined (Photograph 3).
- Seepage was evident along slope that is north of Laurel Creek upstream from the Wideman tributary. A more defined spring was observed downstream from Schnarr Street, also on the north side of the creek. A small tributary enters Laurel Creek from the north-east near the point where the valley orientation changes downstream from Erbsville Road. An abandoned farm lane or road crossing of Laurel Creek, which the main channel has now bypassed, is present downstream from Erbsville Road (Photograph 4).

Photograph 1 - Typical condition of the Wideman tributary to Laurel Creek downstream from Erbsville Road. November 10, 2013.

Photograph 2 - Flooded area behind beaver dam (just visible in lower left), upstream from the confluence of Laurel Creek and the Wideman tributary. November 10, 2013.

Photograph 3 - Abandoned beaver dam and flooded area upstream from Schnarr Street. November 19, 2013.

Photograph 4 - Laurel Creek has eroded around a former farm lane or road crossing downstream from Erbsville Road. November 14, 2013.

2.13 Fluvial Geomorphology (JTB Environmental Systems Inc)

- A site walk was completed in the fall along the environmental area adjacent to the site to determine existing field conditions and to put the area in context for the overwinter study work. A preliminary meander belt study for Laurel Creek has been undertaken based on the 1954 and 2010 images resulting in a preliminary maximum belt of 40 metres. There are some relatively tight meanders but the creek itself is more of a swampy wet area and there appears to be no meandering of substance in the air photo periods. JTB staff did attend the site more recently to see if there were erosion scars on some of the tight banks however, winter conditions prevented a clear view of the banks. This will be reviewed again in the spring.
- With respect to threshold work sensitive sites for analysis have been selected. Possible stormwater outlet locations will be included when information becomes available.
- The swales running north off Wideman Road as well as Wideman Creek were also reviewed on site. JTB staff are currently waiting for a spring melt in order to document what happens when higher flows go through the study area

2.2 Natural Hazards (IBI Group)

- The analysis of the culvert crossing has commenced, and the results, once finalized, will be provided to the terrestrial and aquatic resources team members to determine the impacts on and mitigation measures for the watercourse and wetland. Based on the results to date, the replacement culvert will be an open-bottomed concrete box structure that will have the capacity to lower the upstream floodline elevations. The modelling has also accounted for a natural creek bottom at the crossing location, which will provide benefits for aquatic habitat.

2.3 Hydrogeology (LVM inc.)

- Borehole Drilling: Nine boreholes were drilled between October 18 and November 18, 2013 by Geo-Environmental Drilling Inc. to depths ranging from 4.57 to 26.36 metres. Soil samples were recovered at regular .75 and 1.50 metre depths. Monitoring wells were installed in each of the boreholes in accordance with Ontario Regulation 903 (as amended). Multiple monitoring wells were installed in two of the wells to enable measurement of vertical gradients between saturated units encountered during drilling.
- Mini-Piezometer Installation: Twenty-five mini-piezometers were installed around the wetland areas in the study area using a hand auger in order to assess the connection between shallow groundwater and surface water.
- Surveying: All borehole, mini-piezometer and associated ground surface elevations were surveyed to geodetic datum by IBI Group and supplied to LVM.
- Monitoring: Manual measurements of stabilized groundwater levels in the monitoring wells and mini-piezometers were collected between November 20 and 27, 2013 representing the first quarterly water level measurement. Continuous groundwater monitoring is currently being conducted with the first datalogger download occurring later in February 2014 during the second quarterly measurement. Datalogger readings will be compared with the manual readings taken during the quarterly measurements.
- Laboratory Soil Testing: Soil samples from the boreholes were examined for moisture content analysis and particle size distribution analysis. Depending on the location topsoil is either underlain by a layer of clay or silt/sand. Granular deposits are less extensive in the study area and are typically saturated forming a shallow overburden aquifer. The granular deposits are underlain at depth by deposits of silt, silt till, clay and silt/sand.
- Hydraulic Conductivity: Single response slug tests were undertaken in each of the boreholes for the saturated soils at depth in order to determine hydraulic conductivity estimates.
- Groundwater Elevations and Flow Directions: Based on the data collected by LVM and previously by others, groundwater is typically found within the granular deposits below the study area, which are interpreted to be hydraulically connected. Groundwater in the overburden aquifers flows toward Laurel Creek and Wideman Creek driven by the topography and surface drainage

features. The general flow gradient slopes towards Laurel Creek. An aquitard separates an unconfined Shallow Overburden Aquifer from the generally confined Deep Overburden Aquifer and is important to the protection of groundwater resources in the area. The shallow groundwater table was generally encountered within the first five metres below the ground surface. Groundwater recharge was noted in a small area with outcropping granular deposits around Schnarr Street and on till deposits (mounding) south of Regal Place. A cluster of monitoring wells installed in the Extended Study Area to measure downward vertical gradient between the upper and lower aquifers indicated recharging conditions in this location. However, a second cluster on the east side of Laurel Creek indicated both upward and downward gradients within the same week. This will be further investigated as monitoring continues. Discharging conditions were noted at the confluence of Wideman Creek with Laurel Creek. In proximity to the wetland areas measurements from the mini-piezometers indicated groundwater levels range from 0.2 above to 0.4 below the ground surface.

- Groundwater Chemistry: Groundwater samples were obtained from the monitoring wells on November 21 and 22, 2013 as well as three residential wells located within the study area on January 27, 2013. Samples taken from eight of the monitoring wells had Total Lead values that exceed ODWS criteria limits. In addition one well exceeded criteria limits for total Barium and Chromium. These exceedances may be related to the adsorption of metals onto suspended soil particles which are not field filtered per ODWS guidelines. Concentrations of all dissolved metals were well below the ODWS criteria threshold. Chloride levels were also relatively low with the highest measurement noted in the sample taken from a well in close proximity to Erbsville Road. A post-development chloride loading calculation will be completed once a preliminary road layout has been established.
- Pre-Development Water Balance: Overall runoff within the study area is relatively high and infiltration low due to poorly draining silt/till soils. Where localized conditions permit, at-source infiltration will be possible to the shallow aquifer, however, infiltration will be limited in areas of shallow groundwater.

2.4 Storm Water Management (IBI Group)

- The stormwater management and water balance analyses will commence once buffer limits have been established, and once results of the hydrogeological investigation are available. Buffer limits (in conjunction with the Regulatory floodline location) will be used to determine development limits, the locations of stormwater management facilities, and the locations of storm outlets. The hydrogeological investigation will be used in establishing a water balance for the Study Area, and for recommending mitigation measures under proposed conditions (infiltration facilities and Best Management Practices). The results will also be used in establishing pre-development, during-construction, and post-construction monitoring programs.

3.0 COMPARISON OF FINDINGS WITH EXISTING STUDIES

Only the Terrestrial Resources component being undertaken by Dougan & Associates and the Hydrogeology component undertaken by LVM inc. have proceeded sufficiently to provide any measurable comparison with existing studies. The existing studies used for comparison include the Laurel Creek Watershed Study, the subsequent Subwatershed Management Plan 309/313, as well as the recently approved North Waterloo Scoped Subwatershed Study.

3.1 Terrestrial Resources:

- Laurel Creek Watershed Study: Study area size is a determining factor in the level of detailed investigations that can be undertaken in a study. The Laurel Creek Study field identified 128 vegetation units excluding agricultural fields and hedgerows within the watershed. However, in order to simplify presentation and discussion these units were merged into four categories. Dougan & Associates on the other hand have classied vegetation within the Erbsville South study area in accordance with the protocol of the Ecological Land Classification (ELC) System for

Southern Ontario, thus providing significantly more detail. For the Laurel Creek Study wetland and wildlife information was obtained from the Ministry of Natural Resources. Only two limited areas were identified as having specialized habitat value and both were located well outside the Erbsville South study area. In addition no breeding bird surveys were conducted. The study relied on observations during vegetation field work and bird lists available for ESPAs. In comparison, fifty-two species were identified during the breeding bird surveys undertaken by Dougan & Associates. The Greenspace System and Constraint Levels developed in the Laurel Creek Watershed Study identified areas for protection and continues to be a foundation for subsequent and current studies.

- Subwatershed Management Plan 313/309: The Subwatershed Study provided some further detail and made some modifications to the constraint mapping of the Laurrel Creek Watershed. Within the Erbsville South Study area almost all of the natural areas are identified as Constraint Level 1 which requires form and function to be protected. Core Feature areas will be confirmed and appropriate buffers determined as the Erbsville South Study proceeds.
- Waterloo North Scoped Subwatershed Study: The study area for this scoped subwatershed study is immediately adjacent to the Erbsville South Study Area with some overlap along Laurel Creek. Significantly more detail utilizing current protocols has been incorporated into Waterloo North study than previous subwatershed studies such as Subwatershed Management Plan 313/309. Where appropriate, connections between the two have been taken into consideration by Dougan & Associates when planning the terrestrial work schedule. For example, report was reviewed to see if any terrestrial linkages were envisioned between the two areas. Although none were highlighted, special attention was paid to potential linkage opportunities. In addition, the various species lists contained within the appendices were reviewed to help anticipate the range of species that might be expected on the Erbsville South Environmental Study Area and thus guide the need for any additional surveys to be conducted in 2014.

3.2 Hydrogeology

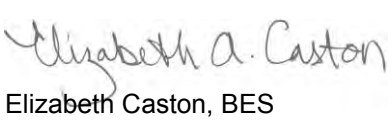
- Laurel Creek Watershed Study: For this exercise, the Laurel Creek Study provides us with the earliest understanding of the hydrogeology of the area. Work undertaken by Terraqua Investigations identified the stratified nature of the overburden with silty/clay till aquitards separating layers of sandy/granular aquifers. Although no monitoring wells were drilled within the Erbsville South study area, several seepage meters and mini-piezometers were install along Laurel Creek and Wideman Creek. This study determined that groundwater generally flows south-easterly and towards Laurel Creek. The layer of Maryhill Till prevents significant quantities of groundwater to migrate or recharge to depth. Permeable material above this layer controls local recharge and discharge. This report also identified that in some locations in the Erbsville area upward movement of water from depth indicating it is a regional discharge area. LVM has concluded that the Erbsville south area is within a transition zone with both recharging and discharging conditions.
- Subwatershed Management Plan 313/309: Only two boreholes were drilled within Subwatershed 309 and none drilled within the Erbsville Study Area for this study. However the two monitoring wells were in close proximity to the study area and were located a) on the south side of Wideman Road just west of Erbsville Road and b) on the south side of Conservation Drive just east of Erbsville Road near Conservation Creek. Only three mini-piezometers were installed on Wideman Creek, Laurel Creek and Conservation Drive. Where possible the Subwatershed utilized data from instruments installed for the Laurel Creek Watershed study. The LVM investigation confirms what was previously understood that groundwater is found within granular deposits that are layered between layers of silt, silt till, clay and silt/sand and that groundwater generally flows towards Laurel Creek.
- Waterloo North Scoped Subwatershed Study: The Waterloo North Study incorporated work undertaken in 2007 by Bajc and Shirota to undertake a hydrogeologic model of the Waterloo Moraine Area. The Bajc and Shirota model builds upon the work undertaken by Terraqua in 1995. Their work confirmed the importance of the Maryhill Till layer. LVM has also utilized this model in their work undertaken for the Erbsville South study. Only one mini-piezometer was installed along

the overlapping reach of Laurel Creek that falls within the two studies. Again the flow of groundwater was noted to generally flow in a southeasterly direction.

4.0 CONCLUSIONS

The work undertaken to date, particularly with the Terrestrial Resources and Hydrogeological components, has shown that it is in alignment with previous work undertaken in the area and thus fulfills the purpose of the Erbsville South Environmental Study, which is to supplement existing environmental information for the Erbsville South Study Area. Further field work scheduled for this spring will be reported in the next Interim Technical Memo in early June 2014 at the eighth month mark from the commencement of the study.

Respectfully Submitted
On Behalf Of
Sunvest Development Corp.
and the
Erbsville South Environmental Study Team



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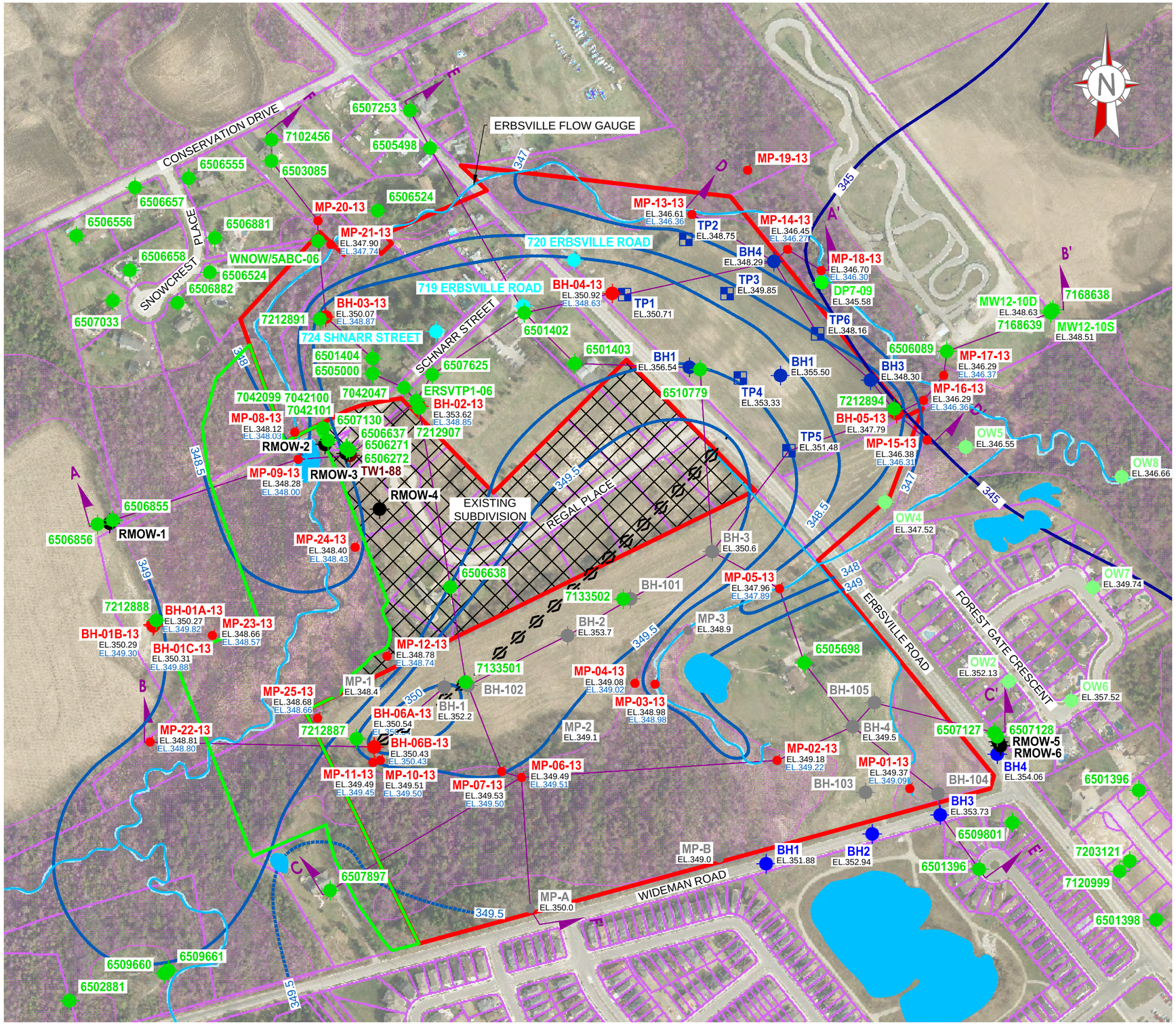

LEGEND :

- STUDY AREA
- EXTENDED STUDY AREA
- EXCLUDED STUDY AREA
- GRCA WETLANDS
- BOREHOLE LOCATION — Current Investigation
- BOREHOLE LOCATION — Previous NEA Investigation 6454G1 (2006)
- BOREHOLE LOCATION — Previous NEA Investigation 1704G10 (2003)
- BOREHOLE LOCATION — Stantec (2010)
- BOREHOLE LOCATION — Davidson Well Drilling Ltd. (1988)
- BOREHOLE LOCATION — Mitz & Associates (2009)
- BOREHOLE LOCATION — MOE Well Records
- BOREHOLE LOCATION — Municipal Water Well
- TEST PIT LOCATION — Previous NEA Investigation 6454G1 (2006)
- MINI PIEZOMETER LOCATION — Current Investigation
- MINI PIEZOMETER LOCATION — Mitz & Associates (2009)
- EL.356.54 — GROUND SURFACE ELEVATION (m)
- CROSS SECTION LINE — Rerer to Drawings 4 - 9
- GROUNDWATER CONTOURS — 2013-11-27
- EL.348.98 — GROUNDWATER ELEVATION (m) — 2013-11-27
- GROUNDWATER CONTOUR — North Waterloo Scoped Subwatershed Study
- GROUNDWATER DIVIDE

0 50 100 150 m

SCALE 1:4000

NOTES :
1-REFERENCES: GRAND RIVER CONSERVATION AUTHORITY, 2010 Aerial Photograph (2013).
2-REFERENCES: VARIOUS CONSULTANTS, North Waterloo Scoped Subwatershed Study, Figure 5.7, 2011-04.
2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project

Erbsville South Environmental Study

Erbsville Road and Wideman Road, Waterloo, Ontario

Title

GROUNDWATER CONTOURS 2013-11-27

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Project manager	R.Zapata	Sequence no.	08 of 14

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0002619-0-01-300	HD	008	0A

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Technical Work Plan

Erbsville South Environmental Study

(October 2013)

1.0 Introduction

In October 2012, the Council for the City of Waterloo approved the Terms of Reference for the *Erbsville South Environmental Study* (ES) found in Appendix A. The purpose of the study is to supplement existing environmental information that is contained within the *Laurel Watershed Study* (1993) and the subsequent *Final Subwatershed Management Plan 309/313* (SWS, 1996) and will constitute a Comprehensive Environmental Impact Study. In accordance with the Terms of Reference for the ES, this Technical Work Plan has been prepared to outline in more detail the process that will be utilized to complete this study. The ES will identify and categorize natural features and functions, delineate potential development areas and protection areas, and recommend development setbacks and mitigation measures necessary to maintain or improve the ecological sustainability within the study area. Consideration will also be given to the *City of Waterloo's Official Plan* (December 2012), *Region of Waterloo Official Plan* (ROP) policies 7.B.12, 7.B.13 and 7.C.8 to 7.C.10, the Region's *Draft Greenlands Network Implementation Guideline* (2011) as well as the *Grand River Fisheries Management Plan* (1998) and complementary *Implementation Plan* (2001). The findings and recommendations of this study will be integrated into the environmental component of the *Erbsville South Block Plan Study*.

The Erbsville South Study Area is located on the east and west side of Erbsville Road and north of Wideman Road at the southern limits of Erbsville. These lands are anticipated to be serviceable by gravity sanitary sewers.

On behalf of Sunvest Development Corporation, **IBI Group** will be responsible for the coordination and preparation of the ES. In this regard a team of experts has been engaged to investigate the various disciplines that will be examined during this study. They include **Dougan & Associates** for terrestrial resources including flora and fauna, **C. Port and Associates** for aquatic resources, **JTB Environmental Systems Inc.** for the fluvial geomorphology component, **LVM inc.** for hydrogeology and **IBI Group** for civil engineering, hydrology and stormwater management. Study Team members will be responsible for securing any necessary permits and approvals needed to undertake their respective fieldwork.

It is anticipated that the study will take a year or more to complete in order to ensure that a full range of field investigations are undertaken. A Timeline Chart has been provided in Appendix B. The findings and recommendations of this study will input into the Erbsville South Block Plan Study being undertaken as a separate process by a third party consultant and managed by the City of Waterloo.

The details of the various study components are as follows:

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2.0 Natural Heritage

2.1 Terrestrial Resources (Dougan & Associates)

Background Review and Summary

Sources of background information will be collected and reviewed for relevance to the study including the following:

a) Laurel Creek Watershed Study
b) Final Subwatershed Management Plan 309/313 (PEIL et al., 1996)
c) Section 6.35 of the City of Waterloo O.P.
d) City of Waterloo Official Plan (Dec. 2012)
e) ROP policies 7.B.12-13, 7.C.8-10
f) Region of Waterloo Draft Greenlands Network Implementation Guideline (DGNIG) (2011)
g) GRCA Fisheries Management Plan
h) Natural Heritage Reference Manual (OMNR 2010)
i) Schaefer's Woods ESPA (#17) and Laurel Creek ESPA (#80)
j) Laurel Creek Headwater Environmentally Sensitive Landscape
k) NHIC database
l) Simpson Lands Stage I Monitoring Reports (2006 - 2011) (Stantec, 2006 - 2011)
m) Wideman Road EIS (Draft) (Dougan & Assoc., 2008)
n) Hydrogeological Study Report, Michael Property, Waterloo (Mitz & Assoc., 2010)
o) Regal Place Scoped EIS (Dougan & Assoc., 2012)
p) Sunfish Lake – Laurel Creek PSW data record
q) Revised Draft North Waterloo Scoped Subwatershed Study
r) MNR comments on T.O.R.
s) Wildlife data from local naturalists; and
t) Other available documents

Information gathered in this phase will provide field staff with an initial understanding of the Primary Study Area and Extended Study Area, facilitate decision-making during the study, and be incorporated into reporting.

Field Investigations

The following field investigations are planned to take place in 2013/2014:

- Vegetation Assessment: Vegetation communities in the Primary and Extended Study Areas will be classified to Vegetation Type as per the protocol of the Ecological Land Classification (ELC) System for Southern Ontario, 1st approximation (Lee et. al., 1998). Spring, summer and fall botanical surveys will be carried out within each unique vegetation community. ELC and botanical surveys will be completed simultaneously by an Ecologist during three field visits (spring, summer and fall 2013). Plant rarity status will be assessed using COSEWIC rankings for federal status, S-rank for provincial status, and Region of Waterloo (1999 Significant Species List) for local status.

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- Wetland Assessment: A small unevaluated wetland has been identified and will be reviewed by a Certified OWES Wetland Evaluator. The assessment will include correspondence with MNR and GRCA, one field visit in summer 2013, formation of an opinion on whether the wetland should be complexed with the existing PSW – Sunfish Lake Laurel Creek Wetland Complex, and submission of a brief letter report to MNR for approval and copied to GRCA. This is not intended to be a full wetland evaluation update as per the Ontario Wetland Evaluation System.
- Feature Staking and Confirmation: Natural feature boundaries will be established onsite with agency staff (GRCA, City of Waterloo, Region of Waterloo, MNR & IBI Group). Site walks for this purpose will be scheduled for summer 2013. Features to be staked include wetlands (PSW and/or non-PSW), ESPA and hazard lands.
- Winter Wildlife Survey: One visit will be carried out by a wildlife ecologist in late December 2013 or early 2014. The survey will take place within 48 to 72 hours after a snow fall event. Areas with the highest likelihood to support animal movement will be given priority. All tracks and other miscellaneous signs of animal activity will be documented and identified to species whenever possible. Special attention will also be given to documenting birds present in winter as well as the presence and movements of deer within the known deer wintering area.
- Nocturnal Amphibian Call Surveys: Three rounds of nocturnal amphibian call surveys will be completed at approximately monthly intervals between mid-April and mid-June. The surveys will follow the protocol outlined in the Marsh Monitoring Program (MMP) (BSC, 2009) with regard to timing and weather conditions, however, survey locations will include all potentially suitable amphibian breeding habitats (i.e., swamps) in addition to marsh habitats. Some deviation from the MMP protocol will be used to ensure adequate survey coverage of existing amphibian populations. Point counts will be used to document amphibians recorded within a 360˚ radius, as opposed to the MMP 180˚ radius. The duration of each point count will be extended from the standard 3 minute length to 6 minutes to help ensure the data collected is as representative of the habitat conditions on the property as possible. Eight point count stations will be surveyed allowing all habitats potentially supporting amphibian breeding to be surveyed (Appendix C, Figure 1).
- Snake Surveys: Snake surveys will be undertaken in accordance with MNR Guelph District Milksnake Survey Protocol. Three surveys, at least two weeks apart will be undertaken between late April and late June, under sunny conditions between 8 - 25°C or at least 15°C if overcast. Active hand searches will be utilized with Animal Care Protocol.
- Turtle Surveys: Turtle Surveys will be undertaken referencing MNR's Occurrence Survey Protocol for Blandings Turtle in Ontario. At least three visits will be undertaken between mid-April and mid-June under appropriate weather conditions, on sunny days after days of inclement weather when turtles are most likely to be observed basking. Only two suitable foraging/overwintering areas are known to be present within the Primary and Extended Study Areas. One is a pond and the other is a slightly wider and more open section of Laurel Creek (Figure1, Appendix C). Both will be surveyed using high quality, 12 power, image-stabilized binoculars. The species and number of individuals will be documented.
- Salamander Surveys: Two ponds will be surveyed on the southerly property, one immediately north of Wideman Road and the other south of Wideman Creek. In accordance with current protocols, traps will be set out on five separate nights during early spring March-April 2014.

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Approvals will be obtained for a Wildlife Animal Care Committee research protocol, a Wildlife Scientific Collectors Authorization, and an Endangered Species Act permit.

- Breeding Bird Surveys: Two field visits will be carried out between the last week of May, 2013 and first week of July, 2013, as per the Ontario Breeding Bird Atlas protocol (Cadman et al., 2007). If possible, survey visits will take place as close as possible to the middle of June when song output is highest and detection rates are greatest. Each survey will be conducted a week apart and under appropriate weather conditions (*i.e.,* light winds and little to no rain). Breeding bird evidence will be documented visually on aerial photography for future reference and review. Each survey visit will follow a wandering transect in such a way that both the Primary Study Area and Extended Study Areas are appropriately covered (*i.e*., that no location is greater than 125 metres away from any given survey location). In fact, most habitats will not be more than 75 metres away from a given survey station. Figure 1 in Appendix C shows an anticipated route through the study area.
- Incidental Wildlife Surveys: All wildlife species (*e.g*., mammals, butterflies, odonates, etc.) observed by ecologists during other field surveys conducted in the study area will be recorded. Information will include species name, number of individuals, and location.
- Road Kill Survey: A dedicated Road Kill Survey will be conducted on foot along Erbsville Road. Although all wildlife species will be noted, documenting amphibian movement will be the focus. To maximize success, the survey will take place within 36 hours of a rain event. Other incidental road kill observations will be duly documented throughout the field season.

Data Analysis & Reporting

- Plant and wildlife records will be entered into a Microsoft Access database to allow for easy data assessment and preparation of a species lists to be included in the final report. Species lists will be keyed to individual ELC mapping units.
- Spring and summer field tasks will provide insight into the environmental constraints within the study area. A brief letter and map will be prepared and shared with IBI Group to communicate these preliminary findings and discuss initial opinions on opportunities and constraints.
- Text for the Environmental Study Report will be prepared and submitted to IBI Group. Accompanying maps will be prepared in ArcMap by a qualified GIS Technician.

Potential Additional Tasks

A number of extra tasks outside the scope of the above work plan may become necessary as the project progresses including:

- Species at Risk (SAR) Surveys: The MNR may request additional field surveys specific to plant or wildlife SAR that they suspect may be present in the Primary and Extended Study Areas. If any such surveys become necessary, specific survey methodologies will be determined in consultation with MNR as needed. The MNR may also request additional field surveys for SAR based on the findings of 2013/2014 field findings. For example, if Butternut trees (*Juglans cinerea*) are found during botanical surveys, MNR may request that a Butternut Health Assessment be carried out.

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- OWES Wetland Evaluation: The wetland assessment in the current work plan is not intended to include a full wetland evaluation update based on OWES protocol, however if this becomes necessary it will be added to the work plan.

2.2 Aquatic Resources (C. Portt and Associates)

Background review

- Acquire existing fish community, fish habitat, and benthic invertebrate information from MNR/GRCA/City of Waterloo and C. Portt and Associates files. Compile this information and refine data needs.

Field investigations

- Conduct reconnaissance level habitat assessments of Wideman Creek and reaches of Laurel Creek adjacent to the subject property in spring, summer and autumn, to assess permanence of flow and identify key features such as areas of groundwater seepage, barriers to fish migration, etc.
- Conduct electrofishing (OSAP screening survey) of potential seasonal fish habitats in the spring to determine if fish are present.
- Conduct OSAP Standard Single Pass electrofishing survey, and complete OSAP Section 1 Modules 1, 2, 3, and Section 4, Module 2, at three locations, two on Laurel Creek and one on Wideman creek corresponding to the locations identified for temperature loggersduring the summer low flow period (see Figure 2, Appendix C). No fish sampling will be taken at location 4 as there is insufficient length of stream to establish a station between locations 3 and 5. Existing data from the recent Draft North Waterloo Scoped Subwatershed Study (Stantec, April 2013) will be utilized for this reach of Laurel Creek.
- Deploy water temperature loggers between June 1 and September 30 at one location in Wideman Creek and five locations in Laurel Creek as follows (see Figure 2, Appendix C):
    1. Laurel Creek upstream from the existing stormwater discharge from Regal Place.
    2. Laurel Creek downstream from the existing stormwater discharge from Regal Place and upstream from Erbsville Road. This location may be upstream or downstream from Schnarr Street, depending upon where the most appropriate habitat occurs.
    3. Laurel Creek downstream from Erbsville Road and upstream of the potential stormwater discharge location for the property east of Erbsville Road.
    4. Laurel Creek between the potential stormwater discharge location for the property east of Erbsville Road and Wideman Creek.
    5. Laurel Creek downstream from Wideman Creek.
    6. Wideman Creek downstream from Erbsville Road.
- Conduct a salmonid spawning survey of Wideman Creek and the reaches of Laurel Creek within the study area, consisting of at least two sets of observations, one in the latter half of October for brown trout (*Salmo trutta*) and one in mid- to late November, after brook trout (*Salvelinus fontinalis*) spawning would have occurred.
- Conduct benthic invertebrate sampling according to the OBBN protocol at the locations where OSAP Single Pass electrofishing is conducted (Figure 2, Appendix C), with identification to the lowest practical taxonomic level. Existing data from the recent Draft North Waterloo Scoped

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Subwatershed Study (Stantec, April 2013) will be utilized for the reach between Temperature Logger locations 3 and 5 on Laurel Creek.

Data Analysis

- Characterize the aquatic habitats based on the habitat condition and the fish and benthic invertebrate communities.
- Identify potential impacts to aquatic habitats using the Pathways of Effect approach.
- Identify methods to prevent or mitigate negative effects.
- Identify opportunities for the enhancement, restoration, and long-term conservation of aquatic habitats.
- Assess the risk/benefit to fish and aquatic habitats using the DFO Risk Management Framework.

Monitoring Plan

- Develop a monitoring plan to assess the condition of aquatic habitats so that adaptive management can be undertaken if unpredicted and undesirable effects occur.

2.3 Fluvial Geomorphology (JTB Environmental Systems Inc.)

- A full geomorphic assessment of all surface watercourses within the Primary Study Area will be completed. The geomorphic assessment will include the examination of channel and valley morphological characteristics (sinuosity, meander wavelength, valley and channel profiles, bed material composition, physical habitat attributes (pool-riffle sequencing and stability)), evaluation of fluvial processes including bedload transport, hydraulic and energy properties of the flow regime, bed and bank stability, and the identification of sites sensitive to erosion and sedimentation. The result of this analysis will be a detailed stream characterization based on morphological properties of the channels and fluvial process, which will be the basis for the development of various alternative strategies for the area.
- The detailed geomorphological assessment will include:
  - **a) Flow Assessment**: Flow analysis will be completed in two ways: during channel stability/channel form surveys, flows will be measured using an AVP measurement device, which determines discharge and velocity under various flow conditions. Additionally, HOBO U20 water level loggers will be installed in the channels at measurement locations to obtain a continuous flow record. These loggers, through the use of pressure transducers, are able to track water levels which are then converted to discharge values using the cross-section and velocity measurements. The result is a stage/discharge curve which can be integrated into the hydrology component of the study. Through understanding flow behaviour in response to storm events as well as base flows, erosion/sedimentation risk at critical points in the Study Area can be thoroughly assessed. Flow monitoring will ensure the capture of the 2014 spring freshet.
  - **b) Channel Stability**: Information on channel stability will be collected at each of the flow monitoring locations in section a) above. In order to assess channel stability, detailed studies into the sediment characteristics of each location are required. This includes samples of bed material (pavement and subpavement); bank material; near-bed sediment transport rates; and Total Suspended Solids sampling. This component of the study assists

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in determining critical thresholds for erosion on sensitive reaches, which is used as input into any stormwater pond release rates.

c) **Reach Stability**: Cross-sectional transects for the purpose of flow assessment are not detailed enough to establish stability criteria within the system. As a result, the areas of study will be mapped and used for reach stability assessment. Each reach will be visited and mapped at the same time flow measurements are collected.

d) **Historical Channel Patterns**: In order to understand what the creek is trying to achieve, the historical changes in channel pattern will be reviewed through the use of air photo interpretation/analysis. The result of this study component is a determination of meander characteristics and setbacks for development based on fluvial patterns.

- Erosion thresholds will be determined utilizing a 14-step protocol which includes:
    1. A stream walk will be undertaken at the start of the assessment to document overall watercourse conditions and to identify areas of potential erosion risk. During this walk notations of changes in soil type and bed characteristics are made and digital photographs are taken. A further purpose of the creek walk is to choose potential cross-sections for further study. The number of cross-sections chosen reflects the concerns of the study TOR. Additional creek walks will be completed in the spring during recession of the freshet to review high–energy events. At this time loggers will be installed at critical locations (and in conjunction with flow nodes of interest from the hydrology component of the study).
    2. A rapid reach assessment is undertaken which identifies particular concerns with respect to channel form, bank properties, riparian conditions, substrate and flow characteristics. A numerical score of out of 100 results which can be used comparatively to select reaches for further study. Additional metrics (RGA, RSAT) will also be collected and reported upon.
    3. Once all potential cross-sections have been identified choices are made as to which ones would require further analysis. This decision is based on relative stability to other reaches and the proximity to areas of concern or specific interest: in particular areas of differing soil type, proximity to structures, or proximity to catchment nodes with respect to the hydrological modeling. A minimum of five cross-sections will be established. Each section will get a flow logger installation for recording of continuous flows.
    4. Each cross-section is monumented for future use. Cross-sectional measurements of channel and bankfull area are made at tight intervals to get a detailed indication of form. Local slope is determined using a levelling exercise. This cross-sectional data is input into a flow model along with information on channel roughness (Manning's 'n' and the Limerinos method) to determine stage/discharge relationships and specific velocities. All sections will be tied together using GPS coordinates and a sub-centimetre differential GPS system (RTK-type base station and rover as well as robotic total station). Velocities will be validated using an acoustic Doppler velocity meter.
    5. Bank and bed samples of pavement and sub-pavement will be collected and returned to the lab for grain-size analysis. The grain size distribution is used in the tractive force analysis. Each section will have a minimum of two bed and two bank samples collected

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for analysis. Analysis will be by standard grain size methods (sieve shaker). Total number of samples will be a minimum of 20.

6. Critical shear stress for the bank and bed material (pavement and sub-pavement) will be determined using standardized methods for the D_{10}, D_{50} and D_{90} fraction of each sample. Multiple modes of assessment will be used including Chow, Dunn and Freisenrich and reporting on those which are appropriate for each watercourse.
7. Critical velocities for entrainment for the bank and bed material (pavement and sub-pavement) will be determined using standardized methods for the D_{10}, D_{50} and D_{90} fraction of each sample. Multiple modes of assessment will be used, ranging from Hjusltrom for finer materials to Komar for coarser materials.
8. Boundary shear stress will be determined from the cross-sectional profile, slope and roughness components measured in the field utilizing Shields calculations as standard practice. Comparisons are made between the critical and boundary shear at bankfull stage to establish erosion potential for each fraction.
9. Existing relationships between stage and velocity through the sections will be determined using standard equations (e.g., Komar, 1987) and a stage/velocity curve is developed. This curve is validated through direct measurement in the field of flow velocity on a minimum of three different flow events. Flowmaster will be used to create the hydraulic models for each of the sections to determine stage/discharge relationships. Velocity validation will be achieved using the acoustic Doppler velocity meter.
10. Critical velocities for the erosion of bank and bed material (pavement and sub-pavement) will be determined using standardized methods for the D_{10}, D_{50} and D_{90} fraction of each sample. Multiple modes of assessment will be used, ranging from Hjusltrom for finer materials to Komar for coarser materials.
11. Critical discharge to match the critical/boundary shear relationship as well as the critical velocity relationship is then mathematically determined and reported to the engineer for placement in the hydrological model as a threshold value. The hydrological model is then run against the threshold value to determine exceedence for the pre-development and post-development scenarios; this is input into the decision matrix for the sizing of the stormwater management pond.
12. Theoretical erosion and transport is based on ideal conditions; however ideal conditions in the field are not often found. Validation of the transport results are required and are achieved through direct bedload transport sampling at the cross-sections where calculated thresholds are determined, again using a minimum of three samples under different flow events. Field results are used to validate the erosion and transport model results. As required, the theoretical model shall be tweaked. Multiple sediment transport equations (including Ackers and White, Bagnold, Einstein, Meyer-Peter and Muller) will be used to determine theoretical sediment transport results. These results will be compared to field samples taken using a Helly-Smith bedload sampler to determine which equation best represents actual transport rates under varying flows.
13. Reporting will include critical shear, critical discharge, critical velocity, stream power and erosion potential for the selected cross-sections. These other critical thresholds are reported in case there are issues surrounding the use of shear stress as a decision-

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making tool. Reporting will include a graphic (map) showing threshold values along the length of each creek as necessary.

14. Recommendations will be made from the perspectives of fluvial functioning of the watercourse as a component of the final report.

3.0 Natural Hazards (IBI Group)

- Review existing reports and mapping available for the area.
- Review and analyze increasing the size of the culvert under Erbsville Road to reduce the floodplain depth, including simulation of various scenarios using HEC-RAS hydraulic model.
- In co-ordination with the Study Team review/mitigate resulting hydrological impacts, ecological impacts to upstream wetland/forest complex and other on-site vegetation, as well as flooding and erosion impacts downstream of the culvert.
- Provide preliminary design options for a new culvert which include an open bottom to benefit aquatic resources and small wildlife.
- All on-site constraints as a result of the Regulatory Floodline (including any changes as a result of culvert upgrading) will be identified and mapped.

4.0 Hydrogeology (LVM inc.)

Background Review

- Review of existing topographic, geological, and hydrogeological mapping and reports for the area including the draft North Waterloo Scoped Subwatershed Study (Stantec, April 2013) and the Waterloo North Water Supply Class EA Environmental Study Report (AECOM, November 2011).

Field Investigations

- Drill six boreholes in locations shown on Figure 3 in Appendix C. All boreholes will be completed as monitoring wells, with selected wells extending to the regional aquifer and completed as nested monitoring wells.
- Installation of approximately fifteen mini piezometers in and adjacent to the on-site wetland areas and surface water features, as shown on Figure 3 in Appendix C.
- Installation of electronic pressure transducers (dataloggers) in ten monitoring wells for continuous measurement of groundwater levels and fluctuations.
- In-situ single response (slug) testing of the new monitoring wells, and selected existing monitoring wells within the Primary Study Area.
- Grain size analysis of nine soil samples.
- Water chemistry sampling at six on-site monitoring wells and four residential water supply wells, with analysis for general chemistry parameters.
- A door-to-door survey of existing properties within a 500 metre radius of the Primary Study Area to obtain information about well construction, well depth, and existing water quantity and quality issues.

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Monitoring

- Groundwater monitoring will be undertaken for a minimum of one year, including quarterly manual water level measurements at all on site monitoring wells and mini piezometers, and quarterly downloading of dataloggers. Monitoring will ensure the capture of the 2014 spring freshet.
- Any monitoring wells that will not be used for long-term monitoring will be decommissioned by a licensed well contractor in accordance with O. Reg. 903.

Analysis

- Calculation of soil hydraulic conductivity from slug test results and grain size analysis.
- Assessment of the depth to shallow groundwater connections to local surface water features, and the vertical gradient between the shallow groundwater aquifer and the deep regional aquifer system.
- Calculation of a pre-development site water balance.
- Performing a chloride impact assessment for the shallow groundwater table under proposed conditions.
- Assessment of potential impacts to municipal wellhead protection areas.
- Assessment of potential impacts of site servicing and development on surface water features and groundwater, and provision of mitigation measures.
- Providing options for post-development infiltration.
- The hydrogeology report will include conclusions about the connection between surface water features and shallow groundwater, recommendations for post-development site infiltration, and recommended methods to maintain the shallow groundwater processes and their contribution to surface water features.
- Recommendations will be made for ongoing monitoring, including establishing trigger levels as appropriate.

5.0 Impact Assessment and Mitigation Measures

- An assessment of all potential impacts will be undertaken for all disciplines. This will include identifying potential for adverse environmental impacts (as defined the R.O.P. Glossary) to occur pre-, during-, and post development. Significance of the identified adverse impacts will be assessed.
- Ways to prevent, minimize, or mitigate potential adverse environmental impacts (in that order of precedence) will be identified in that no such impacts are permitted within Core Environmental Features.
- Mitigation measures and specific construction methods will be identified that protect and enhance core and supporting natural features and functions and minimize environmental impact.
- Appropriate buffers will be recommended to protect the significant natural features and ecological functions on site including wetlands, watercourse, the ESPAs and existing hedgerows from future development, and features that maintain and/or enhance ecological linkages on and off site with other natural areas including the ESPAs and Wideman Creek corridor.
- The buffer analysis will take into account the recharge/discharge relationship within the watershed when reviewing potential water quality impacts from land use activities. Any buffer evaluation will be in accordance with Sections 8.2.4 and 8.2.5 of the City of Waterloo's Official Plan, Part IV of

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the Region's Draft Greenlands network Implementation Guideline, and Section 16 of the Natural Heritage Reference Manual (OMNR 2010).

- Ecological enhancements, as defined in the Region's Draft Greenlands Network Implementation Guideline, will be identified.
- Potential restoration areas will also be identified.
- Management of human uses after construction will be addressed, including demarcation of buffers and/or natural features, trails, invasive landscape materials, domestic pets, increased noise and exposure to artificial light. Proposed stewardship options will be provided for all components of the natural heritage system, including core natural areas, buffer zones and ecological linkages.

6.0 Stormwater Management (IBI Group)

- Water balance calculations utilizing the GRCA's most recent version of GAWSER (as required) will be completed based on the results of the hydrogeological component of the study to ensure that the hydrologic balance for the Primary Study Area and hydrogeological regimes sustaining the ESPAs, wetlands, and watercourses are maintained. An analysis of wetland hydroperiod (depth, duration, and extent of flooding) and lag times between storm events and peak discharge rates will be undertaken.
- Recommendations and preliminary designs for infiltration methods and infrastructure will be provided.
- An assessment will be undertaken of current stormwater flow from the Laurel Creek Village Subdivision south of Wideman Road and the effects of such flow on the water balance for the subject lands. Impacts to water quality from the effluent of the Laurel Creek Village stormwater management facility, as well as potential impacts to the physical integrity of the wetland and any downstream water channel will also be considered.
- The proposed conditions hydrologic modelling will be completed using the SWMHYMO computer model to determine storage requirements for a range of events including the 25mm, and 2, 5, 25, and 100-year storms
- The required quantity criteria will be controlling proposed conditions peak flows to pre-development conditions as defined in the SWS.
- An Enhanced Protection Level for water quality control is required, including modelling and retention times for the 25mm storm, as is extended detention for erosion control as per the SWS.
- Preliminary plans for stormwater management facilities, including ponds and infiltration facilities will be prepared. The stormwater management pond designs will account for thermal impacts of storm runoff. A complete analysis will be undertaken of all proposed stormwater management facilities relative to the existing water balance and natural areas.
- A comprehensive Monitoring Plan will be prepared based on Subwatershed guidelines for pre-development, during-construction, and post-construction stages.

7.0 Coordination and Reporting

7.1 Coordination

- Findings will be provided to consultants undertaking the Erbsville South Block Plan Study.
- Environmental Study team members will coordinate with the Block Plan study team as required.

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7.2 Interim Technical Memos

- Interim Technical Memos covering all parameters of the study will be prepared and issued at the 4 and 8 month mark from the commencement of the study, immediately following acceptance of this Technical Work Plan, for City of Waterloo, Regional Municipality of Waterloo, Grand River Conservation Authority and Ministry of Natural Resources review.
- The Technical Memos will summarize the findings to date and demonstrate how they fit within the context of/align with existing data as understood through the *Laurel Creek Watershed Study* and subsequent *Subwatershed Management Plan 309/313*.
- Should the data not align, the Technical Memos will outline how the fieldwork program will be modified to address anomalies/inconsistencies.
- If substantive work plan changes are required it is understood that City staff will report back to Council.
- The Interim Technical Memos will be made available to members of the public as information upon request and will be available on the City's website.

7.3 Final Report

- Prepare a draft Environmental Study Report outlining findings and recommendations for submission and review by agencies.
- Make editorial changes based on agency comments and prepare Final Environmental Study Report.

APPENDIX A

CITY OF WATERLOO COUNCIL APPROVAL (OCTOBER, 2012) FOR TERMS OF REFERENCE, ERBSVILLE SOUTH ENVIRONMENTAL STUDY

Moved by Councillor Durrell, seconded by Councillor Scian:

"That Council approve Development Services report DS2012-045 and approve Z-12-01 General Amendments to Zoning By-Law No. 1108 and Zoning By-Law No. 1418, in accordance with Appendices A-E of Staff Report DS2012-045."

Carried Unanimously

6. STAFF REPORTS

a) Proposed Erbsville South Block Plan Study and Environmental Study Terms of Reference

Report No. DS2012-025.1
Prepared By: Cameron Salisbury and Robyn McMullen

Robyn McMullen, Environment Planner reviewed the report and responded to questions from Council.

Mayor Halloran joined the meeting. (Time: 6:38 p.m.)

Deb Lehman, a Kitchener resident and photographer, described her wildlife findings within the Erbsville South area and discussed her concerns with the Environmental Study not extending to the Schnarr Street area. Ms. Lehman spent over 1500 hours photographing many species throughout the proposed lands, finding many Special Concern Animals such as the Northern Map Turtle, Read Headed Woodpecker and Snapping Turtles and is concerned that these animals will diminish once development begins.

Deb Swidrovich of Waterloo described the significant wildlife within the Block Plan and expressed concerns with the proposed development area. Mrs. Swidrovich requested an extension of the Environmental Study area at the end of Schnarr Street and that wording be put in place to ensure the North Waterloo Scoped Subwatershed Study is complete before proceeding with the Erbsville Block Plan.

Moved by Mayor Halloran, seconded by Councillor Scian:

"That DS2012-025.1 be approved and,

1) that Council endorse the proposed Terms of Reference for the Environmental Study attached as Appendix A, **and direct staff to extend the study area to include land within a 120m circumference of the end of Schnarr Street, excluding existing residential development**;

2) that Council approve the proposed Terms of Reference for the Erbsville South Block Plan Study attached as Appendix B; and

3) that Council receive as information the documents attached as Appendices C, D and E."

Carried Unanimously

b) **New Sign By-law**
Report No. DS2012-056
Prepared By: Danielle Ingram

Danielle Ingram reviewed the report and responded to questions from Council.

Mike Gaudreau, React Signs expressed his concerns with respect to the proposed Sign By-law and implementation of sign zones which will significantly decrease the portable sign allowance throughout the City. He also noted that portable signs are the most heavily regulated signs, are proactively enforced by the Waterloo By-Law division and this year the portable sign permit fees brought in about $84,000 in revenue to the City to date. Mike Gaudreau provided the Clerk with a petition opposing the proposed changes to the zoning for portable signs.

Councillor Scian left meeting: (Time: 8:28 p.m.)
Councillor Scian returned to meeting: (Time: 8:32 p.m.)

Cindy Watkin, Chair, Eastbridge Neighbourhood Association, shared her appreciation of the new Sign By-law in regard to the leniency for neighbourhood associations. Mrs. Watkin also suggested that sign permit applications be available online for convenience.

Dave Lamka, A to Z Signs Ltd., expressed his concerns regarding the portable sign zoning changes, stating that small business owners will lose sales and potentially jobs as a direct result of the constraints in the new By-law. Mr. Lamka requested there not be a ban on mobile portable signs from any zone in Waterloo.

Nima Kia, Planner, Lakeshore Group expressed his concerns regarding the maximum number of signs per property, the discontinuation of freestanding signs at commercial plazas and the lack of a transitioning clause which would permit the property at 315 Lincoln Road to continue with their current sign variance application. Mr. Kia requested that these concerns be considered before the new Sign by-law is approved.

Ben Nightingale, owner of Shoes 22, expressed his concerns regarding the exclusion of portable signs at commercial plazas as 70% of the businesses at his location do not have street facing signs. Mr. Nightingale explained how pertinent portable signs are to their small businesses and the potential negative impact due to proposed zone change in the By-law. He described the accessory signs as not being reasonable as slush and snow will cover them in the winter, and they are subject to vandalism and theft.

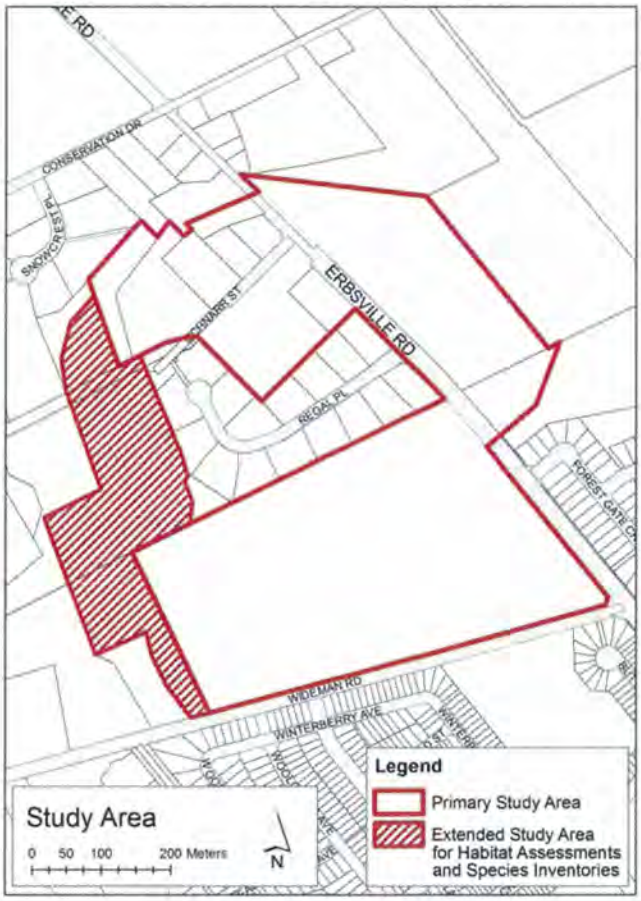
Terms of Reference

Environmental Study
for
Erbsville South Lands, Waterloo
Sunvest Development Corporation

1.0 OVERVIEW

The following Terms of Reference have been prepared by IBI Group to direct environmental research and preparation of an Environmental Study (ES) to support a block planning exercise for the Erbsville South Lands. This study will supplement existing environmental investigations including the *Final Subwatershed Management Plan 309/313* (SWS), prepared by Planning Initiatives Ltd. and Associates, 1996. The purpose of the ES is to identify and categorize natural features and functions, delineate potential development areas and protection areas, and recommend development setbacks and mitigation measures necessary to maintain or improve the ecological sustainability of the area. In this regard, the features and functions of the Laurel Creek Headwater Environmentally Sensitive Landscape will be considered along with those of the Schaefer's Woods Environmentally Sensitive Policy Area (ESPA #17) and Laurel Creek Forest Environmentally Sensitive Policy Area (ESPA #80).

The study area consists of lands located on the east and west side of Erbsville Road at the southern limits of Erbsville that are anticipated to be serviceable by gravity sanitary sewers.



These Terms of Reference have been based on site visits as well as discussions and correspondence with staff from the City of Waterloo, the Regional Municipality of Waterloo and the Grand River Conservation Authority (GRCA). The ES will address issues related to natural heritage including terrestrial and aquatic features, natural hazards, hydrogeology and stormwater management and will be consistent with the recommendations and requirements of the Laurel Creek Watershed Study, Subwatershed Plan #309/313 as well as in accordance with Section 6.35 of the City of Waterloo Official Plan. Consideration will also be given to the City of Waterloo's Draft Official Plan (February 2012), Regional Official Plan (R.O.P.) policies 7.B.12, 7B.13 and 7.C.8 to 7.C.10, the Region's Draft Greenlands Network Implementation Guideline (2011) as well as the Grand River Fisheries Management Plan (1998) and complementary Implementation Plan (2001). A technical work plan will be submitted for review and acceptance prior to the commencement of any field work and must include the actual location, type and number of field surveys and sampling points, a detailed schedule for field work and assessment methodologies and protocols.

2.0 NATURAL HERITAGE

Assessment of vegetation communities will include a review and summary of background information and previous studies, coupled with field inventories to ensure information is current and covers a minimum of three seasons (spring, summer and fall) of data. The Region of Waterloo's Draft Greenlands Network Implementation Guide (Section 3.4) will be referenced for the timing of specific surveys. Existing vegetation communities will be mapped as polygons onto aerial photographs and biophysical data will be collected from all natural and cultural communities according to the Ecological Land Classification System for Southern Ontario (ELC). The botanical survey will include identification of rare, threatened or endangered species based on regional/local, provincial and federal lists. This data will be used for analysis of constraint sensitivities and potential impacts. The Ontario Wetland Evaluation System (OWES) for southern Ontario will be used to delineate all wetland boundaries, which will be confirmed with the GRCA ecologist before being surveyed and mapped. The sedge marsh nearest the intersection of Wideman and Erbsville Roads will be evaluated for potential inclusion within the Sunfish Lake – Laurel Creek Provincially Significant Wetland Complex. Any discrepancies between GRCA and MNR wetland boundaries (>30 metres) will be reviewed with Ministry of Natural Resources staff. The study will also include confirmation to the satisfaction of Region staff of ecologically and topographically appropriate boundaries for ESPA #17 and ESPA #80 consistent with the boundary delineation principles in the Greenlands Network Implementation Guideline, as well as the Laurel Creek Headwater's Environmentally Sensitive Landscape.

The wildlife habitat assessment will include an assessment of the type, structure and quality of vegetative habitats for wildlife use, and the presence of corridors and linkage features to nearby habitats including Monastery Creek and Laurel Creek. Wildlife studies will incorporate review of available wildlife information, supplemented by field assessments. Specifically wildlife surveys will be completed in accordance with the Region of Waterloo's Draft Greenlands Network Implementation Guide during all seasons with emphasis on spring, summer and fall and will include breeding birds following breeding bird atlas protocols, breeding amphibians throughout the spring using the marsh monitoring protocol; and mammals, reptiles, butterflies, and odonates. The presence of species will be based on actual observations as well as the examination of signs such as scats, castings, and tracks. The summary inventory will identify any species of regional/local, provincial and federal significance including species at risk (SAR) in accordance with Ministry of Natural Resources protocols.

Following a review of existing information on aquatic and fish species, including any previous fish assessments, Wideman Creek, the existing pond on the southwesterly parcel as well as the reaches of Laurel Creek that border the study area will be assessed for presence of fish species and quality of fish habitat. A multiple season sampling period (spring, summer, fall) including a fall spawning survey for trout, will be undertaken utilizing the Standard Single Pass Survey approach of the Ontario Stream Assessment Protocol. Classification of fish assemblage (cold, cool or warm water) will be confirmed based on the species observed and habitat will be classified as direct or indirect habitat. In this regard water quality and flow conditions will be assessed when determining the quality of fish habitat. The

GRCA's Aquatic Resource Pre-consultation Checklist will be completed as part of the ES and habitat features such as groundwater recharge and discharge points and constraints will be mapped. An inventory of benthic invertebrates will be undertaken as an indicator of water and habitat quality. Identification will be provided to the lowest practical taxonomic level (genus or species) and will be analyzed according to the reference condition approach (RCA). As the watercourses have been identified as a coldwater fishery, protection will be premised on enhanced criteria. Areas for protection and enhancement will be identified including appropriate buffers from the watercourse. The impact of the existing pond on the wetland and coldwater creek will also be assessed.

A Fluvial Geomorphology component will be included to identify the form and function of the watercourses on the subject lands, to assess the overall stability of the channels based on geomorphic principals, and to provide a general evaluation of the channels and their interaction with the surrounding floodplain. The channel form will be determined by field reconnaissance and reach assessment techniques. Cross sectional bankfull parameters will be determined using standard field indicators, and the plan form and channel profile characteristics will be determined from desk top analysis. Bed form and sedimentary characteristics will be included in the field assessment as an indicator of channel stability and diversity. The critical flow velocity of Wideman Creek will be determined. Indicators of historical and recent erosion and aggradation will be included in the evaluation as an additional indicator of channel dynamics and stability. If deemed appropriate based on the findings, this assessment will include recommendations for stream channel enhancement.

3.0 NATURAL HAZARDS

The Natural Hazard component will address flooding and erosion hazards associated with the two watercourses, Wideman Creek and Laurel Creek. In this regard the floodplain is delineated by the Regulatory Floodline. The ES will explore the possibility of increasing the size of the culvert under Erbsville Road to reduce the floodplain depth on the upstream West Parcel. Various scenarios will be simulated using the most current version of the HEC-RAS hydraulic model and will consider resulting hydrological impacts, ecological impacts to the wetland/forest complex and other onsite vegetation, as well as flooding and erosion impacts downstream of the culvert. Preliminary design investigations will include an open bottom and bridge options to benefit aquatic resources and which allow passage of wildlife under Erbsville Road. All on-site constraints as a result of the Regulatory Floodline (including any changes as a result of culvert upgrading) will be identified and mapped as part of the ES.

4.0 HYDROGEOLOGY

The local hydrogeologic characteristics will be determined through a literature review of existing Studies and Reports previously undertaken in the area. Fieldwork will be completed to provide the required level of site-specific detail including a complete characterization of the shallow overburden groundwater flow regime. The ES will address the linkages between local surface water features, the shallow ground water system and the deeper regional aquifer system.

Borehole locations will be identified and reviewed with City, Region and GRCA staff and may include multi-level monitoring wells. It should be noted that any boreholes within the wooded areas of the properties will be installed with hand-held augers to minimize disturbance to sensitive areas. A survey of private wells within one kilometer of the study area will be undertaken to provide baseline information with respect to groundwater quantity and quality in local private water supplies. A timeframe (minimum one year) for groundwater monitoring will be established in order to identify an appropriate seasonal high groundwater table elevation.

Recharge and discharge areas will be identified, as well as areas vulnerable to groundwater contamination. An assessment of vertical hydraulic gradients and depth to the Regional aquifer will also be undertaken. Water table elevations and flow gradients will be identified as part of geotechnical and hydrogeological investigations. In addition, a water budget assessment will be completed in conjunction

with the surface water component of the ES. These analyses will include a discussion of impacts on Regional well capture zones, a chloride impact assessment, impacts of proposed residential densities, impacts of buried services, and a description of Best Management Practices to allow for existing infiltration rates to be maintained.

5.0 LINKAGES

The significance and role of the study area within the larger landscape and how this will be affected by development will be discussed. The ES will identify existing and potential linkages to core natural features as well as the connection with the adjacent Environmentally Significant Landscape in accordance with Part V of the Region's Draft Greenlands Network Implementation Guideline. This will include consideration of an eco-passage beneath Erbsville Road along Wideman Creek.

6.0 MITIGATION MEASURES

In light of construction activities on adjoining lands, stormwater flows from new development and previous agricultural use, the ES will identify existing impacts in accordance with Section 3.9 of the Region's Draft Greenlands Network Implementation Guideline.

The study will identify mitigation measures and specific construction methods to protect and enhance Core and Supporting natural features and ecological functions and minimize environmental impacts. Consideration will include, but not be limited to, grading activities and secondary containment of any hazardous materials on site. Appropriate buffers will be recommended to protect the significant natural features and ecological functions on site including wetlands, watercourse, the ESPAs and existing hedgerows from future development, and that maintain and/or enhance ecological linkages on and off site with other natural areas including the ESPAs and Wideman Creek corridor. Ecological enhancements, as defined in the Region's Draft Greenlands Network Implementation Guideline, will be identified. The buffer analysis will take into account the recharge/discharge relationship within the watershed when reviewing potential water quality impacts from land use activities. Any buffer evaluation will be in accordance with Sections 8.2.4 and 8.2.5 of the City of Waterloo's Draft Official Plan, and Part IV of the Region's Draft Greenlands network Implementation Guideline. Potential restoration areas will also be identified. Special focus on management of human uses after construction will be addressed, including demarcation of buffers and/or natural features, trails, invasive landscape materials, domestic pets, increased noise and exposure to artificial light. Proposed stewardship options for the ESPAs and buffer areas on the site will also be provided.

7.0 STORMWATER MANAGEMENT

Specific stormwater management criteria for the study area are identified in the approved Subwatershed Study #309/313 (Table D1.3). The proposed conditions hydrologic modeling will be completed using the SWMHYMO computer model to determine pond storage requirements for a range of events including the 25mm, and 2, 5, 25, and 100-year storms. Control of the Regulatory storm event is not required as outlined in the SWS. Controlling proposed conditions peak flows to pre-development conditions (as defined in the SWS) will be the required quantity criteria. An Enhanced Protection Level for water quality control is required, including modelling and retention times for the 25mm storm, as is extended detention for erosion control as per the SWS. In addition, infiltration targets in accordance with the SWS will be addressed.

The study will assess current stormwater flow from the Laurel Creek Village subdivision, south of Wideman Road and the effects of such flow to either sustain or impact the current site water balance. Preliminary plans for stormwater management facilities, including ponds and infiltration areas will be prepared. The stormwater management pond preliminary design will account for thermal impacts of storm runoff. A complete analysis will be undertaken of all proposed stormwater management facilities relative to the existing water balance and natural areas. Water balance calculations, utilizing GRCA's

most recent GAWSER model, will be completed based on the results of the hydrogeological component of the ES to ensure that the hydrologic balance for the site, including the quantitative and qualitative aspects of the hydrological and hydrogeological regimes sustaining the ESPAs, wetlands and watercourses, is maintained.

A Pre-Development Monitoring Program for the developing lands will be outlined in the ES, and will follow the criteria set out in the SWS for collecting baseline conditions. Specific parameters will be identified including but not limited to dissolved oxygen (preferably pre-dawn DO measurements), total suspended solids, total phosphorus, water temperature and *E. coli*. A Terms of Reference for Pre-Development Monitoring will be prepared and submitted to the City, Region and GRCA for review and approval and will be appended to the ES. The program will include in-stream temperature monitoring in locations above and below any future stormwater management facilities.

8.0 CONCLUSIONS AND RECOMMENDATIONS

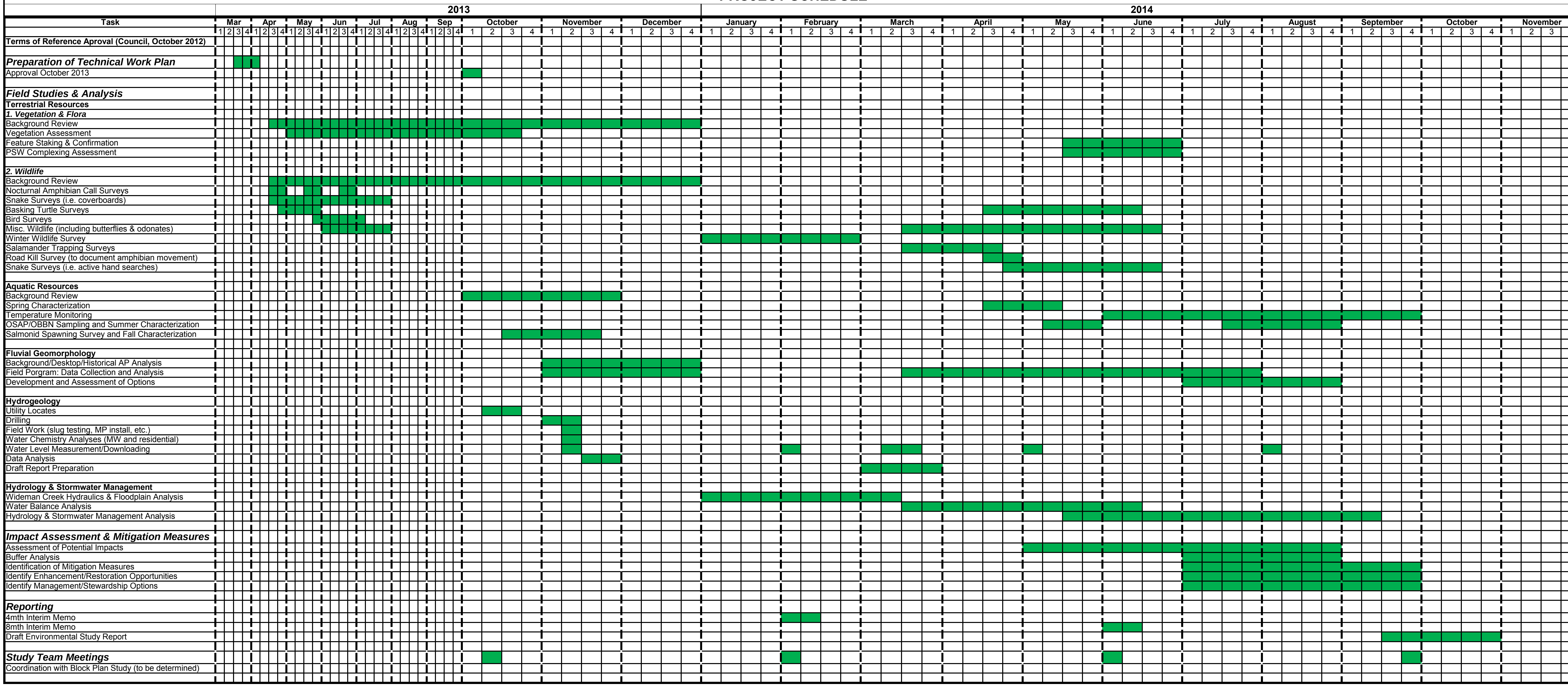
Utilizing the findings from all components, an Opportunities and Constraint Map will be prepared to guide the block planning exercise and future residential development proposed for the study area. In addition, any revisions to the SWS constraint mapping will be identified. Recommendations for next steps and mitigation of any adverse impacts and special issues will also be provided.

APPENDIX B

TIMELINE CHART

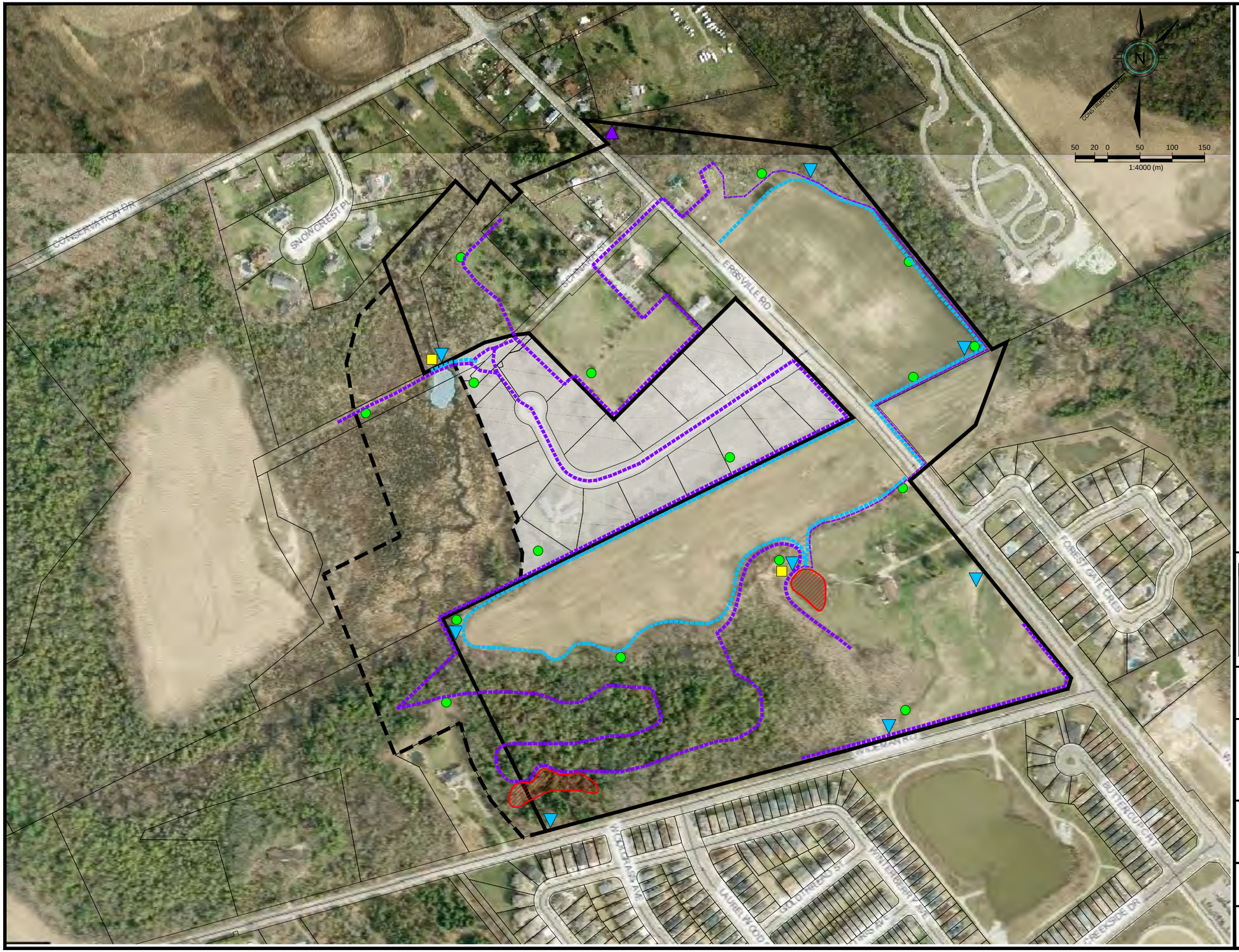
ERBSVILLE SOUTH ENVIRONMENTAL STUDY

PROJECT SCHEDULE



APPENDIX C

SURVEY LOCATION MAPPING



LEGEND

- STUDY AREA BOUNDARY
- EXTENDED STUDY AREA BOUNDARY FOR HABITAT ASSESSMENTS AND SPECIES INVENTORIES
- AREA NOT INCLUDED IN STUDY AREA
- BTS - BASKING TURTLE SURVEY
- BBS - BREEDING BIRD SURVEY
- BBS ROUTE
- CB - COVER BOARD SURVEY
- NACS - NOCTURNAL AMPHIBIAN CALL SURVEY
- NACS ROUTE
- SALAMANDER TRAPPING SURVEY

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DATE	OCTOBER, 2013
PROJECT No.	34168

CITY OF WATERLOO
REGIONAL MUNICIPALITY OF WATERLOO

ERBSVILLE SOUTH ENVIRONMENTAL STUDY

WILDLIFE SURVEY STATIONS & ROUTES

FIGURE 1

FILE:J:\34168_TechnclStudy\5.9 Drawings\59pln\layouts\Figures\34168F-Wildlife.dwg LAYOUT:11 x 17 L
LAST SAVED BY:Philip.thibert, October-01-13 2:15:32 PM PLOTTED BY:Philip Thibert October-01-13 2:19:20 PM

LEGEND

- STUDY AREA BOUNDARY
- EXTENDED STUDY AREA BOUNDARY FOR HABITAT ASSESSMENTS AND SPECIES INVENTORIES
- AREA NOT INCLUDED IN STUDY AREA
- POTENTIAL OSAP AND OBBN SITES
- 4 POTENTIAL LOCATION OF TEMPERATURE LOGGERS

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ERBSVILLE SOUTH ENVIRONMENTAL STUDY

AQUATIC RESOURCES WORK PLAN

FIGURE 2

FILE:J:\34168_TechnclStudy\5.9 Drawings\59pln\layouts\Figures\30231F-Aquatic Resources.dwg LAYOUT:11 x 17 L
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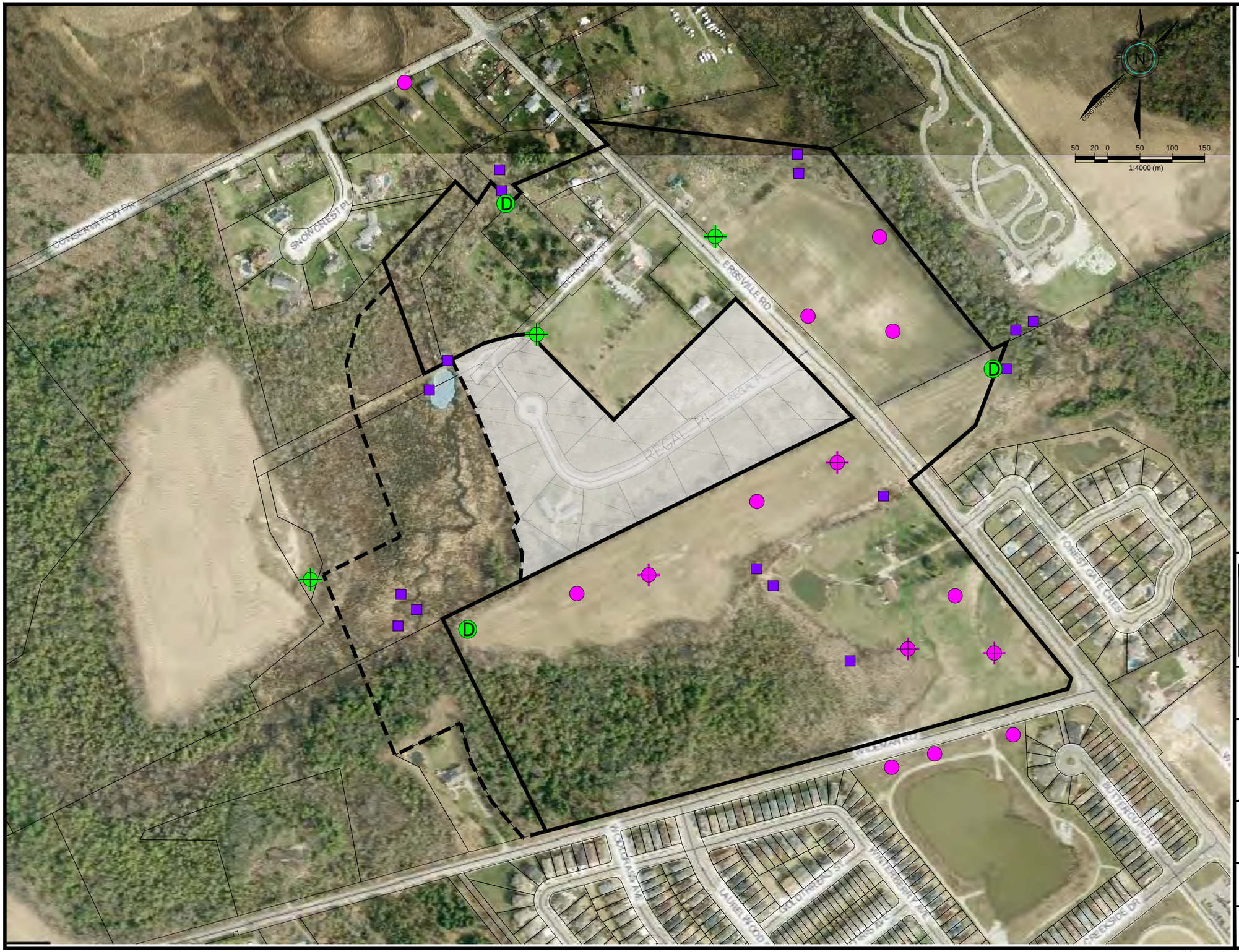

LEGEND

- STUDY AREA BOUNDARY
- EXTENDED STUDY AREA BOUNDARY FOR HABITAT ASSESSMENTS AND SPECIES INVENTORIES
- AREA NOT INCLUDED IN STUDY AREA
- APPROXIMATE LOCATION OF PREVIOUSLY DRILLED BOREHOLES/MONITORING WELLS
- APPROXIMATE LOCATION OF EXISTING MONITORING WELLS
- APPROXIMATE LOCATION OF PROPOSED NEW MONITORING WELLS
- APPROXIMATE LOCATION OF DEEP MONITORING WELLS INSTALLED IN REGIONAL AQUIFER
- APPROXIMATE LOCATION OF PROPOSED MINI PIEZOMETERS

NOTES

1) LOCATIONS OF NEW MONITORING WELLS ARE APPROXIMATE AND MAY BE ADJUSTED TO REFLECT PROPERTY ACCESS AND LANDOWNER AUTHORIZATION.
2) SOME NEW MONITORING WELLS WILL BE COMPLETED AS MULTI-LEVEL (NESTED) WELLS.
3) EXITING WELLS SELECTED FOR LONG TERM MONITORING PROGRAM ARE SUBJECT TO CHANGE, BASED ON ASSESSMENT OF WELL CONDITION DURING FIELD PROGRAM.

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HYDROGEOLOGY WORK PLAN

FIGURE 3

FILE:J:\34168_TechnclStudy\5.9 Drawings\59pln\layouts\Figures\34168F-Hydrogeology.dwg LAYOUT:11 x 17 L
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Erbsville South Environmental Study

2nd Interim Technical Memo
(8th Month Mark from Study Commencement)
June 13, 2014

1.0 Introduction

In October 2012, the Council for the City of Waterloo approved the Terms of Reference for the *Erbsville South Environmental Study* (ES). The purpose of the study is to supplement existing environmental information that is contained within the *Laurel Watershed Study* (1993) and the subsequent *Final Subwatershed Management Plan 309/313* (SWS, 1996) and will constitute a Comprehensive Environmental Impact Study for the Erbsville South Area. The findings and recommendations of the ES will be integrated into the environmental component of the *Erbsville South Block Plan Study*.

On behalf of Sunvest Development Corporation, **IBI Group** is responsible for the coordination and preparation of the ES. In this regard a team of experts has been engaged to investigate the various disciplines that will be examined during this study. They include **Dougan & Associates** for terrestrial resources including flora and fauna, **C. Port and Associates** for aquatic resources, **JTB Environmental Systems Inc.** for the fluvial geomorphology component, **LVM inc.** for hydrogeology and **IBI Group** for civil engineering, hydrology and stormwater management. Study Team members are responsible for securing any necessary permits and approvals needed to undertake their respective fieldwork.

In accordance with the Terms of Reference for the ES, a Technical Work Plan was prepared by the Study Team to outline in more detail the process that will be utilized to complete this study. The work plan was reviewed by various agencies including the City of Waterloo, Regional Municipality of Waterloo, Grand River Conservation Authority and the Ministry of Natural Resources with final approval given on October 4, 2013. This approval date marks the commencement of the Study.

As part of the Environmental Study process, the following protocol is to be adhered to for the purpose of embedding checkpoints to ensure study findings and results are aligning with existing information:

- *Interim Technical Memos covering all parameters of the study will be prepared and issued at the 4 and 8 month mark from the commencement of the study.*
- *The Technical Memos will summarize the findings to date and demonstrate how they fit within the context of/align with existing data.*
- *Should the data not align, the Technical Memos will outline how the fieldwork program will be modified to address anomalies/inconsistencies.*
- *If substantive work plan changes are required it is understood that City staff will report back to Council.*
- *The Interim Technical Memos will be made available to members of the public as information upon request and will be available on the City's website.*

This report is provided to satisfy the second Interim Technical Memo at the eighth month mark from the commencement of the study. The format of this report follows the various disciplines and study components outlined in the Technical Work Plan. The Laurel Creek Watershed Study, the subsequent Subwatershed Management Plan 309/313, as well as the recently approved North Waterloo Scoped

Subwatershed Study have been referenced as sources of existing data for comparison purposes. It is recommended that the reader review the 1st Interim Technical Memo prior to proceeding with this report in order to obtain a complete overview of the progress of the study to date. The 1st Interim Technical Memo also contains the approved Technical Work Plan.

2.0 Summary of Study Components Completed Between February 4, 2014 and June 4, 2014

2.1 Natural Heritage

2.11 Terrestrial Resources (Dougan & Associates)

In accordance with the list of field investigations outlined in the Technical Work Plan, Dougan & Associates has completed the following additional components:

- Wetland Assessment: A conclusion on whether the small unevaluated wetland that was assessed in 2013 should be complexed with the existing PSW along with the report to the agencies is scheduled to be completed later in June 2014.
- Feature Staking and Confirmation: Site walks with the agencies to confirm natural feature boundaries will be scheduled in June/July 2014. Once the feature limits have been confirmed appropriate buffers can be determined.
- Winter Tracks Survey: The winter wildlife survey was conducted on February 4th, 2014. Weather conditions were ideal for the survey with temperatures at -12.2°C at the beginning of the survey (8am) reaching to about -7°C by the end of the survey (12pm) with sunny skies and calm winds (~1.4km/h max wind speed). The survey was also conducted approximately 50 hours after a large snowfall event. This timing window allowed for both enough time for wildlife activity to have imprinted snow in the survey area and for fresh snow on site to offer clear and lightly weathered wildlife sign. During the survey eight mammal species (White-tailed Deer, Striped Skunk, Raccoon, Meadow Vole, Woodchuck, Eastern Cottontail, Grey Squirrel and Domestic Dog) and seven bird species (American Crow, Blue Jay, Red-bellied Woodpecker, Mourning Dove, American Robin, Cedar Waxwing and Black Capped Chickadee) were detected.
- Snake Surveys: In response to MNR guidance with respect to recommended survey techniques, an active hand search protocol under suitable weather conditions was adopted to detect snakes within the study area. On May 21st the first of three snake surveys was undertaken. Specifically this protocol involves overturning cover objects such as logs, rocks and other debris (e.g. tires, shingles, particle board etc.) and searching the protected habitat underneath cover for snakes and other wildlife. In conjunction with the active manipulation of these potential snake shelter and basking objects, the ground was carefully scanned within various habitat types (e.g. field, forest floor, wetlands etc.) in an effort to detect any snakes or other wildlife present. As of the end of May, 2014, no snakes have been observed during the first active hand search. Two additional active searches will be undertaken in early to mid-June in accordance with MNR survey protocols.
- Turtle Surveys: In accordance MNR protocol, three Blanding's Turtle surveys will need to be completed by June 15th, under suitable weather conditions within the study area. The protocol involves approaching suitable Blanding's turtle habitat quietly, while scanning the entire shoreline and potential basking areas (e.g. emergent rocks or deadfall) with binoculars. As of the end of May, two of the three Blanding's Turtle surveys have been conducted (on May 5th and May 21st). On May 21st, 2014 one mid- to large sized Snapping Turtle (*Chelydra serpentina*) was observed basking on wetland vegetation. This observation was made in wider section of Laurel Creek, at the northwestern edge of the study area (west end of Schnarr Street). No other turtles have been observed during the Blanding's Turtle surveys to date.
- Salamander Trapping Surveys: In early spring, site reconnaissance was employed to monitor ice melt on targeted ponds for salamander surveys. Surveys were undertaken once the ponds were sufficiently melted to allow for Jefferson Salamander breeding and MNR protocol sampling. Just before sunset, minnow traps were installed in the two target ponds on the evenings of April 8, 9,

10, 14 and 16. At first light on the mornings following each trap set, traps were checked, emptied and stowed away from water as per MNR protocols. During the 5 rounds of trapping, two amphibian species were detected (Green frog [tadpole] and Eastern Newt [adult]). No evidence of Jefferson Salamander presence was observed.

- Roadkill Survey: Within 12 hours of a major rainfall event, on May 21st, 2014, the sections of Schnarr St, Wideman Rd and Erbsville Rd adjacent to the study area were slowly walked and driven to document the extent and diversity of roadkill in the area. Roadkill observed on these three roadway sections during the May 21st survey included 6 Northern Leopard Frogs and one unidentified small mammal.

2.12 Aquatic Resources (C. Portt and Associates)

- Habitat conditions were observed and temperature loggers (Watertemp Pro V2, Onset Corporation) were installed at one location on Wideman Creek (just upstream from the confluence with Laurel Creek) and at five locations on Laurel Creek (Upstream from Regal Place, just downstream from Schnarr Street, downstream from Erbsville Road, upstream from the confluence with Wideman Creek and downstream from the confluence with Wideman Creek) on May 22, 2014.
- A reach approximately 60 m long on the unnamed tributary that originates on the north side of Wideman Road approximately 80 m west of Erbsville Road was electrofished on May 29, 2014. Individuals of five fish species (fathead minnow, Iowa darter, brook stickleback, common white sucker and northern redbelly dace) were captured. As a consequence additional temperature loggers have been installed on this reach as well as on Wideman Creek upstream of the confluence with this tributary.

2.13 Fluvial Geomorphology (JTB Environmental Systems Inc)

- A site walk was completed in late March and early April to get a sense of the flood conditions and determine flow paths under higher water levels
- RGA sheets were completed in May and results are being used to determine final locations for threshold analysis
- Preliminary survey of the channels has been completed; the next step is to add the cross-sections relating to potential outflow locations
- Sediment samples (bulk) were collected for grain size analysis and sent to the lab; pebble counts will be completed in June under low water levels
- Preliminary threshold model structure has been set up and is awaiting the grain size results and section details
- At this point the model is ready to receive the flow information (event based and continuous) when those are available.

2.2 Natural Hazards (IBI Group)

- No further analysis has been undertaken during this period.

2.3 Hydrogeology (LVM inc.)

- Surveying: During surveying operations conducted by IBI Group, two mini-piezometers could not be located. Additionally, boreholes from a previous investigation by Mitz & Associates (2009) required survey data to calculate groundwater elevations from water level measurements and was undertaken on May 29, 2014.
- Monitoring: Manual measurements of stabilized groundwater levels in the monitoring wells were collected again on February 27, 2014, and May 20, 2014. The groundwater elevations from the monitoring wells and mini-piezometers are summarized on the appended Table 101. Continuous

groundwater monitoring is currently being conducted in the nine monitoring wells drilled by LVM inc. in 2013. Electronic Pressure Transducers (dataloggers) programmed to measure water levels at hourly intervals, along with a Barologger to measure barometric pressure changes, were installed in November, 2013. Data from the loggers was retrieved on February 27, 2013 and May 20, 2014 at the time of manual measurements. The data was barometrically compensated, and summarized hydrographs are provided on the appended Figures 1 to 4.

- Groundwater Monitoring Findings:
    - As shown on the appended Figures 1 to 4, groundwater elevations fluctuated between 0.45 m at BH-01B-13, and 1.17 m at BH-06B-13 during the monitoring period from November, 2013 to May, 2014 across the site. Groundwater elevations in all wells peaked in early April, 2014 with the exception of monitoring well BH-02-13, which shows a seasonal high in late April, 2014. Manual measurements of the groundwater levels coincide with information obtained from the dataloggers.
    - Figure 2, appended, illustrates the groundwater fluctuations in monitoring wells BH-01A-13, BH-01C-13, and BH-02-13 which are screened in the Upper Waterloo Moraine stratified sediments and equivalents. The Ontario Geologic Survey (OGS) identifies this layer as AFB1, as indicated on the cross sections on the appended Drawings 4 to 7. The appended Drawing 2 shows the cross section alignments. The continuous water level measurements from all three wells correlate well, demonstrating the hydraulic connection between the screened intervals at each well. A maximum groundwater fluctuation of 0.50 m occurred at BH-01A-13 between November 27, 2013 and May 20, 2014. The data gaps on the hydrograph for BH-02-13 are associated with the data logger being removed for slug testing purposes.
    - Groundwater elevations for monitoring wells BH-04-13 and BH-06B-13 are shown on the appended Figure 3. These two monitoring wells are screened in an outwash deposit aquifer, identified by the OGS as AFA2, as shown on cross sections A – A' and B – B' on the appended Drawings 4 and 5 . Both BH-04-13 and BH-06B-13 are screened in a confined aquifer, and the correlation between the continuous water level measurements from each monitoring well demonstrates the hydraulic connection between the screened intervals. A groundwater fluctuation of 1.17 m was measured between November 27, 2013 and May 20, 2014.
    - The water levels from monitoring wells BH-01B-13, BH-03-13, BH-05-13, and BH-06A-13 are shown on the appended Figure 4. As with Figures 2 and 3, the correlation between the continuous water level measurements at the four monitoring wells demonstrates the hydraulic connection between the screened intervals at each location. These wells are screened in a confined aquifer in the Upper and Middle Waterloo Moraine stratified sediments and equivalents. The Middle Maryhill Till is a poor aquitard that was not encountered at BH-05-13; therefore, it is concluded that the AFB1 and AFB2 strata combine to become one aquifer east of BH-06B-13. Groundwater elevations in the AFB2 / AFB1 aquifer fluctuated up to 0.54 m, as measured in monitoring well BH-06A-13.
- Hydraulic Conductivity: Single response in-situ (slug) testing was conducted at BH-05-13 on May 22, 2014. Table 102 provides the hydraulic Conductivity estimates.

2.4 Stormwater Management (IBI Group)

- Development of drainage area mapping and soils mapping for use in the hydrologic modeling has been initiated. Further consultation with the City of Waterloo and the GRCA will be undertaken to confirm the detailed technical components of the work plan for the hydrologic modeling and stormwater management analysis. Once environmental buffer limits have been established, the proposed conditions stormwater management analysis will be initiated.

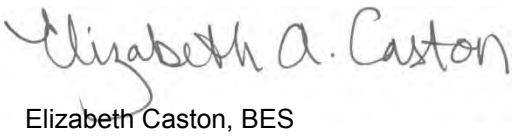
3.0 Comparison of Findings with Existing Studies

The existing studies used for comparison include the Laurel Creek Watershed Study, the subsequent Subwatershed Management Plan 309/313, as well as the recently approved North Waterloo Scoped Subwatershed Study. Given the long winter conditions experienced during the second reporting period (4 to 8 months into the study), most of the field work did not move forward until late May. The Terrestrial Resources and Hydrogeology investigations reported in this report have not altered the comparisons reported in the 1st Interim Technical Memo and are therefore not repeated here. The Aquatic Resources, Fluvial Geomorphology and Natural Hazards components require more field work and analysis before any measurable comparisons can be made with the existing studies. Stormwater Management is dependent upon the hydrogeological investigations as well as the establishment of buffer limits which are expected in July.

3.3 Conclusions

The work undertaken to date, particularly with the Terrestrial Resources and Hydrogeological components, continues to show that it is in alignment with previous work undertaken in the area and thus fulfills the purpose of the Erbsville South Environmental Study, which is to supplement existing environmental information for the Erbsville South Study Area.

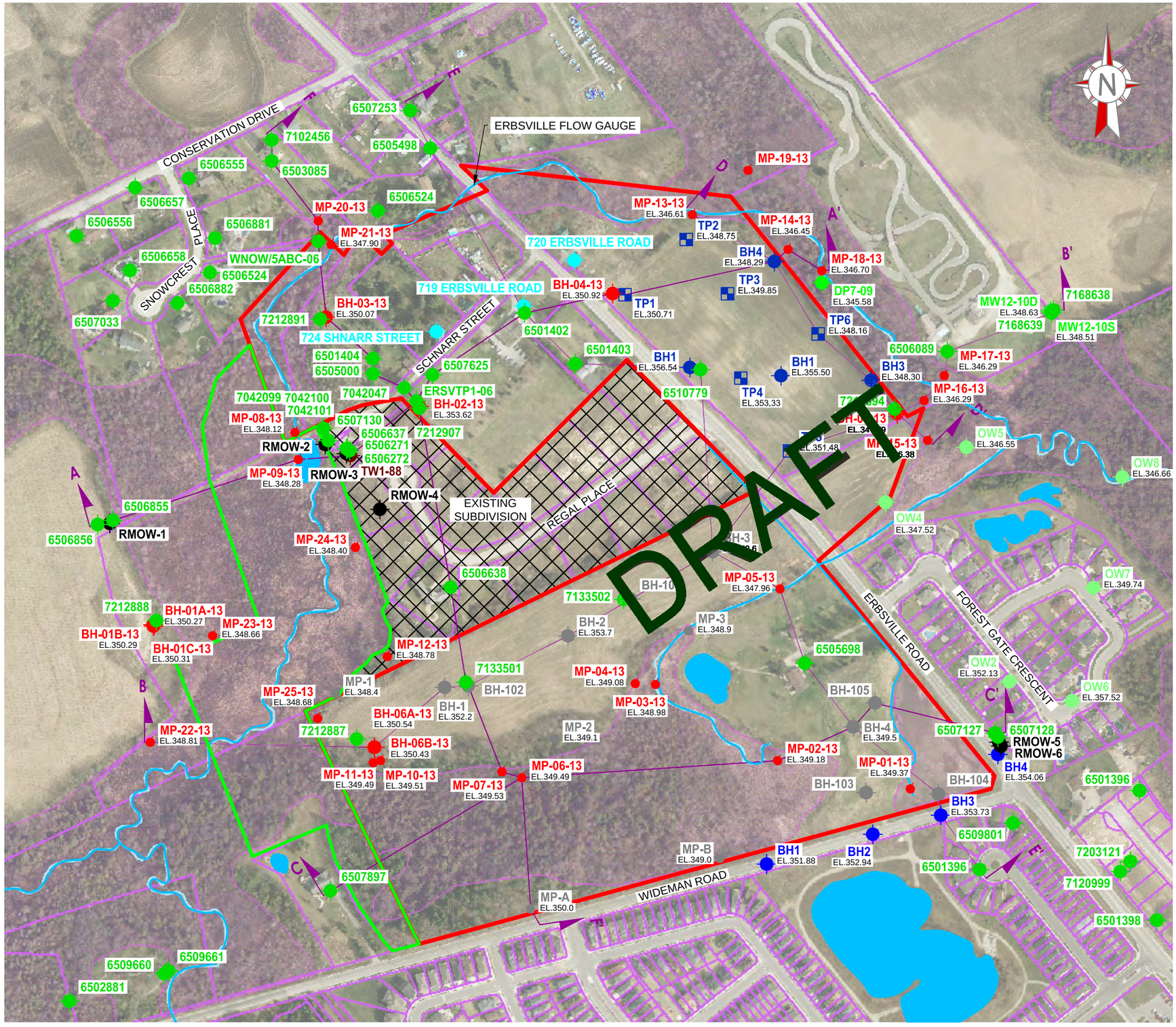
Respectfully Submitted
On Behalf Of
Sunvest Development Corp.
and the
Erbsville South Environmental Study Team.



Elizabeth Caston, BES
Environmental Planner, IBI Group
Erbsville South Environmental Study Co-ordinator

Thomas C. Hardacre, MCIP, RPP
Associate, IBI Group
Erbsville South Environmental Study Manager

EC/TH/baw



LEGEND :

- STUDY AREA
- EXTENDED STUDY AREA
- EXCLUDED STUDY AREA
- GRCA WETLANDS
- BOREHOLE LOCATION — Current Investigation
- BOREHOLE LOCATION — Previous NEA Investigation 6454G1 (2006)
- BOREHOLE LOCATION — Previous NEA Investigation 1704G10 (2003)
- BOREHOLE LOCATION — Stantec (2010)
- BOREHOLE LOCATION — Davidson Well Drilling Ltd. (1988)
- BOREHOLE LOCATION — Mitz & Associates (2009)
- BOREHOLE LOCATION — MOE Well Records
- BOREHOLE LOCATION — CH2MHILL (1991)
- BOREHOLE LOCATION — Regional Municipality of Waterloo
- BOREHOLE LOCATION — Residential Water Well
- TEST PIT LOCATION — Previous NEA Investigation 6454G1 (2006)
- MINI PIEZOMETER LOCATION — Current Investigation
- MINI PIEZOMETER LOCATION — Mitz & Associates (2009)
- EL.356.54 — GROUND SURFACE ELEVATION (m)
- CROSS SECTION LINE — Rerer to Drawings 4 - 9

0 50 100 150 m

SCALE 1:4000

NOTES :

1-REFERENCES: GRAND RIVER CONSERVATION AUTHORITY, 2010 Aerial Photograph (2013).

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project

Erbsville South Environmental Study

Erbsville Road and Wideman Road, Waterloo, Ontario

Title

SITE PLAN

LVM inc.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
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Prepared	A.Higgins	Discipline	HYDROGEOLOGY
Drawn	A.Higgins	Scale	1 : 4000
Checked	S.Meteer	Date	2014-01-31
Project manager	R.Zapata	Sequence no.	02 of 14

M. dept.	Project	Disc.	Dwg no.	Rev.
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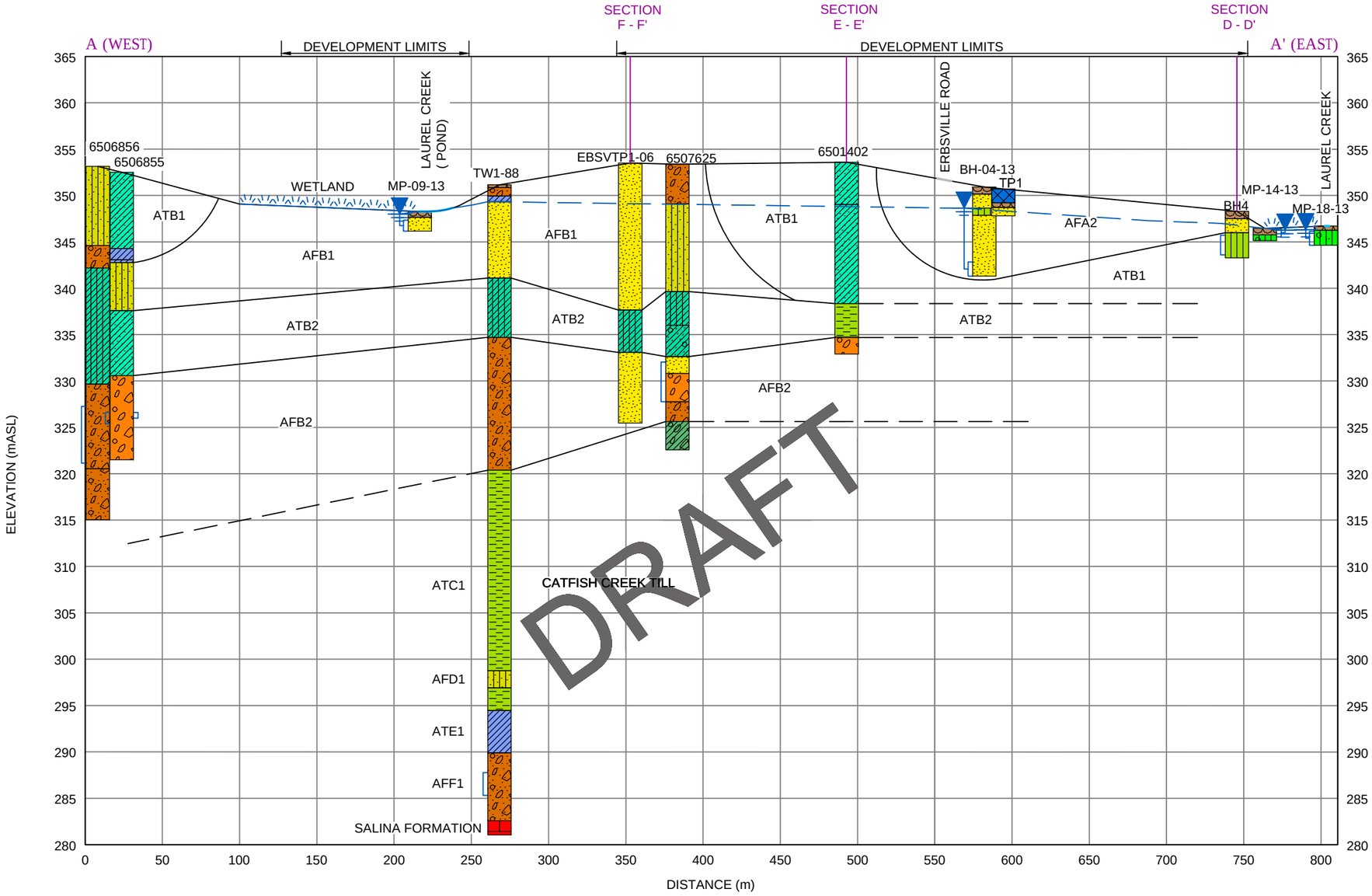

LEGEND :

- PAVEMENT
- FILL
- TOPSOIL
- PEAT
- GRAVEL
- SAND AND GRAVEL
- SAND
- SILT AND SAND
- SILT
- SILT TILL
- CLAY TILL
- CLAY AND SILT
- CLAY AND SAND
- CLAY AND GRAVEL
- CLAY
- HARDPAN
- BEDROCK
- SCREENED INTERVAL
- GROUNDWATER LEVEL
- * ELEVATION INFERRED

SCALE 1:3000 (0 20 40 60 80 100 m)

SCALE 1:500 (15 m, 10, 5, 0)

NOTES :
1-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project
Erbsville South Environmental Study
Erbsville Road and Wideman Road, Waterloo, Ontario

Title
CROSS SECTION A - A'

LVM inc.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
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Prepared	A.Higgins	Discipline	HYDROGEOLOGY	Project manager	R.Zapata
Drawn	A.Higgins	Scale	HS 1:3000; VS 1:500	Sequence no.	04 of 14
Checked	R.Zapata	Date	2014-01-30		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0002619-0-01-300	HD	004	0A

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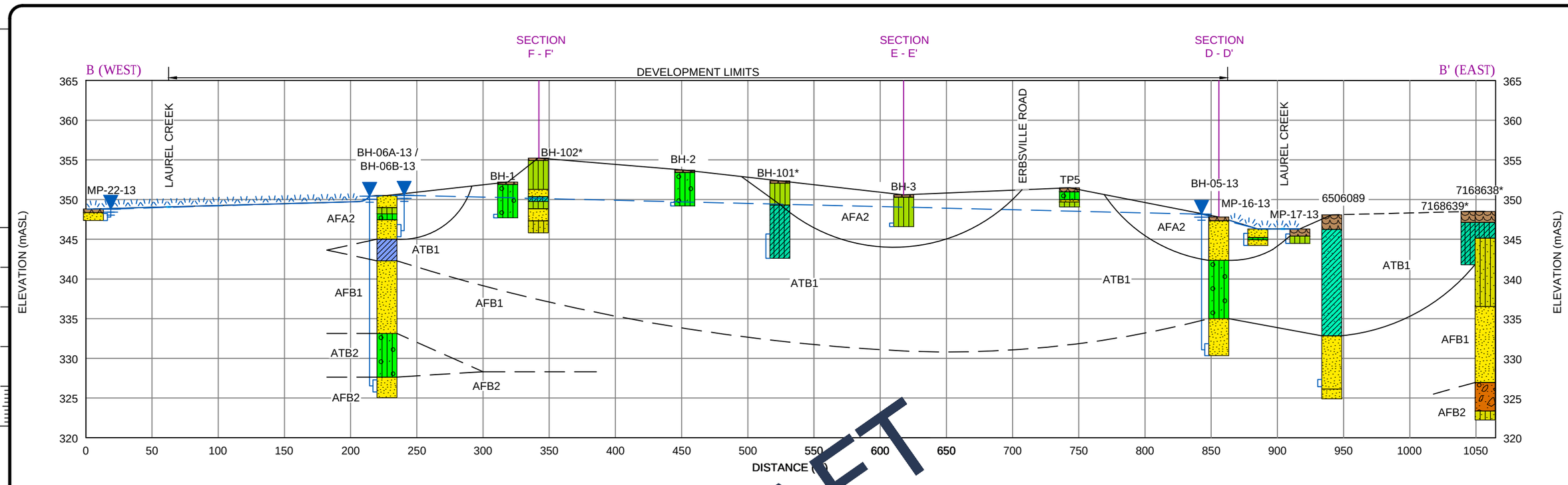

LEGEND :

- PAVEMENT
- FILL
- TOPSOIL
- PEAT
- GRAVEL
- SAND AND GRAVEL
- SAND
- SILT AND SAND
- SILT
- SILT TILL
- CLAY TILL
- CLAY AND SILT
- CLAY AND SAND
- CLAY AND GRAVEL
- CLAY
- HARDPAN
- BEDROCK
- SCREENED INTERVAL
- GROUNDWATER LEVEL
- * ELEVATION INFERRED

SCALE 1:3000 (0 20 40 60 80 100 m)

SCALE 1:500 (15 m, 10, 5, 0)

NOTES :
1-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project
Erbsville South Environmental Study
Erbsville Road and Wideman Road, Waterloo, Ontario

Title
CROSS SECTIONS B - B' AND C - C'

LVM inc.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
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Fax : 519.741.5422

Prepared	A.Higgins	Discipline	HYDROGEOLOGY
Drawn	A.Higgins	Scale	HS 1:3000; VS 1:500
Checked	R.Zapata	Date	2014-01-30

Project manager: R.Zapata
Sequence no.: 05 of 14

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0002619-0-01-300	HD	005	0A

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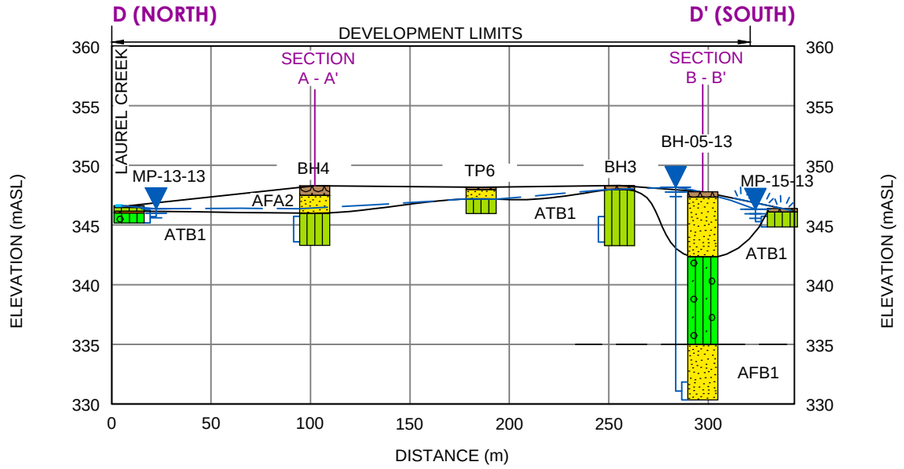

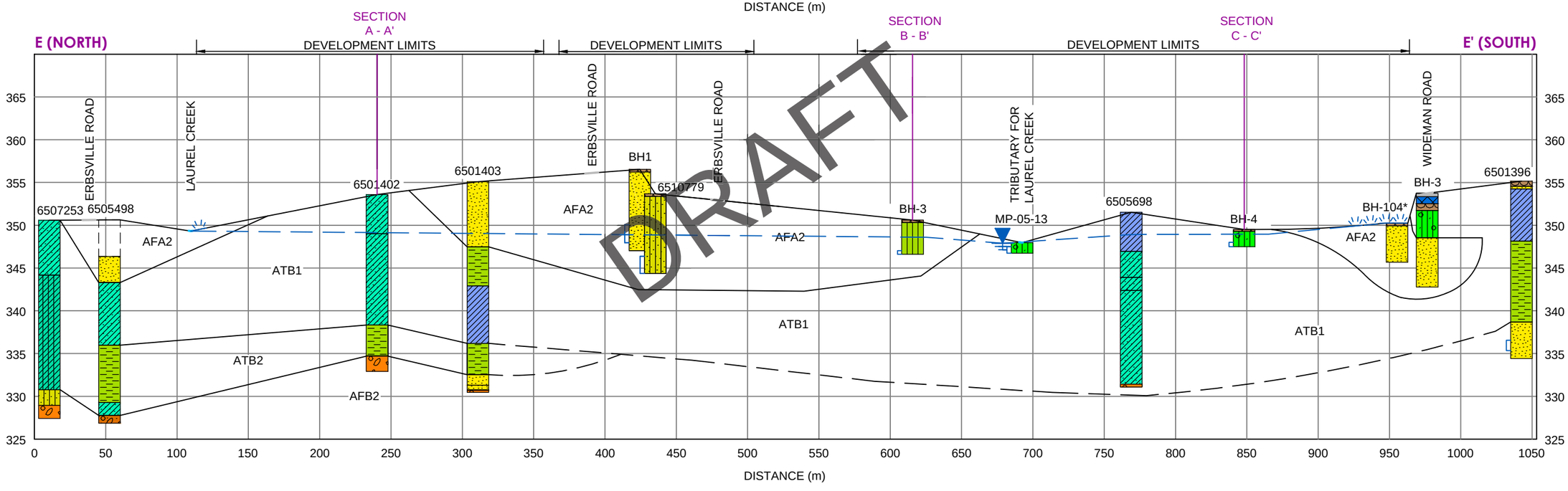

DRAFT

LEGEND :

- PAVEMENT
- FILL
- TOPSOIL
- PEAT
- GRAVEL
- SAND AND GRAVEL
- SAND
- SILT AND SAND
- SILT
- SILT TILL
- CLAY TILL
- CLAY AND SILT
- CLAY AND SAND
- CLAY AND GRAVEL
- CLAY
- HARDPAN
- BEDROCK
- SCREENED INTERVAL
- GROUNDWATER LEVEL
- * ELEVATION INFERRED

SCALE 1:3000 (0 20 40 60 80 100 m)

SCALE 1:500 (15 m, 10, 5, 0)

NOTES :
1-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project
Erbsville South Environmental Study
Erbsville Road and Wideman Road, Waterloo, Ontario

Title
CROSS SECTION D - D' AND E - E'

LVM inc.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	A.Higgins	Discipline	HYDROGEOLOGY
Drawn	A.Higgins	Scale	HS 1:3000; VS 1:500
Checked	R.Zapata	Date	2014-01-30

Project manager: R.Zapata
Sequence no.: 06 of 14

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0002619-0-01-300	HD	006	0A

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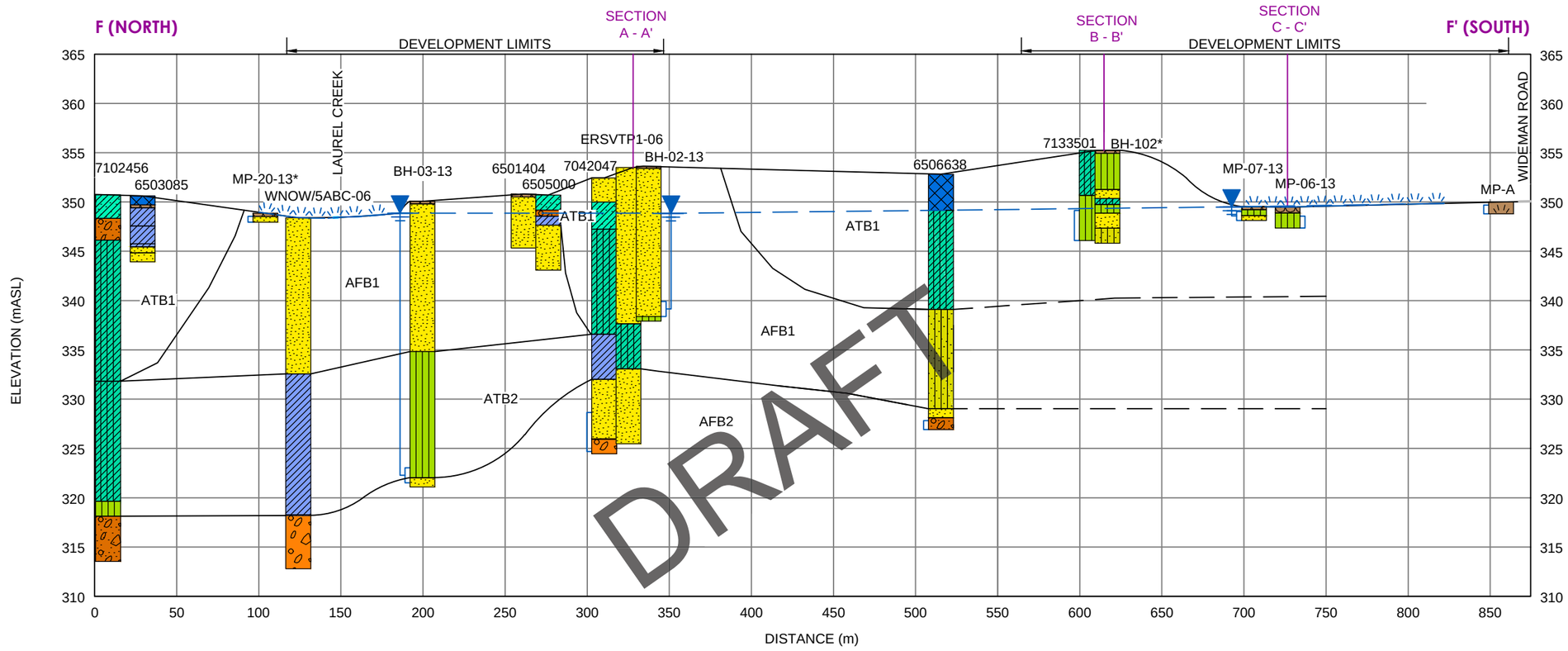

LEGEND :

- PAVEMENT
- FILL
- TOPSOIL
- PEAT
- GRAVEL
- SAND AND GRAVEL
- SAND
- SILT AND SAND
- SILT
- SILT TILL
- CLAY TILL
- CLAY AND SILT
- CLAY AND SAND
- CLAY AND GRAVEL
- CLAY
- HARDPAN
- BEDROCK
- SCREENED INTERVAL
- GROUNDWATER LEVEL
- * ELEVATION INFERRED

SCALE 1:3000 (0 20 40 60 80 100 m)

SCALE 1:500 (15 m, 10, 5, 0)

NOTES :
1-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project
Erbsville South Environmental Study
Erbsville Road and Wideman Road, Waterloo, Ontario

Title
CROSS SECTION F - F'

LVM inc.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	A.Higgins	Discipline	HYDROGEOLOGY	Project manager	R.Zapata
Drawn	A.Higgins	Scale	HS 1:3000; VS 1:500	Sequence no.	07 of 14
Checked	R.Zapata	Date	2014-01-30		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0002619-0-01-300	HD	007	0A

10 cm 0 1 2 3 4 5

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FIGURE 1

MEASURED GROUNDWATER LEVELS - All Wells

Erbsville South Environmental Assessment - Hydrogeology Study
Erbsville Road and Wideman Road
Waterloo, Ontario

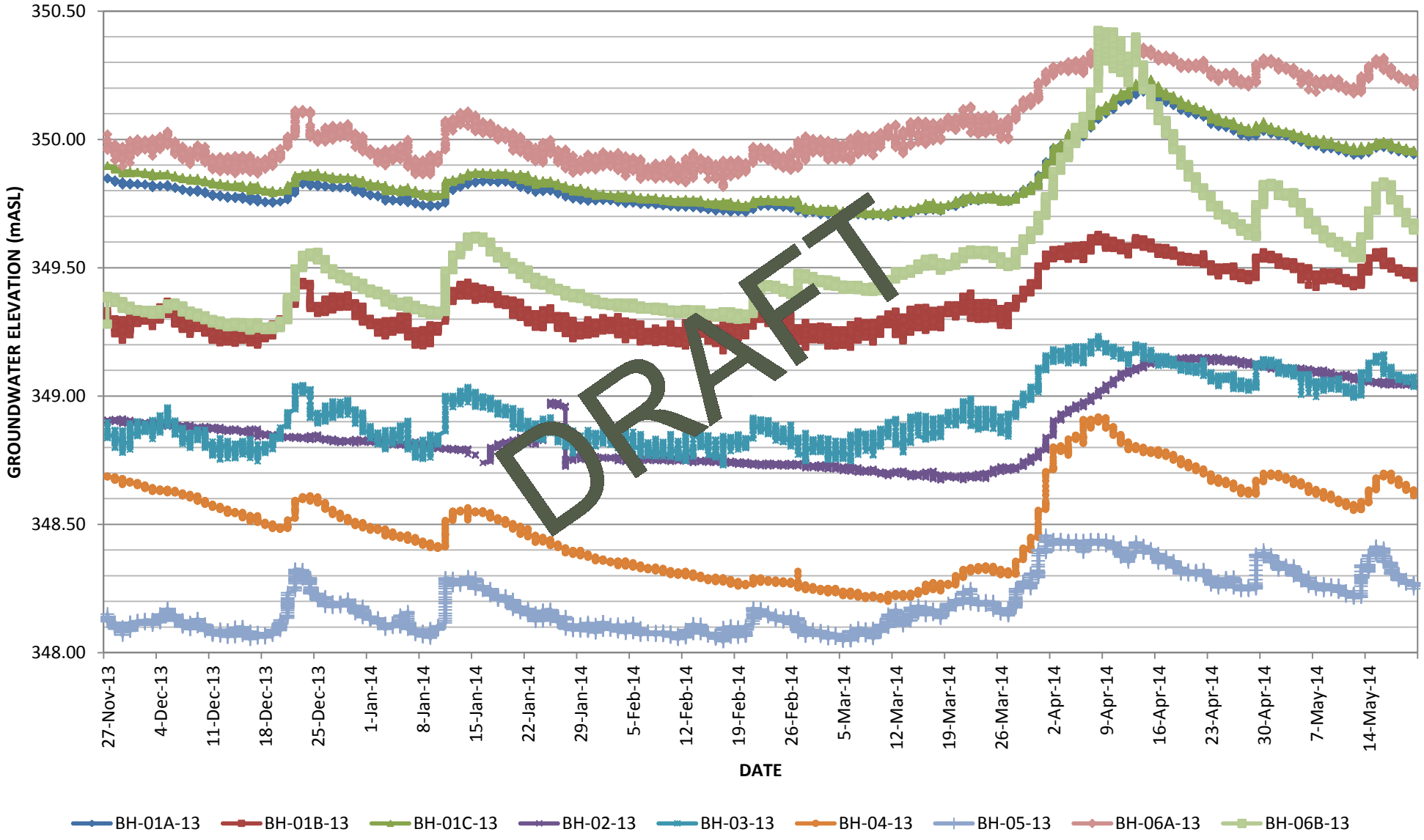

FIGURE 2

MEASURED GROUNDWATER LEVELS - Shallow Wells (AFB1)

Erbsville South Environmental Assessment - Hydrogeology Study
Erbsville Road and Wideman Road
Waterloo, Ontario

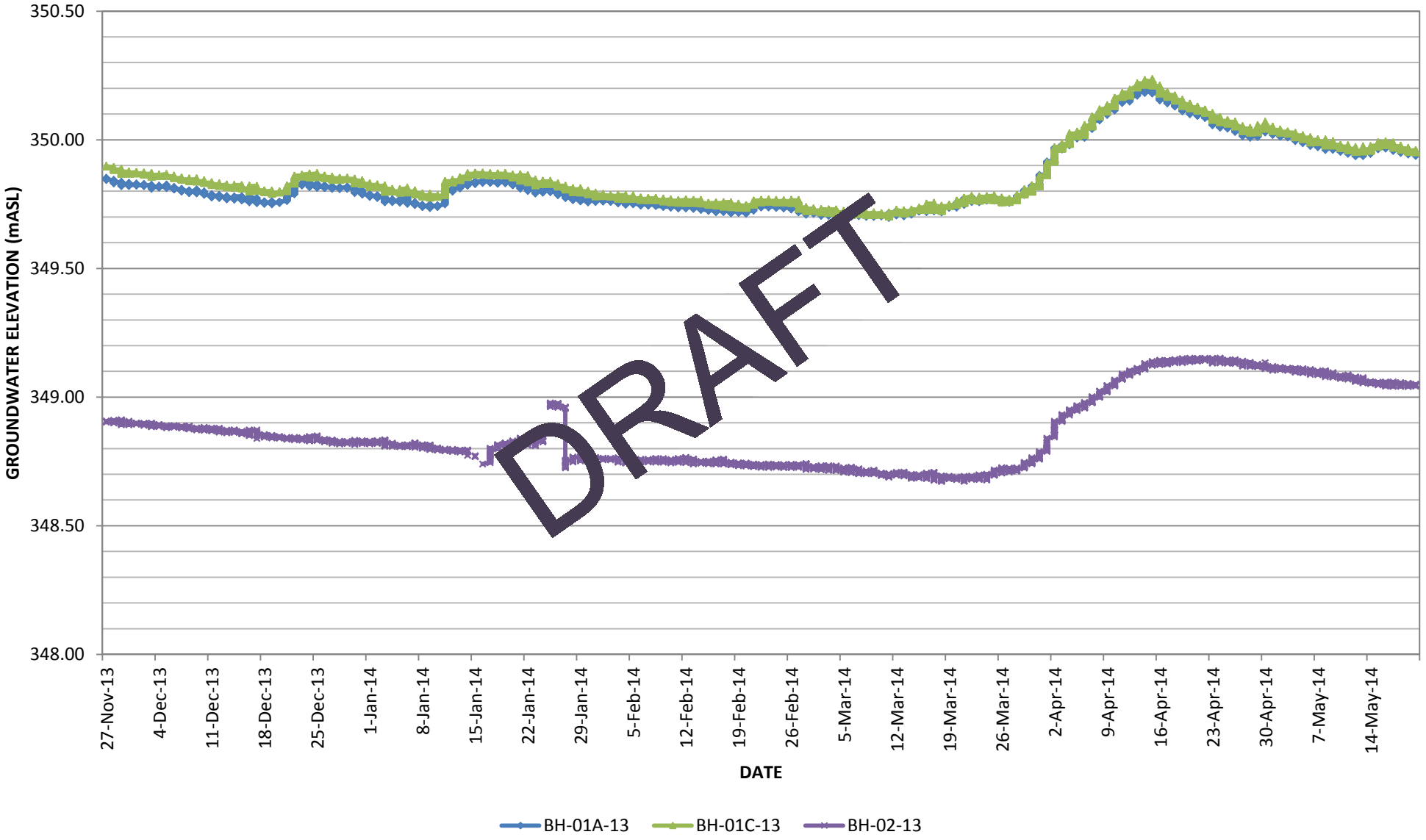

FIGURE 3

MEASURED GROUNDWATER LEVELS - Intermediate Wells (AFA2)

Erbsville South Environmental Assessment - Hydrogeology Study
Erbsville Road and Wideman Road
Waterloo, Ontario

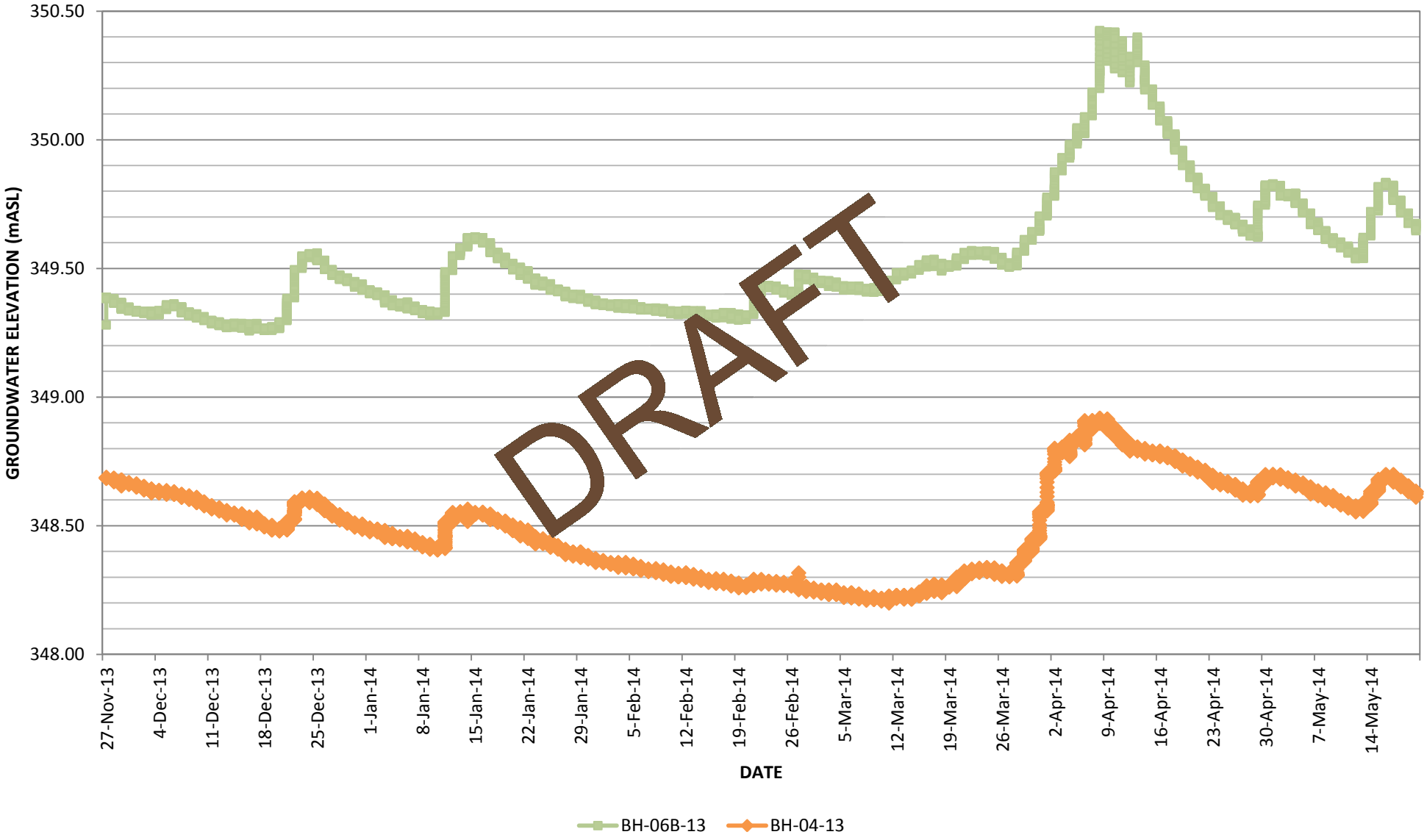

FIGURE 4

MEASURED GROUNDWATER LEVELS - Deep Wells (AFB2)

Erbsville South Environmental Assessment - Hydrogeology Study
Erbsville Road and Wideman Road
Waterloo, Ontario

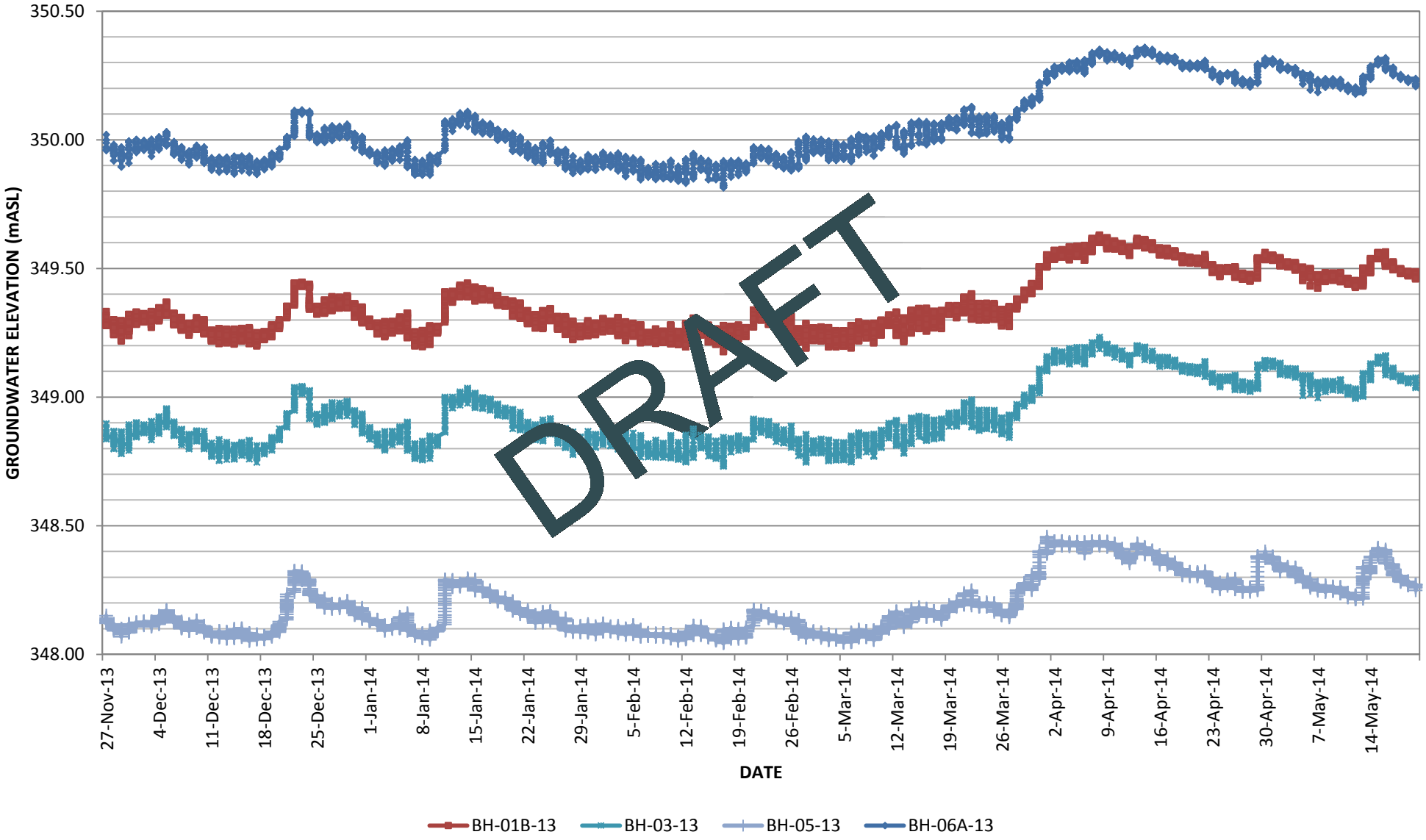

TABLE 101

MEASURED GROUNDWATER ELEVATIONS

Erbville South Environmental Assessment - Hydrogeology Study
Erbsville Road and Wideman Road
Waterloo, Ontario

Borehole Name	Ground Surface Elevation (mASL)	Top of Pipe Elevation (mASL)	Stickup (m)	27-Nov-13			27-Feb-14			20-May-14		
				Depth to WL (mBTOP)	WL Elev. (mBGS)	WL Elev. (mASL)	Depth to WL (mBTOP)	WL Elev. (mBGS)	WL Elev. (mASL)	Depth to WL (mBTOP)	WL Elev. (mBGS)	WL Elev. (mASL)
BH-01A-13	350.27	351.22	0.95	1.40	0.45	349.82	1.71	0.76	349.51	1.31	0.36	349.91
BH-01B-13	350.29	351.29	1.00	1.99	0.99	349.30	2.23	1.23	349.06	1.84	0.84	349.45
BH-01C-13	350.31	351.11	0.80	1.23	0.43	349.88	1.56	0.76	349.55	1.15	0.35	349.96
BH-02-13	353.62	354.37	0.75	5.52	4.77	348.85	5.92	5.17	348.45	5.42	4.67	348.95
BH-03-13	350.07	351.05	0.98	2.18	1.20	348.87	2.45	1.47	348.60	2.04	1.06	349.01
BH-04-13	350.92	351.63	0.71	3.00	2.29	348.63	3.60	2.89	348.03	3.04	2.33	348.59
BH-05-13	347.79	348.43	0.64	0.28	-0.36	348.15	0.18 (Ice)	Ice	Ice	0.16	-0.48	348.27
BH-06A-13	350.54	351.19	0.65	1.17	0.52	350.02	1.47	0.82	349.72	1.05	0.40	350.14
BH-06B-13	350.43	351.53	1.10	2.25	1.15	349.28	2.46	1.36	349.07	2.12	1.02	349.41
MP-01-13 IN	349.37	351.07	1.70	1.98	0.28	349.09	1.28 (Ice)	Ice	Ice	1.87	0.17	349.20
MP-01-13 OUT	349.37	351.07	1.70	Snow	Snow	Snow	Snow	Snow	Snow	1.70	0.00	349.37
MP-02-13 IN	349.18	350.94	1.76	1.72	-0.04	349.22	1.60 (Ice)	Ice	Ice	1.76	0.00	349.18
MP-02-13 OUT	349.18	350.94	1.76	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-03-13 IN	348.98	350.69	1.71	1.71	0.00	348.98	1.13 (Ice)	Ice	Ice	1.71	0.00	348.98
MP-03-13 OUT	348.98	350.69	1.71	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-04-13 IN	349.08	350.91	1.83	1.89	0.06	349.02	1.94	0.11	348.97	1.90	0.07	349.01
MP-04-13 OUT	349.08	350.91	1.83	Frozen Ground	Frozen Ground	Frozen Ground	Snow	Snow	Snow	1.83	0.00	349.08
MP-05-13 IN	347.96	349.80	1.84	1.91	0.07	347.89	1.90	0.06	347.90	1.92	0.08	347.88
MP-05-13 OUT	347.96	349.80	1.84	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-06-13 IN	349.49	350.42	0.93	0.91 (Ice)	Ice	Ice	0.60 (Ice)	Ice	Ice	0.93	0.00	349.49
MP-06-13 OUT	349.49	350.42	0.93	Frozen Ground	Frozen Ground	Frozen Ground	Snow	Snow	Snow	Dry	Dry	Dry
MP-07-13 IN	349.53	351.22	1.69	1.72	0.03	349.50	1.86	0.17	349.36	1.70	0.01	349.52
MP-07-13 OUT	349.53	351.22	1.69	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-08-13 IN	348.12	349.32	1.20	1.29	0.09	348.03	1.[illegible] (Ice)	Ice	Ice	1.32	0.12	348.00
MP-08-13 OUT	348.12	349.32	1.20	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-09-13 IN	348.28	349.30	1.02	1.30	0.28	[illegible]	[illegible]2 (Ice)	Ice	Ice	1.30	0.28	348.00
MP-09-13 OUT	348.28	349.30	1.02	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-10-13 IN	349.51	351.20	1.69	1.70	0.0[illegible]	3[illegible]	0.70	-0.99	350.50	1.72	0.03	349.48
MP-10-13 OUT	349.51	351.20	1.69	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-11-13 IN	349.49	351.29	1.80	1.84	0.04	34[illegible]45	1.29 (Ice)	Ice	Ice	1.83	0.03	349.46
MP-11-13 OUT	349.49	351.29	1.80	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-12-13 IN	348.78	350.59	1.81	1.85	[illegible]	[illegible]8.74	0.78 (Ice)	Ice	Ice	1.86	0.05	348.73
MP-12-13 OUT	348.78	350.59	1.81	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-13-13 IN	346.61	348.24	1.63	1.88	0.25	346.36	1.36 (Ice)	Ice	Ice	2.02	0.39	346.22
MP-13-13 OUT	346.61	348.24	1.63	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-14-13 IN	346.45	348.19	1.74	1.92	0.18	346.27	2.10 (Ice)	Ice	Ice	2.06	0.32	346.13
MP-14-13 OUT	346.45	348.19	1.74	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-15-13 IN	346.38	347.88	1.50	1.57	0.07	346.31	0.63 (Ice)	Ice	Ice	1.67	0.17	346.21
MP-15-13 OUT	346.38	347.88	1.50	Frozen Ground	Frozen Ground	Frozen Ground	Snow	Snow	Snow	Dry	Dry	Dry
MP-16-13 IN	346.29	348.13	1.84	1.77 (Ice)	Ice	Ice	1.92	0.08	346.21	1.89	0.05	346.24
MP-16-13 OUT	346.29	348.13	1.84	Frozen Ground	Frozen Ground	Frozen Ground	Snow	Snow	Snow	Dry	Dry	Dry
MP-17-13 IN	346.29	347.53	1.24	1.16 (Ice)	Ice	Ice	1.37	0.13	346.16	1.21	-0.03	346.32
MP-17-13 OUT	346.29	347.53	1.24	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-18-13 IN	346.70	348.18	1.48	1.88	0.40	346.30	2.08	0.60	346.10	1.95	0.47	346.23
MP-18-13 OUT	346.70	348.18	1.48	Frozen Ground	Frozen Ground	Frozen Ground	Snow	Snow	Snow	Dry	Dry	Dry
MP-19-13 IN	--	--	1.81	1.61	--	--	1.78	--	--	1.58	--	--
MP-19-13 OUT	--	--	1.81	Frozen Ground	Frozen Ground	Frozen Ground	Snow	Snow	Snow	Dry	Dry	Dry
MP-20-13 IN	--	--	2.12	2.14	--	--	2.20 (Ice)	Ice	Ice	2.17	--	--
MP-20-13 OUT	--	--	2.12	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-21-13 IN	347.90	349.50	1.60	1.76	0.16	347.74	2.00 (Ice)	Ice	Ice	1.75	0.15	347.75
MP-21-13 OUT	347.90	349.50	1.60	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-22-13 IN	348.81	350.38	1.57	1.58	0.01	348.80	1.23 (Ice)	Ice	Ice	1.64	0.07	348.74
MP-22-13 OUT	348.81	350.38	1.57	Frozen Ground	Frozen Ground	Frozen Ground	Snow	Snow	Snow	Dry	Dry	Dry
MP-23-13 IN	348.66	350.19	1.53	1.62	0.09	348.57	1.48 (Ice)	Ice	Ice	1.68	0.15	348.51
MP-23-13 OUT	348.66	350.19	1.53	Frozen Ground	Frozen Ground	Frozen Ground	Snow	Snow	Snow	Dry	Dry	Dry
MP-24-13 IN	348.40	349.90	1.50	1.47	-0.03	348.43	1.38 (Ice)	Ice	Ice	1.51	0.01	348.39
MP-24-13 OUT	348.40	349.90	1.50	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
MP-25-13 IN	348.68	350.18	1.50	1.52	0.02	348.66	1.43 (Ice)	Ice	Ice	1.56	0.06	348.62
MP-25-13 OUT	348.68	350.18	1.50	Snow	Snow	Snow	Snow	Snow	Snow	Dry	Dry	Dry
BH3	348.30	348.93	0.63	1.17	0.54	347.76	1.34	0.71	347.59	1.28	0.65	347.65
BH4	348.29	348.94	0.65	1.06	0.41	347.88	--	--	--	1.17	0.52	347.77
A090736	--	--	0.86	6.17	5.31	--	5.41	4.55	--	4.76	3.90	--
A090705	--	--	0.95	3.66	2.71	--	4.02	3.07	--	3.59	2.64	--

Notes:
1. mBTOP = meters below top of pipe
2. mBGS = meters below ground surface
3. mASL = meters above sea level
4. Highlighted text indicates water levels above ground surface.

TABLE 102

HYDRAULIC CONDUCTIVITY ESTIMATES

Erbsville South Environmental Assessment – Hydrogeology Study
Erbsville Road and Wideman Road
Waterloo, Ontario

Borehole Name / Location	Ground Surface Elevation (mASL)	Grain Size Analyses				
		Soil Description	Sampled Interval (mBGS)	Hydraulic Conductivity (m/sec)	Method	OGS Layer Name
BH-01A-13	350.27	Sand, some silt, trace clay	12.19-12.65	3.2×10^{-5}	Breyer	AFB1
BH-01B-13	350.29	Silty clayey sand, trace gravel	24.38-24.84	*	Kaubisch	AFB2
BH-01C-13	350.31	Sand, some silt and gravel, trace clay	0.76-1.22	8.6×10^{-6}	Kaubisch**	AFB1
BH-02-13	353.62	Silty sand, trace clay and gravel	1.52-1.98	*	Kozeny-Carman	AFB1
BH-03-13	350.07	Sand, trace silt	1.52-1.98	3.4×10^{-5}	Breyer	AFB1
BH-04-13	350.92	Sand, some silt, trace clay and gravel	9.14-9.60	3.4×10^{-5}	Breyer	AFA2
BH-05-13	347.79	Sandy silty gravel, trace clay	15.85-16.31	*	Kozeny-Carman	AFB1
	347.79	Sand, some silt	1.52-1.98	3.5×10^{-5}	Breyer	AFA2
BH-06A-13	350.54	Sand and silt, trace clay	0.76-1.52	1.8×10^{-5}	Kozeny-Carman	AFA2

Borehole Name / Location	Ground Surface Elevation (mASL)	Slug Tests				
		Soil Description	Screened Interval (mBGS)	Hydraulic Conductivity (m/sec)	Method	OGS Layer Name
BH-01A-13	350.27	Silty sand, trace gravel	12.19-13.72	2.0×10^{-5}	Falling Head	AFB1
BH-01B-13	350.29	Silty sand, trace gravel	24.38-25.91	3.4×10^{-5}	Rising Head	AFB2
BH-01C-13	350.31	Silty sand, trace gravel	3.05-4.57	1.0×10^{-5}	Rising Head	AFB1
BH-03-13	350.07	Sand, trace gravel and silt	26.97-28.50	1.7×10^{-4}	Falling Head	AFB2
BH-04-13	350.92	Silty sand	7.62-9.14	3.8×10^{-5}	Rising Head	AFA2
BH-05-13	347.79	Silty sand, some gravel	15.85-17.37	5.7×10^{-5}	Rising Head	AFB1
BH-06A-13	350.54	Sand, some silt and gravel	23.47-24.99	3.3×10^{-5}	Falling Head	AFA2
BH-06B-13	350.43	Silty sand	3.66-5.18	2.3×10^{-5}	Rising Head	AFB2

Notes:
1. mASL – metres Above Sea Level
2. * Could not calculate Hydraulic Conductivity as C_u outside range for formula or D_{10} value is too low
3. ** Deemed to be most realistic value although P <20%
4. -- Unable to complete slug testing due to outside factors